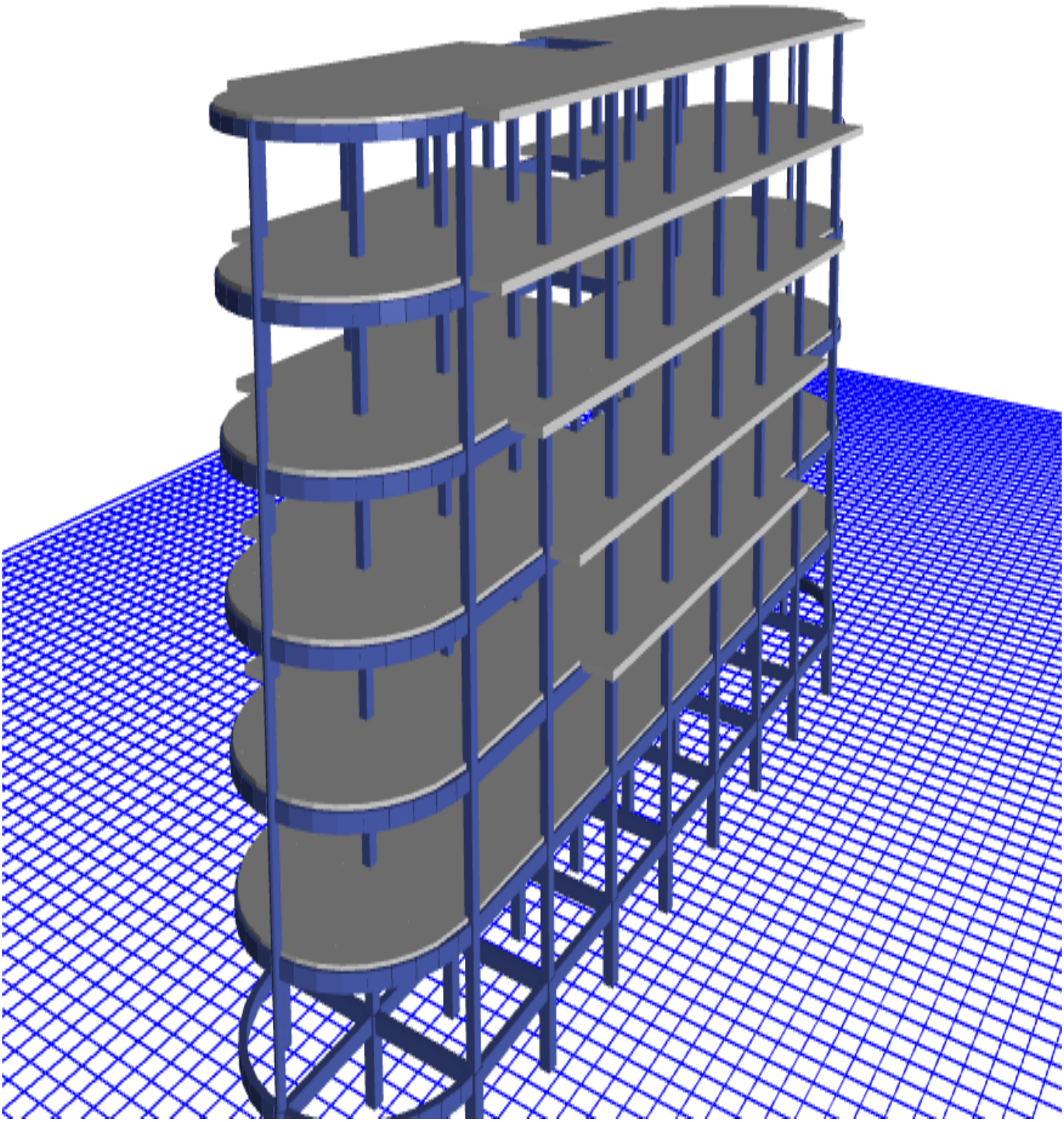


**Civil Engineering Department**

**Wolkite University, College of Engineering and Technology**

# Structural Design of B+G+4 Mixed Use Building In DireDawa



# Declaration

We declare that this project design entitled as Structural design of a B+G+4 Multi-purpose building which is located in Dire Dewa town is our own original work carried out at Wolkite University under the guidance of Instructor Ms. Bethliham A. and Mr. Yosfe G. during the whole project time.

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Firstly, our greatest thanks go to God for giving us the courage, strength as well as health throughout lifetime and for successful accomplishment of this project. Next, we would like to express our deepest gratitude and respect to our project advisor instructor Ms. Bethliham Amare and Mr. Yosfe Getachew. We want to thank them for their dedication and time devotion on guiding us how to proceed and for their uninterrupted advice during the progress of the project work. Our work could have been in vain in their absence. Their approach has built up our academic knowledge and strong desires for our future activities. We would also want to appreciate the efforts of our classmates to share their idea with us. In addition, we express our great thanks to all of all the people how had helped us to complete this project like civil engineering staff.

Finally, we would like to dedicate this project to our group members whose moral & material support kept us through up and downs of our academic life and to our families for their moral and material support.

## Executive summary

This project deals about the structural analysis and design of a B+G+4 Multi-purpose building considering all the external and internal effects that the building receives in its service year according to EBCS 2015. This project is located in Dire Dawa city at 1204m above sea level. This document contains proper design for each structural component and members of the building as follows;

The roof is flat RC roof. The design deals with analysis of the external forces that the roof is exposed. Then, checked for their strength against the applied wind, dead and live loads that they are subjected too.Our buildings floors are all constructed with a solid RC slab. We have designed the slab for serviceability and ultimate limit state. Therefore, we have selected a depth, which satisfies deflection requirement, provided flexural, and shear reinforcement.

The circulation system in our building is facilitated by a open wall stair type. It is designed by analyzing the stair for all loads it is subjected to through its service life and provided with adequate reinforcement.

The lateral load analysis includes both wind and earthquake load analysis. We have calculated the base shear and distributed to the frames according to their stiffness by finding the frame shears using the D-value method. Frame analysis was handle by using ETABS 2016 commercial software. After generating the analysis result, we designed beams and columns by assuming a preliminary cross sections and finally checking with respect to the maximum shear and flexural moments.

We have provided shear and flexural reinforcements. We have also designed a shear wall for the elevator. An isolated footing type is selected for our foundation. The design was made by taking the loads coming from the super structure through columns. The other structure that was needed for the building was a retaining wall as the basement faces a lateral earth pressure. Therefore, we have seen different types of retaining walls and recommended the suitable one.

Finally, we generated detail drawings for roof truss, slab reinforcement, beam reinforcement, column reinforcement and footing reinforcement as per the specification of Ethiopian Building code of Standards, EBCS 2015. Throughout the whole process, different software will be used such as:

- ✓ MS – office (word, excel,) and
- ✓ Analysis & design software (ETABS, SAFE & SAP)

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## Acronomys

A - Cross sectional area

Ac - Cross sectional area of concrete

As - Cross sectional area of reinforcement

As,min - minimum cross sectional area of reinforcement

Asw - Cross sectional area of shear reinforcement

Pd - Design value of an action

Fk - Characteristic value of an action

Gk - Characteristic permanent action

L - Length

M - Bending moment

MEd - Design value of the applied internal bending moment

N - Axial force

Ned - Design value of the applied axial force (tension or compression)

SLS - Serviceability limit state

ULS - Ultimate limit state

V - Shear force

VEd - Design value of the applied shear force

b - Overall width of a cross-section, or actual flange width in a T or L beam

bw - Width of the web on T, I or L beams

d - Diameter; Depth

d - Effective depth of a cross-section

dg - Largest nominal maximum aggregate size

e - Eccentricity

fc - Compressive strength of concrete

fcd - Design value of concrete compressive strength

fck - Characteristic compressive cylinder strength of concrete at 28 days

fcm - Mean value of concrete cylinder compressive strength

fctk - Characteristic axial tensile strength of concrete

fctm - Mean value of axial tensile strength of concrete

fy - Yield strength of reinforcement

fyd - Design yield strength of reinforcement

fyk - Characteristic yield strength of reinforcement

h - Height

h - Overall depth of a cross-section

l - (or l or L) Length; Span

m - Mass

r - Radius

t - Thickness

x - Neutral axis depth

x,y,z - Coordinates

$C_d$ - Dynamic coefficient

CDIR - Direction factor

$C_e$ - Exposure coefficient

$C_p$ - Pressure coefficient

$C_r$ - Roughness coefficient

$C_t$ - Topographic coefficient

Csea - seasonal coefficient

E - Modulus of elasticity

$E_c$ - Modulus of elasticity of concrete

$\varepsilon_c$ -Maximum compressive strain of concrete

ES EN - Ethiopian Standard based on Euro Norms

$E_s$ - Modulus of elasticity of steel

K - Equivalent roughness

KT - Terrain factor

$\lambda$ - Slenderness ratio

$\phi$ - Diameter of Reinforcement Bar

RC - Reinforced Concrete

Vm - Mean wind velocity

$\gamma$ - Unit Weight

Z -Height above the ground

$Z_{min}$ - Minimum height

$Z_o$ - Roughness length

$\gamma_c$ - Partial safety factor of concrete

$\gamma_s$ - Partial safety factor of steel

$\rho$ -Density

$W_e$ -external pressure

$C_{pe}$ - external pressure coefficient

$C_{pi}$ - internal pressure coefficient

$F_b$ - base shear

$L_y$ - long dimension

$L_x$ - short direction

$M_{ys}$ - support moment in the longer direction of panel

$M_{xs}$ - support moment in the shorter direction of panel

$M_{xf}$ - field moment in the shorter direction of the panel

$M_{yf}$ - field moment in the longer direction of panel

# CHAPTER-ONE

# INTRODUCTION

## 1.1. Project Back Ground and Technical Information

The aim of this thesis project is, to examine the structural design techniques used in the design of a building. Now a day's it has being practical to choose types of structural members for different criteria especially economy after assuring safety. This thesis project deals about the structural analysis and design of B+G+4 Multi-purpose building considering all the external effects according to ES EN 2015.

Building structures are solids, which are composed of architectural and structural parts. The structural part of the building supports the body of the building preventing it from any collapse or failure. Therefore, structural design involves the determination of the different sections of the skeletal part of the building to make it stable and sustainable throughout its design life.

A structural design is executed in such a way that the building will remain fit with appropriate degrees of reliability and in an economic way. It should sustain all the actions and influences during execution and use. Therefore, structural design focuses on structural safety and serviceability with due durability. It must also optimize the cost expended in building the structure and maintenance.

This structural design is executed based on the Ethiopian Standard based on Euro Norms (ES EN 2015). This code follows the Limit State design approach. Limit state is a state beyond which the structure no longer satisfies the design performance requirements.

The prime objective of design is structural safety and serviceability. In case the structure fails, it must be in such a way it will minimize risks and casualty. It must extend the time for evacuation of people inside a building. This requirement of structural design is accomplished by the principle called ductility. Ductility allows yielding of steel reinforcement prior to the collapse of the building. Yielding of steel bars warns the start of failure of a structure or its part.

The structural design of this building involves design flat roof slab, floor slabs, stairs, beams, columns, foundation and analysis of frames for lateral loads. The building is composed of solid slab for the floors.This structural design is executed based on the Ethiopian Standard based on Euro Norms (ES EN) prepared in 2015 G.C. This code follows the Limit State design approach. Limit state is a state

beyond which the structure no longer satisfies the design performance requirements. Its main concern is the safety of structure and people.

Serviceability Limit states are those associated to conditions beyond which a structure does not accomplish specified service requirements. It is mainly concerned about the function of construction works, comfort of people, and appearance. The design of any structure is categorized in to functional design and structural design. The intended building for this project is located in Dire Dawa town.

The town is placed under a category III and Seismic zone 3 according to ES EN 1998:2015. Hence, analysis for the wind load becomes vital and the building shall be wind pressure load resistant, which provides an adequate energy dissipation capacity to the structure without substantial reduction of its overall resistance against external and internal wind pressure. The overall design of a building includes design of roof, design of slab, design of beam, design of stair, design of column, frame analysis, and design of foundation. The analysis will be compute using applicable software ETAB 2016.

## 1.2. General description of the building

- Second to fourth floor are typical
- The height of foundation column is 2m.
- The height of building is 20.75m
- The thickness of slab is 200 mm for ground floor, 230mm for first, second third, fourth floor from calculated value.
- The roof type is flat roof.
- Building is located in Dire Dawa, which is seismic region zone 3, and it has 1204m altitude according to ES EN 1998:2015.
- The total area of the building is 599.28$m^2$.
- Our building is B+G+4 which have 6 story.
- Dire Dawa is Category III based on terrain category as set in ES EN 1991 Part 1.4:2015.
- Width and length of the buildings is 45.4m and 13.2m respectively taken from floor plan.

## 1.3. Objective

This thesis Project has wide objectives, which are based on knowledge. This thesis project has an objective:

- Getting basic structural design knowledge.
- Strengthen and accomplishment of different capacity of structural Analysis and design.

- Relating theoretical knowledge to the actual site condition.
- Development of new skills such as development of software and applying existing software.
- Using the courses that we took for required purpose.
- Integrating different disciplines.

### 1.3.1. General objective

The main objective of the project is to carry out a structural design and analysis of a B+G+4 mixed used building in dire dewa town.

### 1.3.2. Specific objective

It needs specific tasks to accomplish the structural design and analysis of our building such as;

- Structural Analysis and design Roof design
- Structural Analysis and design Floor slab design
- Structural Analysis and design Building circulation design
  - ✓ Stair case design
- Lateral load analysis
  - ✓ Wind load analysis
  - ✓ Earthquake load
- Frame analysis using ETABS & SAP
- Structural Analysis and design column
- Structural Analysis and design beam
- Structural Analysis and design Foundation design
- Structural Analysis and design Retaining wall
- Drawings Generating
- Architectural drawings
- Structural drawings

## 1.4. Basic structural components

All structures are composed of a number of inter-connected elements such as; slabs, beams, columns, walls and foundations. Collectively, they enable the internal and external loads acting on the structure to be safely transmitted down to the ground. The actual way that this is achieved is difficult to model and many simplifying, but conservative assumptions have to be made.

**A. Joints or Connections**

At the intersections of every building component occurs a joint. Joints range from the large scale of a building joining the ground to the beam-column connection and to the small scale of mortar joints bonding brick together in certain patterns in a masonry wall. The joint type is dependent on the location and position of adjacent members the main joint types are;

- Structural joints (e.g. load bearing & energy dissipating connections)
- Movement joints which includes soft joints (e.g. expansion joints, isolation joints)
- Control joints (e.g. slip joints, shrinkage strips)

**B. Beams**

Beams are linear members and they are distinguished in shape, cross sections material, Support conditions. The effect of load action (eccentric versus concentric) on beam behavior in response to member shape and profile may be in;

- Simple bending
- Biaxial bending, or
- Unsymmetrical bending
- Unsymmetrical bending

Beams, in general, must be checked for the primary structural determinant of bending, shear, deflection, possible load effect of bearing, and lateral stability.

Usually,

- Short beams are governed by shear,
- Medium-span beams by flexure, and
- Long span beams by deflection.

**C. Columns**

Columns support loads in compression. Where as hangers, ties, and thin brace do so in tension. They carried bending and axial compression where the bending can be more important than the axial load.

Columns are the primary components of skeleton structures. They may carry an entire building. It can be

- Short or long
- Slender or stocky

The cross section of columns may be varied (Sloped, curved, twisted, stepped, etc) and may have its thinnest part at mid-height or top and /or bottom in X or Y directions. Columns range from one-story to

multistory, from single column to groups (e.g. clustered pipe columns), from exterior to interior, from vertical to inclined columns, and so on. They may be separated from beams so that mainly axial forces are transferred, or they may be continuous with beams to form beam-columns.

Columns normally may not solely serve their function as support, according to engineering requirements, but also may define space and may provide visual order to a wall. They may also help to refine proportion and compositional considerations, or they may be more ornamental, expressing other layers of meaning than just function.

**D. Slab**

Slabs are plate elements forming floors & roofs in building which normally carry uniformly distributed loads. Slabs may be simply supported or continuous over one or more supports and are classified according to the method of support as follows.

1. Spanning one –way between beams or walls
2. Spanning two-way between the support beams or walls
3. Flat slabs carried on columns and edge beams or walls with no interior beams.

One-way slabs transmit their load in one direction. Two way slabs resist applied two directions. These types of slabs are composed of rectangular panels supported at all four edges by walls or beams stiff enough to be treated as unyielding.

**E. Foundation**

It is the part of the structure that is usually placed below the surface of the ground and that transmits the load to the underlying soil or rock. All Page All soils compress noticeably when loaded and causes the supported structure to settle.

The two essential requirements in the design of foundations are that the total settlement of the structure be limited to a tolerably small amount and the differential settlement of the various parts of the structure be eliminated as nearly as possible. The foundation is designed for an allowable soil pressure of 280kpa. It is the presumed value. During foundation construction designer will check it and further investigation must be carried out.

## 1.5. Methodology of design

The necessary quality control of the works in the supply of appropriate type of material, the methodology used for casting of concrete from proportioning of ingredients to curing of the concrete

mix, shaping and placing of reinforcement bars, etc. shall be strictly employed during construction in accordance with ES EN 2015.

For a given structural system, the design problem consists of the following steps:

1. Idealization of structure for analysis
   A. Dimension of members,
   B. Support condition of structure and etc.
2. Estimation of loadings
3. Analysis of idealized structural model to determine stress-resultants
   A. Axial forces,
   B. Shear forces,
   C. Torsions &
   D. Bending moments and their effects (deformations)
4. Design of structural elements (if assumed dimensions are adequate)
5. Detailed structural drawings and schedule of reinforcing bars

To achieve safe and economic structures, three philosophies of design had been adopted by codes of practices.

1. Working Stress Design (WSD) or Elastic Design Method
2. Ultimate Strength Design (USD) Method, and
3. Limit State Design (LSD) Method.

Over the years, various design method have evolved in different parts of the world, with regard to reinforced concrete design. A design method, is built up on a few fundamental premises, and is reflective of the way of thinking.

**1. Working stress method**

This was the traditional method of design not only for reinforced concrete, but also for structural steel and timber design. The conceptual basis of WSM is simple. The method basically assumes that the structure material behaves in a linear elastic manner, and that adequate safety can be ensured by suitably restricting the stress in the material induced by the expected 'working loads' on the structure. As the specified permissible (allowable) stresses are kept well below the materials strength (i.e., the linear phase of the stress-strain curve), the assumption of linear elastic behavior is considered justifiable.

**2. Ultimate load method (ULM)**

In this method, the stress condition at the state of impending collapse of the structure is analyzed, and the non-linear stress-strain curves of concrete and steel are made use of. The design stresses used are the ultimate strength of materials and for safety the loads are magnified or scaled up by load factors, defined as the ratio of the ultimate load to working load. The ultimate load method makes it possible for different types of loads to be assigned different load factors under loading conditions, thereby overcoming the related shortcoming of WSM.

**3. Limit states method (LSM)**

Unlike WSM, which based calculations on service load conditions alone, and unlike ULM, which based calculations on ultimate load condition alone, LSM aims for a comprehensive and rational solution to the design problem, by considering safety at ultimate loads and serviceability at working loads. When a structure or structural element becomes unfit for its intended use, it is said to have reached a limit state. The limit states for reinforced concrete structures can be divided into three basic groups.

**A. Ultimate limit state**

This involves a structural collapse of part or all of the structure. Such limit state should have a very low probability of occurrence, because it may lead to loss of life and major financial losses. The major ultimate limit states are loss of equilibrium of part or all of the structure as rigid body, rupture of critical parts of the structure, progressive collapse, formation of plastic mechanism, instability due to deformations of the structure, and fatigue.

**B. Serviceability limit states**

These involve disruption of the functional use of the structure, but no collapse occurs. Because there is less danger of loss of life, a higher probability of occurrence is generally tolerated than in case of an ultimate limit state. The major serviceability limit states include excessive deformations, excessive crack widths, and undesirable vibrations. Special limit states. This class of limit states involve damage or failure due to abnormal conditions or abnormal loadings and includes:

- Damage or collapse in extreme earthquakes,
- Structural effects of fire, explosions, or vehicular collisions,
- Structural effects of corrosion or deterioration, and
- Long-term physical or chemical instability (normally not a problem with concrete structures).

Among the three method of design, the limit state method of design (LSM) is the most widely used method of design in many countries building code standard. Our structural building is based on this method of design according to the revised Ethiopian building code standard ES EN 1992:2015adopted from the European building code standard except for typical flat slabs. Flat slab design in ES EN 1992:2015) is based on American concrete institute (ACI).

### 1.5.1. Method of design and design codes ES EN 2015

Serviceability limit state design was used for member size determination and the limit state design was used in the design of reinforcement. The codes used are:

- ES EN 1990 Ethiopian Building Code Standard 0: Basis of Structural Design
- ES EN 1991 Ethiopian Building Code Standard 1: Actions on structures
- ES EN 1992 Ethiopian Building Code Standard 2: Design of concrete structures
- ES EN 1997 Ethiopian Building Code Standard 7: Geotechnical design
- ES EN 1998 Ethiopian Building Code Standard 8: Design of structures for earthquake resistance

We are using Excel spreadsheet program to facilitate the routine computation in the analysis and design of the structural. To analyze and design a structure, it is necessary to establish criteria's or requirements for determining whether a given structure is acceptable for use in a specified circumstance or for use directly as a design objective that must be met. ES EN 1992:2015 gives the following basic requirements during design of reinforced concrete or any structure for that matter.

1. A structure shall be designed and executed un such a way that it will, during its intended life, with appropriate degree of reliability and in economical way sustain all actions and influences likely to occur during execution and use and remain fit for the use for which it is required (ES EN 1992:2015 section 2.1)
2. A structure shall be designed to have adequate structural resistance, serviceability, and durability (ES EN 1992:2015 section 2.1)
3. In the case of fire, the structural resistance shall be adequate for the required period of time (ES EN 1992:2015 section 2.1)
4. A structure shall be designed and executed in such a way that it will not be damaged by events such as explosion, impact, and the consequences of human errors, to an extent disproportionate to the original cause (ES EN 1992:2015 section 2.1)

5. Potential damage shall be avoided or limited by appropriate choice of one or more of the followings (ES EN 1992:2015 section 2.1)
   - Avoiding, eliminating or reducing the hazards to which a structure can be subjected;
   - Selecting a structural form which has low sensitivity to the hazards considered;
   - Selecting a structural form and design that can survive adequately the accidental removal of an individual or limited part of structure, or occurrence of acceptable localized damage;
   - Avoiding as far as possible structural systems that can collapse without warning;
   - Tying the structural member together.

According to ES EN 1992:2015 section 2.1) the basic design criteria's or requirements listed above should be met by the choice of suitable material, by appropriate design and detailing, and by specifying control procedures for design, production, execution, and use relevant to particular project.

### 1.5.2. Loading

In addition to the gravity loads, which are dead load and live load, Earthquake load on the Global -X and Global -Y directions are considered as per the ES EN 1998:2015 as well as wind load as per the ES EN 1991 Part 1.4:2015.The Critical load combinations are used for designing the Elements (Beams, Column and Foundation).

**Partial safety factors for load**

- 1.35 for dead load
- 1.50 for live load

### 1.5.3. Basic Assumption

The assumptions here under are considered in order to provide necessary safety acceptable degree of reliability as well as economy of the building.

### 1.5.4. Modelling

Reinforced concrete for beam, column, shear wall, and framed structures with isolated footing foundation were used as the structural system of the building to resist all actions.

### 1.5.5. Software

ETABS 2016 is used for analysis and designing the beams modelling the whole building as a 3D space frame. Final year thesis project on structural design of A B+G+4 multi-Purpose building in Wolkite university, collage of engineering and technology, department of civil engineering.

## 1.6. Design Data and Material Property specification we have considered

The Building is Multi-Purpose building and it has the following material property.

- **Material**
  - ✓ Concrete**:** Class I workmanship.
  - ✓ Grade of concrete we used C-25(super-structure) and C-30(sub-structure).
  - ✓ Unit weight of concrete, ϒc = 25KN/$m^3$
  - ✓ Partial Safety factor for ordinary loading γc=1.5…...EBCS-2, 2015 Table 2.1N (Page 20).
- **Design strength value**

**i. Design strength of concrete(fcd)**

✓ **In compression**

$$fcd = 0.85 * \frac{fck}{\gamma c}$$ …….EBCS-2, 2015 Page 20.

Where: fck - Characteristic of compressive strength of concrete.

γc - Partial Safety factor for ordinary loading=1.5.

**Characteristic of compressive strength of concrete (fck)**

For C-25 fck =0.8*25Mpa=20Mpa or from EBCS-2, 2015 Table 3.1 (Page 25).

$$fcd = 0.85 * \frac{20}{1.5} =$$ **11.33 Mpa**

✓ **In tension**

$$fctd = \frac{fctk}{\gamma c}$$…….EBCS-2, 2015 Page 20

Where: fctd - Design of tensile strength of concrete.

fctk - Characteristic tensile strength of concrete.

γc - Partial Safety factor for ordinary loading=1.5.

**Characteristic of tensile strength of concrete(fctk),**

fctk =0.7*fctm……..EBCS-2, 2015 Page 25

Where: fctm -Characteristiccylinder compressive strength.

**Characteristic cylinder compressive strength(fctm),**

$fctm = 0.3*(fck)^{2/3}$……..EBCS-2, 2015 Table 3.1 (Page 25)

Where: fck - Characteristic compressive strength of concrete=20Mpa.

$fctm = 0.3*(20)^{2/3} = 0.3(20)^{2/3} =$ **2.2104Mpa**

$fctk = 0.7*(fctm)^{2/3} = 0.7(2.2104)^{2/3} =$ **1.547Mpa**

Then, fctd = $\frac{1.547}{1.5}$Mpa= **1.03 Mpa**

**ii. Design strength of steel(fyd)**

$$fyd = \frac{fyk}{\Upsilon s}$$

Where: fyk - Grade of steel, S-500 EBCS-2, 2015 (page 35)

γs-Reinforcing steel factor =1.15 Mpa for ordinary loading and class I work….EBCS-2, 1995 Table 3.1 (Page 22)

Then, fyd $= \frac{fyk}{\gamma s} = \frac{500}{1.15} =$ **434.78Mpa**

- ✓ Secant modulus of elasticity (Ecm)= 30Gpa….EBCS-2, 2015 Table 3.1 (Page25)
- ✓ Modulus of elasticity (Es)= 200Gpa….EBCS-2, 2015 (Page37)

## 1.7. Design method and reference

- Method (Approach) = Limit state design method
- References (Code) = ES EN (Ethiopian Standard based on Euro Norms)

Euro Code nowadays is being practiced in most countries around the world and Ethiopia is one of those countries who has shown interest in adopting the Euro Code.

**The codes serve at least four distinct functions:**

- Ensure adequate structural safety, by specifying certain essential minimum requirements for design.
- Render the task of the designer relatively simple; often, the results of sophisticated analyses are made available in the form of a simple formula or chart.
- Ensure a measure of consistency among different designers.
- Have some legal validity, in that they protect the structural designer from any liability due to structural failures that are caused by inadequate supervision and/or faulty material and construction.

## 1.8. Architectural drawings

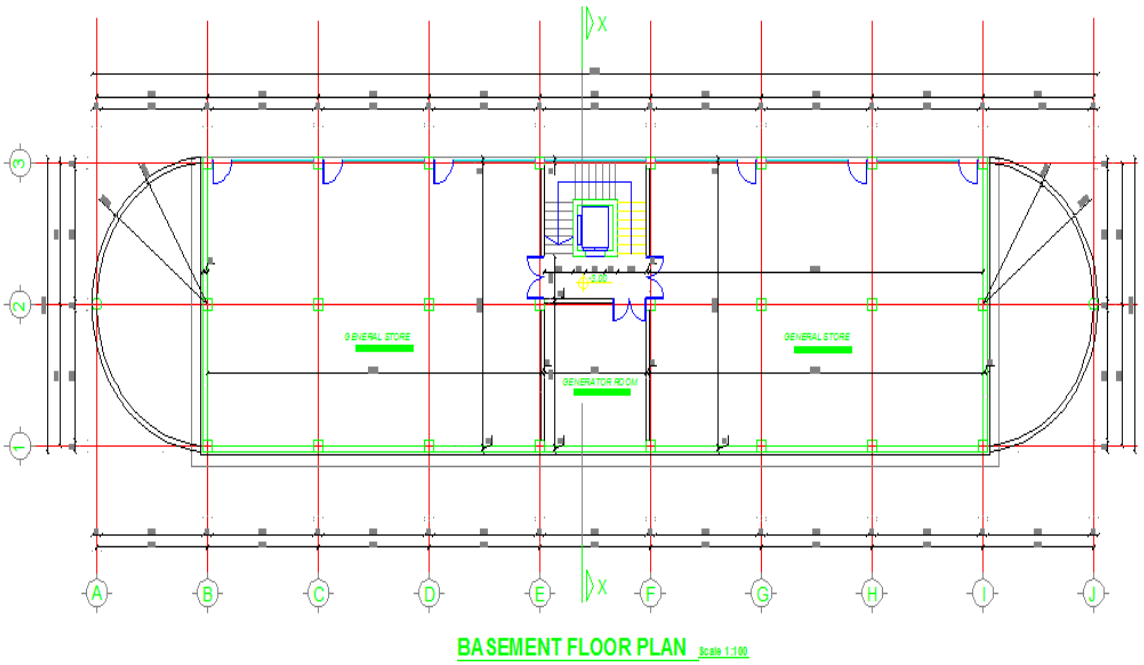



Figure 1. 1: Basement floor plan

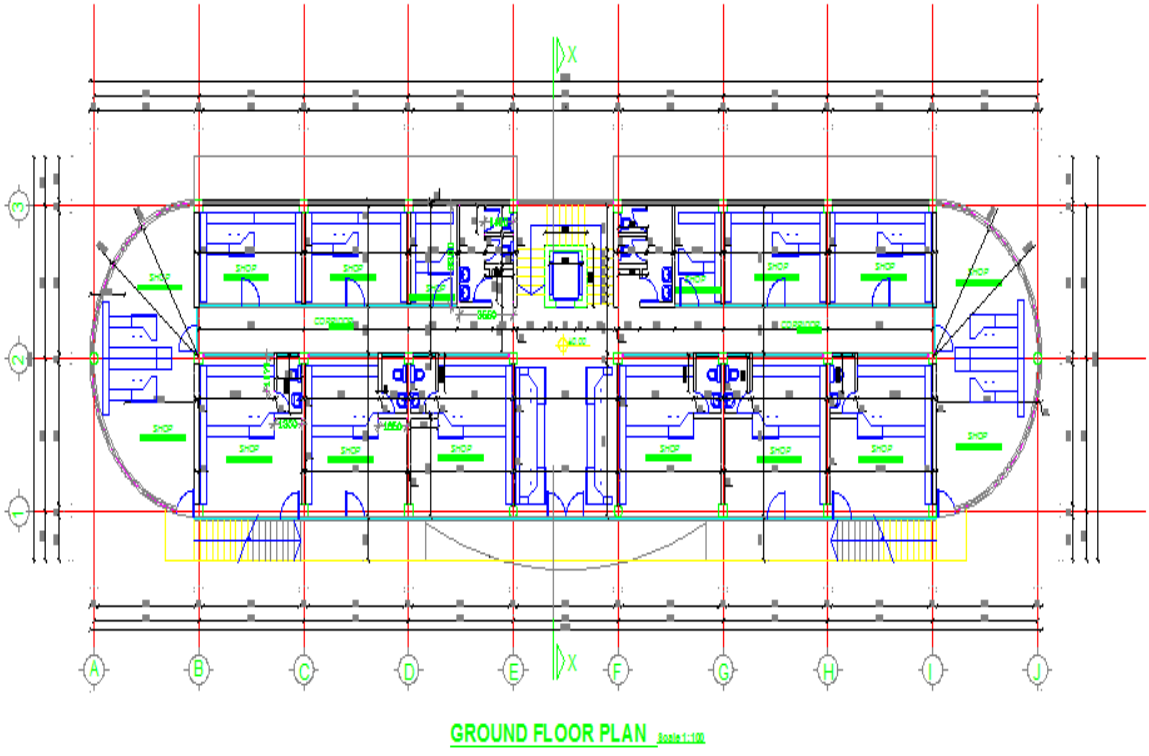



Figure 1. 2: Ground floor plan

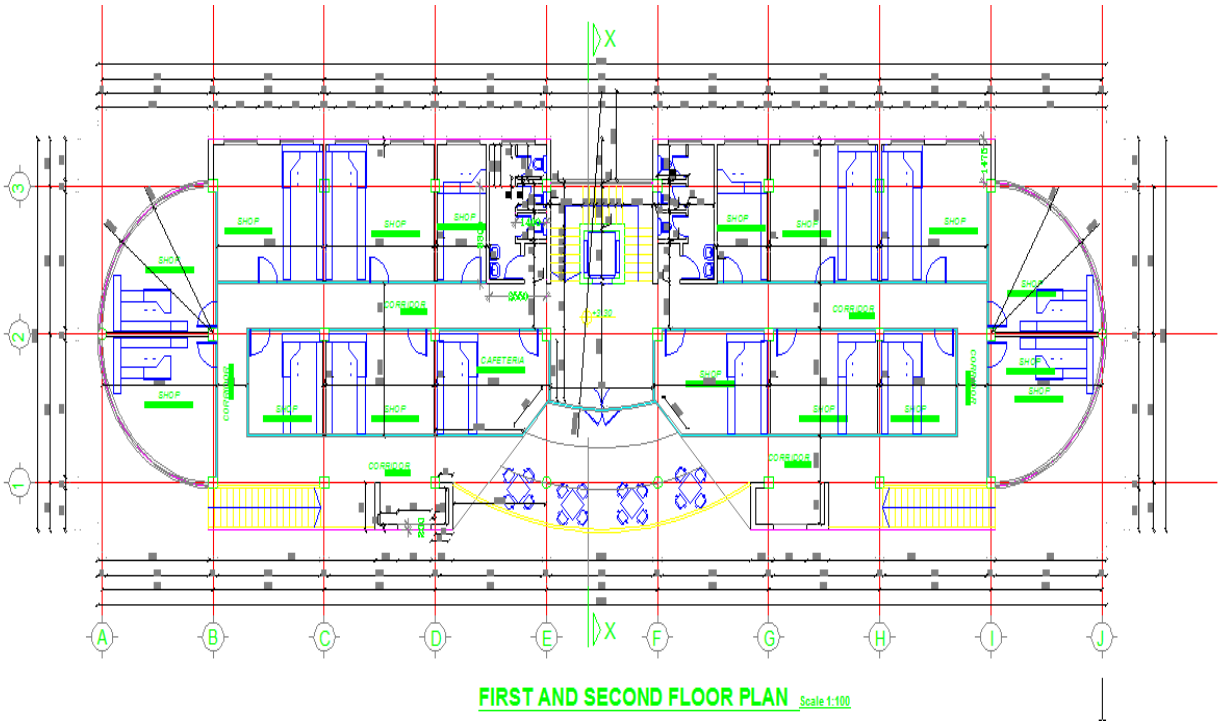



Figure 1. 3: First floor plan and second floor plan

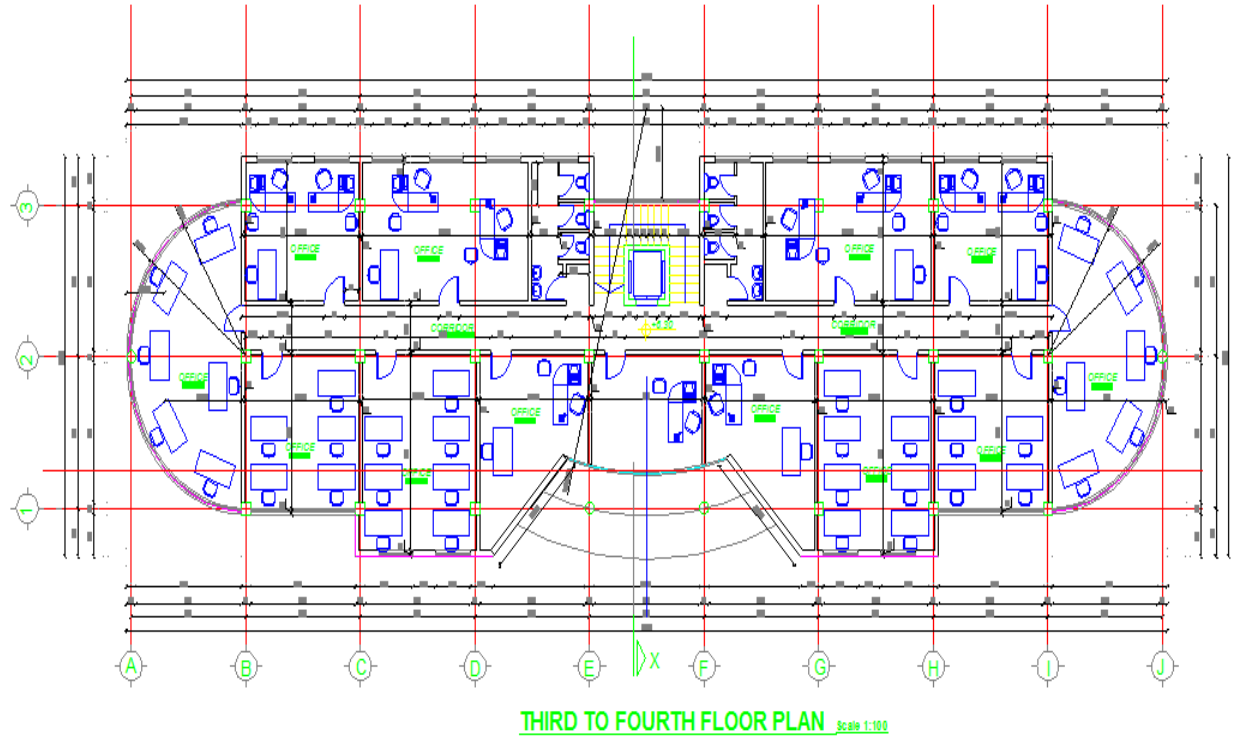



Figure 1. 4: Third and Fourth floor plan

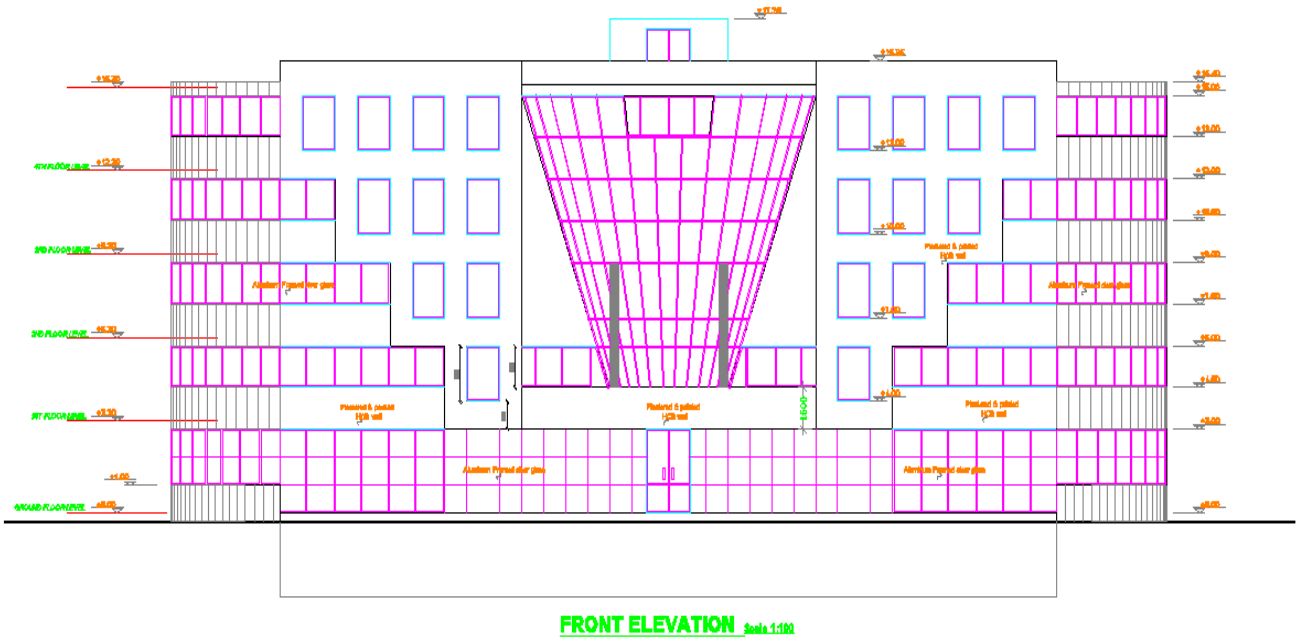



Figure 1. 5: Front Elevation plan

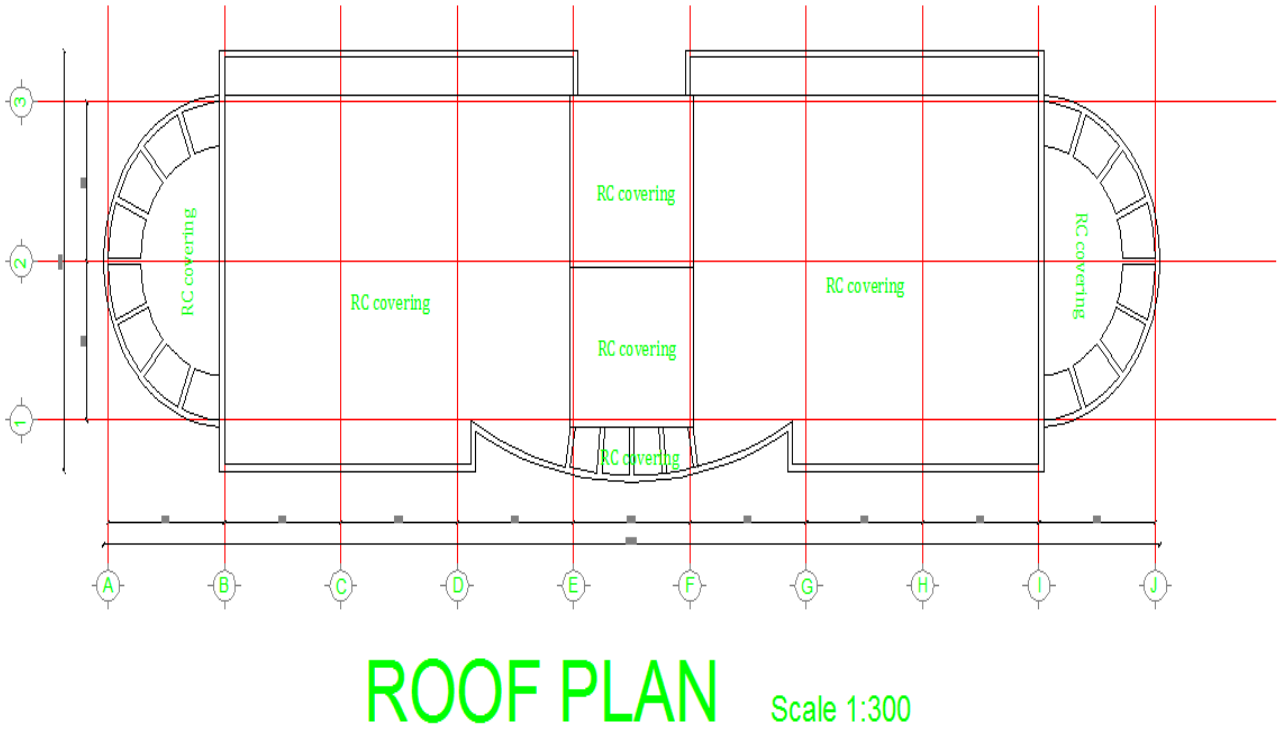



Figure 1. 6: Roof floor plan

# CHAPTER-TWO

# WIND LOAD ANALYSIS ON THE ROOF FLOOR

## 2.1. Structural Analysis of Roof

Roof is the upper part of a building that protects from any kind of weather. It is subjected to different kinds of loads such as wind load, its own self-weight, and the loads of the persons who go on the roof for maintenance and snow loads too. Most type of roof consists of network of frames of wood or steel and covering materials.

A roof consists of the following:

- Roof cover – prevents any kind of weather disturbance & serves as a protecting sheet for the building.

In our case, it is concrete covering roof. Therefore, the roof design comprises determination of different loadings acting on the roof, checking whether the roof cover can carry those loads or not, choosing the appropriate effective depth and determining its dimension and designing of the roof cover.

## 2.2. Wind Load Analysis on the surface of the roof floor

Wind forces are variable loads, which act directly on the internal and external surface of structures.The intensity of wind load on a structure is related to the square of the wind velocity and thedimensions of the members that are resisting the wind (frontal area). Wind produces dynamic loads on a structure at highly variable magnitudes. The variation in pressures at different locations on a building is complex to the point that pressures may become too analytically intensive for precise consideration in design.

To simplify the complexity in analysis of wind load different codes provides specifications for wind load by considering basic static pressure zones on a buildings representative of peak loads that are likely to be experienced. Wind forces act directly or indirectly on the internal and external surface of structures. Wind loads fluctuate with time. A wind load produces static, dynamic and aerodynamic effects on structures. Analysis of wind load Wind loads is dynamic loads and there are two methods of analysis of dynamic loads.

1. **Quasi- Static method**

This is applied to stiff structures in which the movement of the structure with wind is negligible.

2. **Dynamic analysis**

In which the movement of structures with wind loads in considered.

The choice of the two procedures is based on the height of the building and the dynamic coefficient, Cd .Static method or the simplest method of wind load analysis issued for buildings and chimneys less than 200m tall provided that the value of dynamic coefficient. In all other cases the detailed analysis considers the dynamic effect of the load namely dynamic analysis should be applied.

**The effect of wind load on the structure depends on many factors such as:**

- Wind velocity is direction and on geographical location,
- Terrain category
- The height of the structure and Shape of the structure,
- The topography of the area, and
- The roughness of the surrounding terrain.

**Analysis Information**

The building under consideration has the following properties: -

- The height of building above the ground level is 17.75m including slab thickness.
- The building roof is Flat roof from the given.
- Building is located in Dire DewaTown, which is seismic region 3.
- Dire dewa is Category III based on terrain category as set in ES EN.
- Dire DewaTown altitude is 1204m above sea level.
- Width and length of the buildings is 45.4m and 13.2m respectively taken from floor plan.
- Height of parapet of the roof=0.8m
- Thickness of RC solid slab=200mm
- Thickness of cement screed=30mm
- Thickness of Plastering Cielling=20mm

### 2.2.1. Types of loads Acting on roof surface

Dead load, live load and wind loads on panels were converted to equivalent uniformly distributed loads. All loads are calculated depending on the service of the roof slabs and self weight. The design loads are factored according to the following formula.

- Pd = 1.35LL+1.5LL+0.9WL

Where: Pd - design load

DL - total dead load on slab

LL - total live load on slab

WL - total wind load on slab

**i. Live load**

The live load of the roof is determined by assuming the roof is not accessible except for normal maintenance, repair, painting & minor repairs. So it is categorized in Category of H according to EBCS-1, 1995 (Page 49). Therefore, the recommended value as it is set by the National Annex is Live load from code qk = 0.4KN/$m^2$ uniformly distributed load or Qk =1KN concentrated load (as our roof is flat).

ii. **Dead load(DL)**

Usually the major part of the dead load is the weight of the structure itself. It will comprise the forces due to the static weights of the structure as well as attachment to the structures.

**iii. Wind load (W.L)**

Action of the wind loads on structures is represented either as a wind pressure or as a wind force. The action of wind pressure on a structure is assumed to act normal to the surface except otherwise specified; e.g. for tangential friction forces. Wind pressure on the structure may be external wind pressure or internal wind pressure. The magnitude of the wind load depends on the roof shape, wind direction and location of the building. Appropriate fasteners and holding down bolts or anchors must be used.

**A. External wind pressure (We )**

It is the wind pressure acting on the external surfaces of a structure.

**B. Internal wind pressure(Wi)**

It is the wind pressure acting on the internal surfaces of a structure.

- Wind load = $q_p(Z)C_P$
  - ✓ Wnet = We-Wi = $q_p(Z)C_P e - q_p(Z)C_P i$
  - ✓ Wnet = $q_p(Z)(C_{Pe} - C_{Pi})$

Where Wnet: - Net wind pressure load

We: - External wind Pressure

Wi: - Internal wind Pressure

$q_p(Z)$: - is the Peck velocity Pressure

Cpe: - is the external pressure coefficient

Cpi:-is the internal pressure coefficient

### 2.2.2. External wind Pressure on the roof floor

The wind pressure acting on the external surface of a structure is function of the peck velocity Pressure In order to determine the contact pressure on the outside of a structure or part of a structure, the peck velocity Pressure, $q_p$ of the wind must be multiplied by an external pressure coefficient. The external pressure coefficient is accounts for the variation in dynamic pressure on different zones of the structure due to its geometry, area and proximity to other structures. Since our roof is flat roof.

- $W_{ex}=q_p(Z)C_{Pe}$……EBCS-1, 2015

Where: $q_p(Z)$ - is the Peck velocity Pressure

Cpe - is the external pressure coefficient

**Determination of $q_p(Z)$ =Peck velocity Pressure**

- $q_p(Z)= [1 + 7I_v(z)]*0.5* \rho_{air} * V^2_m(z)$

Where: $I_v(z)$ - Turbulence intensity

$\rho$air - Air density

$V_m(z)$ -Mean wind velocity

**A. Turbulence intensity($I_v(z)$)**

- $I_v(z)= \frac{\sigma v}{V_m(Z)}$ for Zmin < Z < Zmax
- $I_v(z)= I_v(Zmin)$ for Z < Zmax

Where:- $V_m(z)$ -Mean wind velocity

$\sigma v -$ Standard deviation of Turbulence

**B. Mean wind velocity $V_m(z)$**

- $V_m(z) = C_r(Z)C_o(Z)\, V_b$

Where: $C_r(Z)$-Roughness factor

$C_o(Z)$- Terrian Topography

$V_b$-basic wind velocity

**C. Standard deviation of Turbulence ($\sigma v$)**

- $\sigma v=K_r V_b K_1$

Where, $K_r$-Terrian factor

$K_1$-Turbulence Factor

$V_b$-basic wind velocity

**D. Basic wind velocity($V_b$)**

The basic wind velocity is defined as a function of wind direction and time of year at 10m above ground of terrain category III.

- $V_b = C_{dir} C_{season} V_{b,o}$

  Where, $C_{dir}$ =Directional factor =1.0

  $C_{season}$ =Seasonal factor =1.0

  $V_{b,o}$=Fundamental value of basic wind velocity =22 m/s

- Therefore, $V_b = C_{dir} C_{season} V_{b,o}$=1*1*22m/s=**22m/s**

**E. Roughness factor ($C_r(Z)$)**

The roughness coefficient Cr (z), accounts for the variability of mean wind velocity due to the height of the structure above ground level and the roughness of the terrain. It is defined by the logarithmic relationship:

- $C_r(Z) = K_r \ln(\frac{Z}{Zo})$, for $Zmin \leq Z \leq Zmax$
- $C_r(Z) = C_r * (Zmin)$, for $Z < Zmin$

Where: $Z_o$-Roughness length

$K_r$- Terrain factor depending on the roughness length $Z_0$ calculated using $K_r = 0.19(\frac{Z_o}{Z_{o,II}})^{0.07}$ ,

$Z_{o,II}$-Roughness length for category III=0.05m

Zmin- Minimum height defined in Table 2.3

Zmax-Maxmum height =200m unless otherwise specified in the National Annex.

Z0, Zmin depend on the terrain category. Recommended values are given in Table 2.3 depending on five representative terrain categories.

Table 2. 1: Terrain Categories and Related Parameters

| Category | Terrain classification | Zo(m) | Zmin |
|---|---|---|---|
| 0 | Sea or coastal area exposed to the open sea | 0.003 | 1 |
| I | Lakes or flat and horizontal area with negligible vegetation and without obstacles | 0.01 | 2 |
| II | Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle height | 0.05 | 4 |
| III | Area with regular cover of vegetation or buildings or with Isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest) | 0.3 | 5 |

| | | | |
|---|---|---|---|
| IV | Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m | 1 | 10 |

**F. Terrian orography ($C_o(Z)$)**

Where orography (E.g. hills, cliffs etc.…) increases wind velocity by more than 5%, the effects should be taken into account using the orography factor coefficient.The effects of orography may be neglected when the average slope of the upwind terrain is less than 3%. The upwind terrain may be considered up to a distance of 10 times the height of the isolated topographic feature. Is accounts for increase of mean wind speed over isolated hills and escarpment (not undulating and mountains regions). It is related to the wind velocity at the base of the hill or escarpment. It shall be considered for location within the topography affected zone. Based on EBCS-1, 2015 Art 3.8.4 (Page 58) defined by

$Ct(z) = 1$ for $\Phi < 0.05$

$Ct(z) = 1 + 2s\Phi$ for $0.05 < \Phi$ 0.3

$Ct(z) = 1 + 0.6s$ for $\Phi > 0.3$

Where: Φ - is the up wind slope H/Lu in the wind direction.

H - is the effective height of the feature.

Lu - is the actual length of upwind slope in the wind direction.

X - is the horizontal distance of the site from the top of the crest.

S -is the factor to be obtained by interpolation from the values of s = 1 at crest of hills, ridge or escarpment and the values of S = 0 at boundary of topography affected zone.Interpolation shall be linear with horizontal distance from crest and with height above the local ground level.

**G. Air density**

Is affected by altitude and depends on the temperature and pressure to be expected in the region during windstorms. This is donated by ρair in kg/m3. A temperature of 20˚C has been selected as appropriate for Ethiopia and the variation of mean atmospheric pressure with altitude is given in table 3.1 of EBCS 1,2015 as below.

Table 2. 2: Air density and its altitude (m) above sea level.

| Site altitude above sea level (m) | Air density ($kg/m^3$) |
|---|---|
| 0 | 1.20 |
| 500 | 1.12 |
| 1000 | 1.06 |

| | |
|---|---|
| 1500 | 1.00 |
| 2000 | 0.94 |

### 2.2.3. Internal Wind Pressure

The internal wind pressure is the pressure found inside the house due to opening of windows and door.

- Wi = $q_p$(Zi) ·Cpi

where: $q_p$(Zi) is the peak velocity pressure

Zi is the reference height for the internal pressure

Cpi is the pressure coefficient for the internal pressure

The value $q_p$(Zi) is calculated above and there is no need to calculate it again.

### 2.2.4. Wind pressure coefficient

1. **External wind pressure coefficient**

External pressure coefficients give the effect of the wind on the external surfaces of buildings.

2. **Internal wind pressure Coefficient**

Internal pressure coefficients give the effect of the wind on the internal surfaces of buildings.

**External Pressure coefficients**

The external pressure coefficients are divided into local coefficients and overall coefficients.

- **Local coefficients**

Cpe1 give the pressure coefficients for loaded areas of $1m^2$.They may be used for the design of small elements and fixings.

- **Overall coefficients**

Cpe 10 give the pressure coefficients for loaded areas of $10m^2$.They may be used for loaded areas larger than $10m^2$.

The roof in our projects have RC slab roof. The RC slab roofs are flat in shape. To calculate the external and internal wind pressure coefficients, Cpe and Cpi, we divide the roof into the following zones. The magnitude of the coefficients depends on the loaded area of the roof. Different zones of the loaded area are subjected to different magnitude.

As per ES EN 1991-1-4, the external pressure coefficients *c*pe for buildings and parts of buildings depend on the size of the loaded area *A*, which is the area of the structure that produces the wind action in the section to be calculated. The external pressure coefficients are given for loaded areas *A* of 1 m2

and 10 m2 in the tables for the appropriate building configurations as *c*pe,1, for local coefficients, and *c*pe,10, for overall coefficients, respectively.

External pressure coefficients (Cpe) can be computed as follow:

- Cpe = Cpe;1 --- for area A < 1 $m^2$
- Cpe = Cpe,10 --- for area A > 10 $m^2$
- Cpe = Cpe,1 + (Cpe,10-Cpe,1) logA --- for 1 < A <10 $m^2$

### 2.2.5. Calculation for external wind pressure on the roof floor

**A. Basic wind velocity($V_b$)**

$V_b = C_{dir}C_{season}V_{b,o}$=1*1*22m/s=**22m/s**

**B. Roughness factor ($C_r(Z)$)**

- **Dire dewa town is under Terrian Category III**

According to ES-EN 1991,1-4:2014 Table 4.1 the location of the building in Dire dewa fall under Terrain Category- III. Category III is characterized with

- Roughness length, Zo = 0.3m
- Minimum height, Zmin = 5m
- $Z_{o,II}$-Roughness length for category III=0.05m
- Building height = 17.75m

$$K_r = 0.19(\frac{Z_O}{Z_{O,II}})^{0.07}=0.19(\frac{0.3m}{0.05m})^{0.07}=\mathbf{0.215}$$

**For Roof 1 at Z=16.25 Roof 1(R1)**

$$C_r(Z) = K_r\ln(\frac{Z}{Zo}) = 0.215\ln(\frac{16.25m}{0.3m}) =\mathbf{0.858}$$

**For Roof 3 at Z=17.75 Roof (R3)**

$$C_r(Z) = K_r\ln(\frac{Z}{Zo}) = 0.215\ln(\frac{17.75m}{0.3m}) =\mathbf{0.877}$$

**C. Terrian Topography ($C_o(Z)$)**

No escarpment or hills are located around the building site which means the site is topography unaffected zone and therefore, the topography coefficient of our building is one.

- Ct (z) = 1

**D. Air density ($\rho$)**

The latitude of Dire dewaTown is 1204m above sea level. To calculate the air density, the altitude is considered at the mid height of the building.

- For Z = 16.25m Roof 1 (R1) the altitude = 1204m + (16.25m/2) = **1212.13m**

- For Z = 17.75m Roof 2 (R2) the altitude = 1204m + (17.75m/2) = **1212.88m**

This altitude values are not directly occurring in the above table but, we can determine the density of air by using interpolation between 1000 and 1500 altitude values.

- **For Z = 16.25m Roof 1 (R1) at altitude of 1212.13m**

Table 2. 3: Air density and its altitude of the building at Z= 16.25m

| Site altitude above sea level (m) | Air density (kg/m$^3$) |
|---|---|
| 1000 | 1.00 |
| 1212.13 | X |
| 1500 | 0.94 |

By using interpolation

$$\frac{1212.13-1000}{1500-1212.13}=\frac{x-1}{0.94-x} \Rightarrow X=\mathbf{0.9741\ kg/m^3}$$

We get the values of air density is equal to, $\rho$ = **0.9741kg/m$^3$.**

- **For Z = 17.75m Roof 2 (R2) at altitude of 1212.88m**

Table 2. 4:Air density and its altitude of the building at Z= 17.75m

| Site altitude above sea level (m) | Air density (kg/m$^3$) |
|---|---|
| 1000 | 1.00 |
| 1212.88 | X |
| 1500 | 0.94 |

By using interpolation

$$\frac{1212.88-1000}{1500-1212.88}=\frac{x-1}{0.94-x} \Rightarrow X=\mathbf{0.9741\ kg/m^3}$$

We get the values of air density is equal to, $\rho$ = **0.9744kg/m$^3$.**

**E. Mean wind velocity $V_m$ (z)**

- **For Z = 16.25m Roof 1 (R1)**
  - ✓ $V_m(z) = C_r(Z)C_o(Z)\ V_b$= 0.858*1*22m/s = **18.876m/s**
- **For Z = 17.75m Roof 2 (R2)**
  - ✓ $V_m(z) = C_r(Z)C_o(Z)\ V_b$= 0.877*1*22m/s = **19.294m/s**

**F. Standard deviation of Turbulence ($\sigma v$)**

- $\sigma v = K_r V_b K_1$

✓ The value of $V_b$ *and* $K_r$ are already obtained in the above. They are $V_b = 22m/s\ , K_r = 0.215$

- ✓ $K_1$-Turbulence Factor=1
  - ➢ σv=$K_r V_b K_1$=0.215*22m/s*1=**4.73 m/s**

**G. Turbulence intensity($I_v(z)$)**

- ➢ **For Z = 16.25m Roof 1 (R1)**

✓ $I_v(z)=\frac{\sigma v}{V_{m(Z)}}=\frac{4.73 m/s}{18.876 m/s}$ = **0.251**

- ➢ **For Z = 17.75m Roof 2 (R2)**

✓ $I_v(z)=\frac{\sigma v}{V_{m(Z)}}=\frac{4.73 m/s}{19.294 m/s}$ = **0.245**

Just to remind, we are trying to find $q_p(Z)$ =Peck velocity Pressure

- ➢ **For Z = 16.25m Roof 1 (R1)**

✓ $q_p(Z) = [1 + 7I_v(z)]*0.5* \rho_{air} * V^2_m(z)$

$= [1 + 7 * 0.251]*0.5* 0.9741\ kg/m^3* (18.876m/s)^2$ = **0.4784Kpa**

- ➢ **For Z = 17.75m Roof 2 (R2)**

✓ $q_p(Z) = [1 + 7I_v(z)]*0.5* \rho_{air} * V^2_m(z)$

$= [1 + 7 * 0.245]*0.5* 0.974\ kg/m^3* (19.294m/s)^2$ = **0.4922Kpa**

Therefore, $q_p(16.25m)$ = **0.4784Kpa**……..This value is when the height becomes 16.25m.

$q_p(17.75m)$ = **0.4922Kpa**……..This value is when the height becomes 17.75m.

### 2.2.6. Calculation for external wind pressure coefficient (Cpe) on the roof floor

**A. Geometric data of the building**

- ➢ The height of building above the ground level is 17.75m including slab thickness.
- ➢ The building roof is Flat roof from the given.
- ➢ Width and length of the buildings is 45.4m and 13.2m respectively taken from floor plan.
- ➢ Height of parapet of the roof=0.8m
- ➢ Our building is B+G+4 which have 6 story.

17.75m<45.4m (h<b), and from EBCS-1 Section A.2.2it is stated that "for building whose height, h is less than b, shall be considered to be one part

**Roof 1 at h= 16.25m**

- ➢ e= b or 2h whichever is the smaller

Then, $e \leq \min\begin{cases} b = 45.4m \\ 2h = 2 * 16.25 = 32.5m \end{cases} \Longrightarrow e = \mathbf{32.5m}$

**B. Dividing the roof into pressure zones**

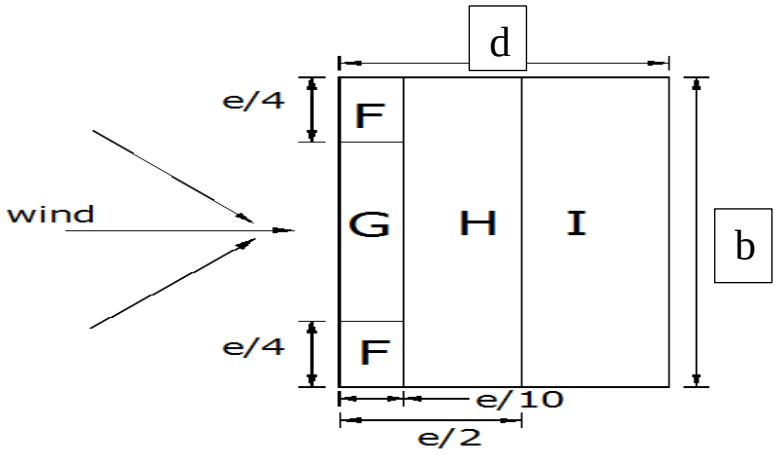



Figure 2. 1:Wind pressure on roof with parapet

**Areas of each roof zone**

- e/4 = 32.5/4 = **8.125m**
- e/10 = 32.5/10 = **3.25m**
- e/2 = 32.5/2 = **16.25m**
- d= **13.2m**
- b= **45.4m**

$$\text{Area F} = \left(\frac{e}{4} * \frac{e}{10}\right) = 8.125 * 3.25 = \mathbf{26.406m^2}$$

$$\text{Area G} = \left(b - \frac{e}{2}\right) * \left(\frac{e}{10}\right) = (45.4 - 16.25) * 3.25 = \mathbf{94.74m^2}$$

$$\text{Area H} = b * \left(\frac{e}{2} - \frac{e}{10}\right) = 45.4(16.25 - 3.25) = \mathbf{590.2m^2}$$

$$\text{Area I} = b * \left(\frac{e}{2} - d\right) = 45.4 * (16.25 - 13.2) = \mathbf{138.47m^2}$$

**Roof 1 at h= 17.75m**

- d= **5m**
- b= **5m**
- e= b or 2h whichever is the smaller

$$\text{Then, } e \leq \min\begin{cases} b = 5m \\ 2h = 2 * 17.75 = 35.5m \end{cases} \Rightarrow e = \mathbf{5m}$$

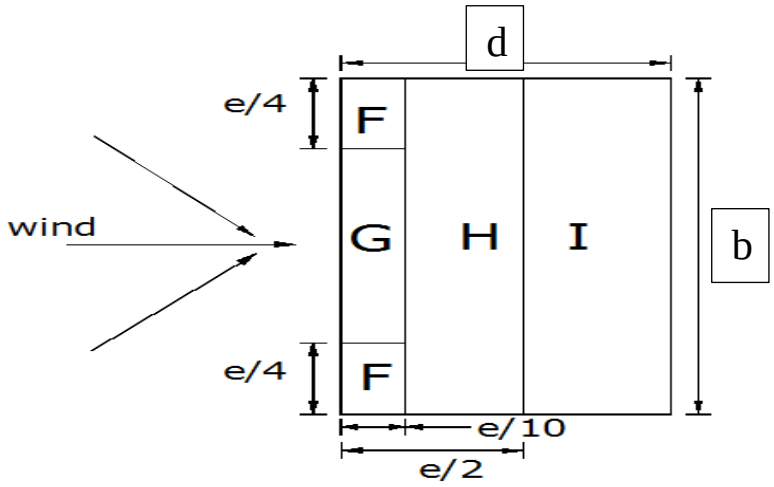



Figure 2. 2:Wind pressure on roof with parapet

**Areas of each roof zone**

- e/4 = 5/4 = **1.25m**
- e/10 = 5/10 = **0.5m**
- e/2 = 5/2 = **2.5m**
- d= **5m**
- b= **5m**

$$\text{Area F} = \left(\frac{e}{4} * \frac{e}{10}\right) = 1.25 * 0.5 = \mathbf{0.625m^2}$$

$$\text{Area G} = \left(b - \frac{e}{2}\right) * \left(\frac{e}{10}\right) = (5 - 2.5) * 0.5 = \mathbf{1.25m^2}$$

$$\text{Area H} = b * \left(\frac{e}{2} - \frac{e}{10}\right) = 5(2.5 - 0.5) = \mathbf{10m^2}$$

$$\text{Area I} = b * \left(d - \frac{e}{2}\right) = 5 * (5 - 2.5) = \mathbf{12.5m^2}$$

**C. Determine external wind pressure coefficient**

**For Roof 1 at h = 16.25**

- Height of with parapet wall hp =0.8m
- Height of the building h = 16.25m

$$\text{For } \frac{hp}{h} = \frac{0.8}{16.25} = 0.04923$$

**For Roof 2 at h = 17.25**

- Height of with parapet wall hp =0.8m

- Height of the building h = 17.75m

For $\frac{hp}{h} = \frac{0.8}{17.75}$ =0.04507

Then using ES EN 2015 Table A.2 (Page 73) to determine external pressure coefficient as in a table below, but for roofs with parapets, linear interpolation may be used for intermediate values of hp/h. Values of $C_{pe}$ are given in Table A.2 in appendix A on EBCS-1 (Page 73), for different values of hp/h and for zone area above 10 $m^2$ and zone area below 1 $m^2$. If the area is below 10$m^2$ we use Cpe 1, but if it is more than 10 $m^2$, we use $C_{pe10}$ . The corresponding values are taken from the Table A.2 using interpolation to determine the value of the intermediate values.

- **For roof 1 at h= 16.25m**
  - ✓ **<u>For region F</u>**

Table 2. 5: External Pressure Coefficients for region F at Z= 16.25m

| Hp/h | Cpe,10 |
|---|---|
| 0.025 | -1.6 |
| 0.04923 | X |
| 0.05 | -1.4 |

By using interpolation

$$\frac{0.04923-0.025}{0.05-0.04923}=\frac{x-(-1.6)}{-1.4-x} \Rightarrow X= \mathbf{-1.4058}$$

We get the values of Cpe,10 for F Region= **-1.4058**

Table 2. 6:External Pressure Coefficients for flat roof at Z= 16.25m

| Region | F | G | H | I |
|---|---|---|---|---|
| hp/h | Cpe,10 | Cpe,10 | Cpe,10 | Cpe,10 |
| 0.025 | -1.6 | -1.1 | -0.7 | ±0.2 |
| 0.05 | -1.4 | -0.9 | -0.7 | ±0.2 |
| 0.04923 | **-1.4058** | **-0.9056** | **-0.7** | **±0.2** |

- **For roof 2 at h= 17.75m**
  - ✓ **<u>For region F</u>**

Table 2. 7: External Pressure Coefficients for region F at Z= 17.75m

| Hp/h | Cpe,10 |
|---|---|
| 0.025 | -2.2 |
| 0.04507 | X |
| 0.05 | -2 |

By using interpolation

$$\frac{0.04923-0.025}{0.05-0.04923}=\frac{x-(-1.6)}{-1.4-x} \Rightarrow X= \mathbf{-2.0379}$$

We get the values of Cpe,1 for F Region= **-2.0379**

Table 2. 8:External Pressure Coefficients for flat roof at Z=17.75m

| Region | F | G | H | I |
|---|---|---|---|---|
| hp/h | Cpe,1 | Cpe,1 | Cpe,10 | Cpe,10 |
| 0.025 | -2.2 | -1.8 | -0.7 | ±0.2 |
| 0.05 | -2 | -1.6 | -0.7 | ±0.2 |
| 0.04923 | **-2.0379** | **-1.6376** | **-0.7** | **±0.2** |

**E. <u>Computing external pressure on the roof surface(We)</u>**

- **For roof 1 at h =16.25m** We = $q_p(Z)$*Cpe
  - ✓ **ZONE –F**

We=0.4787KN/m$^2$ *-1.4058= **-0.6730KN/m$^2$**

Table 2. 9: External wind pressure for all zone at Z= 16.25m

| **Region** | **Area(m$^2$)** | **Peak velocity Pressure, $q_p(Z)$ (KN/ m$^2$)** | **External wind pressure coefficient, Cpe** | **External wind pressure, We(KN/ m$^2$)** |
|---|---|---|---|---|
| F | 26.406 | 0.4787 | -1.4058 | -0.6730 |
| G | 94.74 | 0.4787 | -0.9056 | -0.4335 |
| H | 590.2 | 0.4787 | +0.7 | 0.3351 |
| I | 138.47 | 0.4787 | +0.2 | 0.0957 |
| | | | -0.2 | -0.0957 |

- **For roof 1 at h =17.75m** We = $q_p(Z)$*Cpe

- ✓ **ZONE –F**

We=0.4922KN/m$^2$ *-2.0379= **-1.0031KN/m$^2$**

Table 2. 10: External wind pressure for all zone at Z= 17.75m

| **Region** | **Area(m$^2$)** | **Peak velocity Pressure, $q_p(Z)$ (KN/ m$^2$)** | **External wind pressure coefficient, Cpe** | **External wind pressure, We(KN/ m$^2$)** |
|---|---|---|---|---|
| F | 0.625 | 0.4922 | -2.0379 | -1.0031 |
| G | 1.25 | 0.4922 | -1.6376 | -0.8060 |
| H | 10 | 0.4922 | +0.7 | 0.3445 |
| I | 12.5 | 0.4922 | +0.2 | 0.0984 |
| | | | -0.2 | -0.0984 |

### 2.2.7. Calculation of internal wind pressure on the roof floor

**A. Computing Internal wind pressure**

- Wi= $q_p$(Zi)*Cpi

**B. Internal wind pressure coefficients**

- ✓ For closed building with internal partitions and opening windows the extreme values are
  - ✓ $C_{pi} = 0.8$ for pressure
  - ✓ $C_{pi} = -0.5$ for suction
- ✓ **For roof 2 at h = 16.25m**

Table 2. 11: Internal wind pressure coefficient at Z=16.25m

| Region | F | G | H | I |
|---|---|---|---|---|
| Area (m²) | 26.406 | 94.74 | 590.2 | 138.47 |
| $q_p$(Zi) | 0.4787 | 0.4787 | 0.4787 | 0.4787 |
| Cpi(+ve) for pressure | 0.8 | 0.8 | 0.8 | 0.8 |
| Cpi(-ve) for suction | -0.5 | -0.5 | -0.5 | -0.5 |
| Wi=$q_p$(Zi)*Cpi(+ve) in KN/m² | 0.3830 | 0.3830 | 0.3830 | 0.3830 |
| Wi=$q_p$(Zi)*Cpi(-ve) in KN/m² | -0.2394 | -0.2394 | -0.2394 | -0.2394 |

- ✓ **For roof 2 at h = 17.75m**

Table 2. 12: Internal wind pressure coefficient at Z=17.25m

| Region | F | G | H | I |
|---|---|---|---|---|
| Area (m²) | 0.625 | 1.25 | 10 | 12.5 |
| $q_p$(Zi) | 0.4922 | 0.4922 | 0.4922 | 0.4922 |
| Cpi(+ve) for pressure | 0.8 | 0.8 | 0.8 | 0.8 |
| Cpi(-ve) for suction | -0.5 | -0.5 | -0.5 | -0.5 |
| Wi=$q_p$(Zi)*Cpi(+ve) in KN/m² | 0.3938 | 0.3938 | 0.3938 | 0.3938 |
| Wi=$q_p$(Zi)*Cpi(-ve) in KN/m² | -0.2461 | -0.2461 | -0.2461 | -0.2461 |

## 2.3. Net wind pressure on the roof surface

The net wind pressure is given by the sum of the internal and external pressure.

- ✓ Wnet =We -Wi =$q_p$(Zi)*(Cpe -Cpi)

The summary of the Cpe and Cpi values are shown below in a table.

- ✓ For roof 1 at h = 16.25m

Table 2. 13:Net wind pressure on the surface at Z= 16.25m

| Region | F | G | H | I |
|---|---|---|---|---|
| Area (m²) | 26.406 | 94.74 | 590.2 | 138.47 |
| $q_p$(Zi) | 0.4787 | 0.4787 | 0.4787 | 0.4787 |
| We = $q_p$(Zi)*Cpe in KN/m² | -0.6730 | -0.4335 | 0.3351 | 0.0957 |
| Wi = $q_p$(Zi)*Cpi(+ve) in KN/m² | 0.3830 | 0.3830 | 0.3830 | 0.3830 |
| Wi = $q_p$(Zi)*Cpi(-ve) in KN/m² | -0.2394 | -0.2394 | -0.2394 | -0.2394 |
| Wnet = (We - Wi(+ve)) in KN/m²…Case 1 | -1.056 | -0.8165 | -0.0479 | -0.2873 |
| Wnet = (We - Wi) (-ve) in KN/m²…Case 2 | -0.4336 | -0.1941 | 0.5745 | 0.3351 |

**Note:** Positive sign indicates that the pressure acting towards the wall and negative sign indicates that the pressure is acting away from the wall. From the above two case the maximum values of suction and pressures for the design of this building is taken;

Case 1 Wnet= **-1.056KN/m²** (suction)

Case 2 Wnet = **0.5745KN/m²** (pressure)

Therefore, the overall maximum wind load for flat roof is from this two case Wnet = **-1.056 KN/m²**.

- ✓ **For roof 2 at h = 17.75m**

Table 2. 14: Net wind pressure on the surface at Z= 17.75m

| Region | F | G | H | I |
|---|---|---|---|---|
| Area (m²) | 0.625 | 1.25 | 10 | 12.5 |
| $q_p$(Zi) | 0.4922 | 0.4922 | 0.4922 | 0.4922 |
| We = $q_p$(Zi)*Cpe in KN/m² | -1.0031 | -0.8060 | 0.3445 | 0.0984 |
| Wi = $q_p$(Zi)*Cpi(+ve) in KN/m² | 0.3938 | 0.3938 | 0.3938 | 0.3938 |
| Wi = $q_p$(Zi)*Cpi(-ve) in KN/m² | -0.2461 | -0.2461 | -0.2461 | -0.2461 |
| Wnet = (We - Wi(+ve)) in KN/m²…Case 1 | -1.3969 | -1.1998 | -0.0493 | -0.2954 |
| Wnet = (We - Wi) (-ve) in KN/m²…Case 2 | -0.7570 | -0.5599 | 0.5906 | 0.3445 |

**Note:** Positive sign indicates that the pressure acting towards the wall and negative sign indicates that the pressure is acting away from the wall. From the above two case the maximum values of suction and pressures for the design of this building is taken;

Case 1 Wnet= **-1.3969KN/m²** (suction)

Case 2 Wnet = **0.5906KN/m²** (pressure)

Therefore, the overall maximum wind load for flat roof is from this two case Wnet = **-1.3969 KN/m²**.

## 2.4. Total design load on the roof floor surface

**STEP 1: Load determination**

**A. Dead Load**

- ✓ 200mm RC solid slab=0.2*25 = **5 kN/m²**
- ✓ 30mm thick cement screed =0.03*23 = **0.69 kN/m²**
- ✓ 20 mm plastering on one sides = 0.02*23 = **0.46kN/m²**
- ✓ 2mm bitumen layer tile finishing material= 0.02*14 = **0.28 kN/m²**

Total Dead Load, DL = 5+0.69+0.46+0.28 = **6.43 kN/m²**

**B. Live Load**

The roof is not accessible except for normal maintenance, repair, painting and minor repairs. The characteristic values, qk, and Qk are given in ES EN1991-1-1.

- ✓ It is category H roof, hence
- ✓ The distributed live load, qk = **0.4KN/m²**

- ✓ The concentrated live load, Qk = **1KN**

**C. Wind Load**

**For roof 1 at h = 16.25m**

- ✓ Wind Load (Suction) = **-1.056KN/m$^2$**

**STEP 2: Load combination**

1. **Combination -1 , Dead load + Live load**
   - ✓ Pd = 1.35DL + 1.50LL = 1.35(6.43) + 1.5(0.4) = **9.281 KN/m$^2$**
2. **Combination -2 , Dead load + Wind load**
   - ✓ Pd = 1.35DL + 1.50WL = 1.35(6.43) + 1.5(-1.056) **= 7.097 KN/m$^2$**
3. **Combination -3 , Dead load - Wind load**
   - ✓ Pd = 1.35DL - 1.50WL = 1.35(6.43) - 1.5(-1.056) = **10.265 KN/m$^2$**
4. **Combination -4 , Dead load + live load + Wind load**
   - ✓ Pd = 1.35DL + 1.50LL + 0.9WL= 1.35(6.43) + 1.5(0.4) + 0.9(-1.056) = **8.331 KN/m$^2$**
5. **Combination -5 , Dead load + live load - Wind load**
   - ✓ Pd = 1.35DL + 1.50LL + 0.9WL= 1.35(6.43) + 1.5(0.4) - 0.9(-1.056) = **10.231 KN/m$^2$**

The maximum design load from those various load combinations seem **10.231KN/m$^2$**

**For roof 2 at h = 17.75m**

- ✓ Wind Load (Suction) = **-1.3969KN/m$^2$**

**STEP 2: Load combination**

1. **Combination -1 , Dead load + Live load**
   - ✓ Pd = 1.35DL + 1.50LL = 1.35(6.43) + 1.5(0.4) = **9.281 KN/m$^2$**
2. **Combination -2 , Dead load + Wind load**
   - ✓ Pd = 1.35DL + 1.50WL = 1.35(6.43) + 1.5(-1.3969) **= 6.585 KN/m$^2$**
3. **Combination -3 , Dead load - Wind load**
   - ✓ Pd = 1.35DL - 1.50WL = 1.35(6.43) - 1.5(-1.3969) = **10.776 KN/m$^2$**
4. **Combination -4 , Dead load + live load + Wind load**
   - ✓ Pd = 1.35DL + 1.50LL + 0.9WL= 1.35(6.43) + 1.5(0.4) + 0.9(-1.3969) = **8.023 KN/m$^2$**
5. **Combination -5 , Dead load + live load - Wind load**

✓ Pd = 1.35DL + 1.50LL + 0.9WL= 1.35(6.43) + 1.5(0.4) - 0.9(-1.3969) = **10.538 KN/m$^2$**

The maximum design load from those various load combinations seem **10.776KN/m$^2$**

# CHAPTER-THREE

# STRUCTURAL ANALYSIS AND DESIGN OF SOLID SLAB

## 3.1. Structural design of solid slab

A reinforced concrete slab is a broad, flat plate, usually horizontal, with top and bottom surface parallel or nearly so. It is used to provide flat surface mainly for roofs and floors of building parking lots, air fields, road ways, bridges etc. It may be supported by reinforced concrete beam, by masonry or reinforced concrete walls, by structural steel members, directly by columns, or continuously by the ground. But we are intend to design beam supported floor and roofs solid slabs of the building accordingly ES EN-1992:2015. Beam support slab can be classified as one way slab and two way slab based on the longer to shorter length ratio or based on their load transfer mechanism solid slabs are classified as:

**A. One-way slab**:

They are those either supported on the two out of four opposite sides or the longer span to short span ratio is greater than two. It transmits their load in one direction. Main reinforcement in each element runs in one direction only. The slab is one way if the slab panel longer length to shorter length ratio is greater than two (i.e. $Ly/Lx > 2$).

**B. Two-way slab:**

They are those supported on all four sides and the longer span to short span ratio is less than or equal to two. It resists the applied load in two directions. Main reinforcement runs in both directions where ratio of long to short span is less than or equal to two (i.e. $L_y/L_x \leq 2$).

**C. Cantilever slabs**:

They are those with a fixed support on only one out of four sides. These types of slabs are composed of rectangular panels supported at all four edges by walls or beams stiff enough to be treated as unyielding. In our case most of the slabs are two-way and need to be analyzed based on the principle of design. two way actions also it is composed of cantilever and one-way slab.

## 3.2. Procedure for structural design of solid slab for floor

### 3.2.1. Govering concrete cover

The concrete cover is the distance from the surface of the reinforcement closest to the nearest concrete surface (including links and stirrups and surface reinforcement where relevant) and the nearest concrete surface. Based on ES EN 2015 governing design cover is obtained as following;

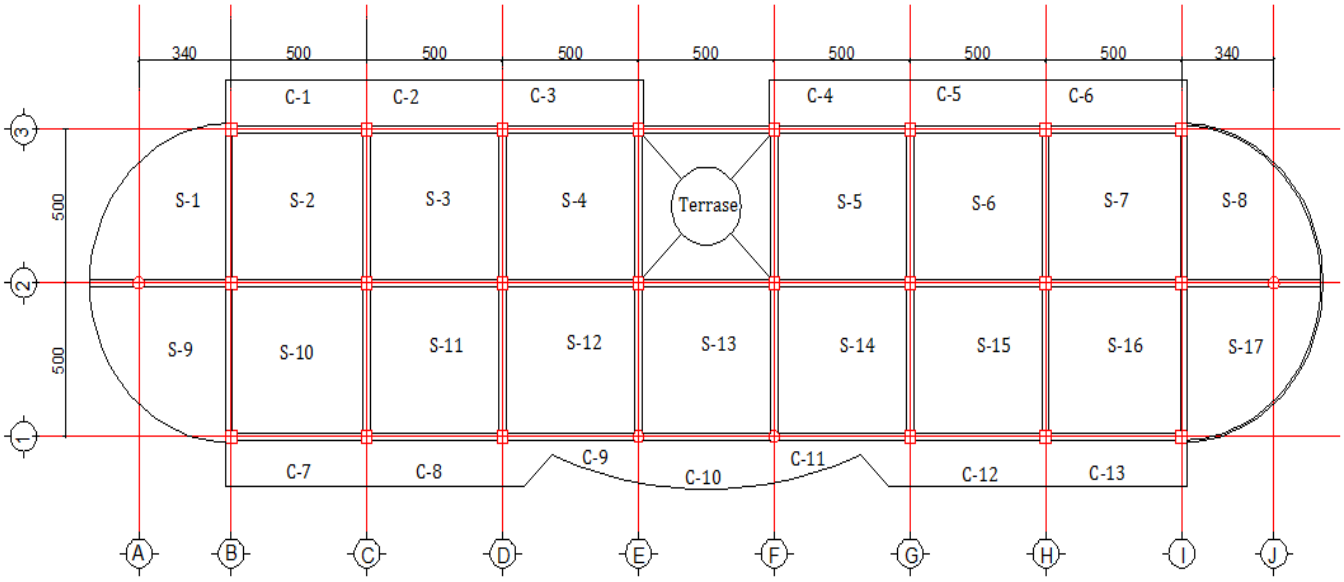
**Procedure for determining minimum concrete cover**

- ✓ Determine panel selection and naming.
- ✓ Determine corrosion type Based on exposure class from EBCS-2,2015 Table 4.1 (Page 46).
- ✓ Determine Indicative strength classes based on corrosion type.
- ✓ Determine structural class based on design working life.
- ✓ Determine the minimum bond cover with regard to bond.
- ✓ Determine the minimum durability cover based on structural class S3.
- ✓ Determine the Allowance in design for deviation based on national annex.
- ✓ Determine the nominal cover of the concrete.
- ✓ Determine the govering concrete cover.

**Step 1: Determination of Panel selection and naming**

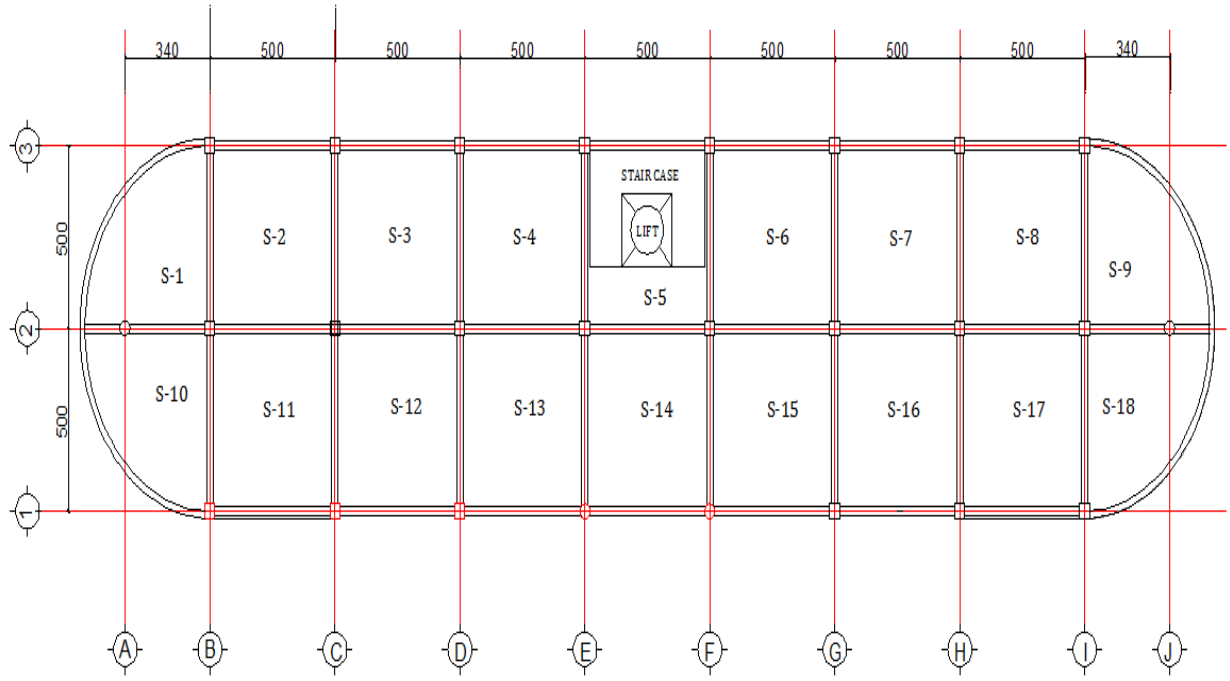
Before proceeding to the analysis and design of solid slab we should select type of panel. The selection of panels is depending on:

- ➢ Boundary condition
- ➢ Shorter(Lx) and longer(Ly) length of the panel
- ➢ Function of panel.



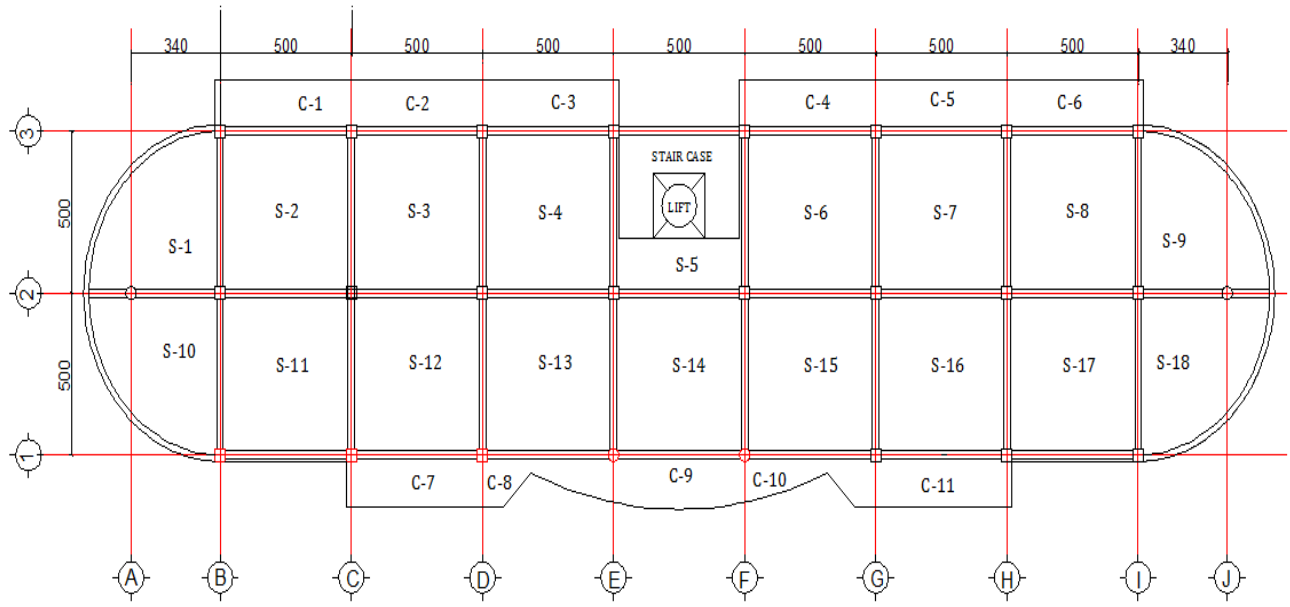

**ROOF FLOOR PLAN LAY OUT**
**Scale 1:300**

Figure 3. 1:Roof floor plan lay out




**GROUND FLOOR PLAN LAY OUT**
**Scale 1:100**

Figure 3. 2: Ground floor layout




**1st & 2nd FLOOR PLAN LAY OUT**
**Scale 1:100**

Figure 3. 3: 1st & 2nd floor layout

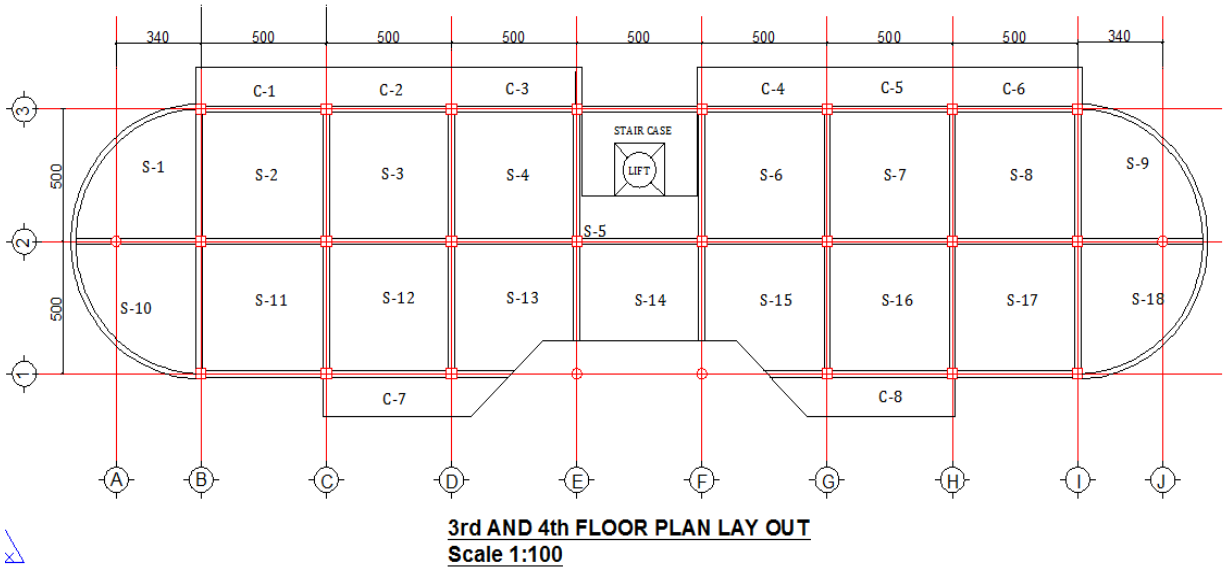



Figure 3. 4: 3rd & 4th floor plan lay out

**Step 2: <u>Slab and Span types</u>**

- **For panel 1(S-1)**
- **For this panel we use equivalent method to determine lx and ly values.**

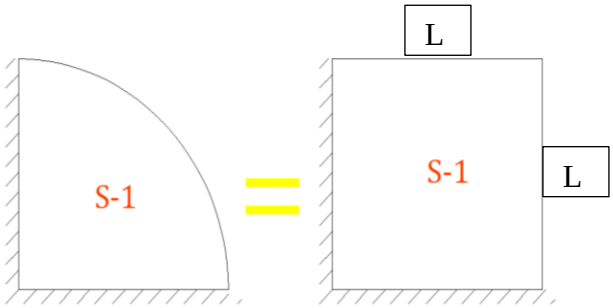



Figure 3. 5: Layout of panel 1(S-1)

- $L=\sqrt{\frac{\pi R^2}{4}}$
- R= 5m
- $L=\sqrt{\frac{\pi R^2}{4}} = L=\sqrt{\frac{\pi(5)^2}{4}}$ **=4.43m**
  - ✓ Lx = **4.43m**
  - ✓ Ly = **4.43m**
  - ✓ Ly/Lx = **4.43m/4.43m**

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form.

**Step 3: <u>Determination of minimum concrete cover design solid slab</u>**

- **<u>Exposure classes</u>**

The exposure class we have selected for our building related to environmental is dry or permanently wet. Therefore, we have selected XC1 using the table found below.

Table 3. 1: Exposure classes related to environmental conditions in accordance with ES EN 2015

| Class Designation | Description of the Environment | Informative examples where exposure classes may occur |
|---|---|---|
| **1. Corrosion induced by carbonation** | | |
| XC1 | Dry or permanently wet | Concrete inside buildings with low air humidity Concrete permanently submerged in water |
| XC2 | Wet, rarely dry | Concrete surfaces subject to long-term water contact Many foundations |
| XC3 | Moderate humidity | Concrete inside buildings with moderate or high air humidity External concrete sheltered from rain |
| XC4 | Cyclic wet and dry | Concrete surfaces subject to water contact, not within exposure class XC2 |

- **Indicative strength classes**

The choice of adequately durable concrete for corrosion protection of reinforcement and protection of concrete attack, requires consideration of the composition of concrete. This may result in a higher compressive strength of the concrete than is required for structural design. For our case we have selected C20/25 using the table below.

Table 3. 2: Indicative minimum strength class in accordance with ES EN 2015

| | **Exposure Classes according to EBCS** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Corrosion** | | | | | | | | | | |
| | Carbonation-induced corrosion | | | | Chloride-induced corrosion | | | Chloride-induced corrosion from sea-water | | |
| | XC1 | XC2 | XC3 | XC4 | XD1 | XD2 | XD3 | XS1 | XS2 | XS3 |
| Indicative Strength Class | C20/25 | C25/30 | C30/37 | | C30/37 | | C35/45 | C30/37 | C35/45 | |
| **Damage to Concrete** | | | | | | | | | | |
| | No risk | Freeze/Thaw Attack | | | Chemical Attack | | | | | |
| | X0 | XF1 | XF2 | XF3 | XA1 | XA2 | XA3 | | | |
| Indicative Strength Class | C12/15 | C30/37 | C25/30 | C30/37 | C30/37 | | C35/45 | | | |

- **Design working life**

In order to achieve the required design working life of the structure, adequate measures shall be taken to protect each structural element against the relevant environmental actions. For our building we

considered design working life is for 50 years. Based on this the structural class for this building is S4 from EBCS-1, 2015.

Table 3. 3: Indicative design working life

| Design working life category | Indicative design working life (years) | Examples |
|---|---|---|
| 1 | 10 | Temporary structures(1) |
| 2 | 10 to 15 | Replaceable structural parts, e.g. gantry girders, bearings |
| 3 | 15 to 30 | Agricultural and similar structures |
| 4 | 50 | Building structures and other common structures |
| 5 | 100 | Monumental building structures, bridges, and other civil engineering structures |
| (1) Structures or parts of structures that can be dismantled with a view to being re-used should not be considered as temporary. | | |

- **Structural classification**

We have considered a structural class by member with slab geometry (position of reinforcement not affected by construction process), since our exposure class we selected is XC1, therefore our structural class is S4 because the class is reduced by 1 using the table below.

Table 3. 4: Recommended structural classification

| **Structural Class** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Criterion** | **Exposure Class according to EBCS** | | | | | | |
| | X0 | XC1 | XC2 / XC3 | XC4 | XD1 | XD2/ XS1 | XD3/ XS2/ XS3 |
| Design working life of 100 years | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 |
| Strength Class[1)2)] | ≥C30/37 reduce class by 1 | ≥C30/37 reduce class by 1 | ≥C35/45 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C45/55 reduce class by 1 |
| Member with slab geometry (Position of reinforcement not affected by construction process) | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 |
| Special Quality Control of the concrete production ensured | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 |

- **Minimum concrete cover**

The concrete cover is the distance between the surface of the reinforcement closest to the nearest concrete surface (including links and stirrups and surface reinforcement where relevant) and the nearest concrete surface. The nominal cover shall be specified on the drawings. It is defined as,

$C_{nom} = C_{min} + \Delta C_{dev}$ ……EBCS-2 2015, (page 47).

where $C_{nom}$ :- Nominal cover.

$C_{min}$ :- Minimum cover.

$\Delta C_{dev}$:- Allowance in design for deviation.

- **Minimum cover (cmin)**

Minimum concrete cover, cmin shall be provided in order to ensure:

- The safe transmission of bond forces.
- The protection of the steel against corrosion (durability).
- An adequate fire resistance.

The greater value for $C_{min}$ satisfying the requirements for both bond and environmental conditions shall be used. $C_{min} = \max \{C_{min,b}; C_{min,dur}, 10\ mm\}$……..EBCS-2, 2015 (Page 47)

where: $C_{min,b}$……..:-Minimum cover due to bond requirement.

$C_{min,dur}$ …….:-Minimum cover due to environmental conditions.

In order to transmit bond forces safely and to ensure adequate compaction of the concrete, the minimum cover should not be less than $C_{min,b}$ given in from EBCS-2, 2015 (Page 48). We have selected separated bond requirement therefore; our minimum cover of bond is depending on diameter of bars using the table below.

Table 3. 5: Minimum cover, $c_{min,b}$, requirements with regard to bond

| **Bond Requirement** | |
|---|---|
| Arrangement of bars | Minimum cover $c_{min,b}$* |
| Separated | Diameter of bar |
| Bundled | Equivalent diameter ($\phi_n$) (see 8.9.1) |
| *: If the nominal maximum aggregate size is greater than 32 mm, $C_{min,b}$, should be increased by 5 mm. | |

- **Requirements for durability**

The requirements for durability shall be included when considering the following According to EBCS-2:

- Structural conception,
- Material selection

- Construction details,
- Execution and Quality Control,
- Inspection
- Verifications,

In our case the structural class we have selected is S3 then minimum concrete cover requirement with regard to durability is 10mm from table below.

Table 3. 6: Values of minimum cover, $c_{min,dur,}$ requirements with regard to durability for reinforcement steel in accordance with ES EN 2015

| **Environmental Requirement for $c_{min,dur}$ (mm)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Structural Class** | **Exposure Class according to EBCS** | | | | | | |
| | X0 | XC1 | XC2 / XC3 | XC4 | XD1 / XS1 | XD2 / XS2 | XD3 / XS3 |
| S1 | 10 | 10 | 10 | 15 | 20 | 25 | 30 |
| S2 | 10 | 10 | 15 | 20 | 25 | 30 | 35 |
| S3 | 10 | 10 | 20 | 25 | 30 | 35 | 40 |
| S4 | 10 | 15 | 25 | 30 | 35 | 40 | 45 |
| S5 | 15 | 20 | 30 | 35 | 40 | 45 | 50 |
| S6 | 20 | 25 | 35 | 40 | 45 | 50 | 55 |

- **Standard Fire resistance**

We have determined the standard fire resistance for each panel in according of EBCS using the following table.

Table 3. 7: Minumum cover of concrete based on fire resistance

| Standard fire resistance | Minimum dimensions(mm) | | | |
|---|---|---|---|---|
| | Slab thickness hs(mm) | One way | Two way Ly/Lx ≤ 1.5 | Two way 1.5 ≤ Ly/Lx ≥ 2 |
| REI 30 | 60 | 10* | 10* | 10* |
| REI 60 | 80 | 20 | 10* | 15* |
| REI 90 | 100 | 30 | 15* | 20 |
| REI 120 | 120 | 40 | 20 | 25 |
| REI 180 | 150 | 55 | 30 | 40 |
| REI 240 | 175 | 65 | 40 | 50 |

- **Allowance in design for deviation**

The value of $\Delta c_{dev}$ for use in a Country may be found in its National Annex According to EBCS-2. The recommended value is 10 mm. so that we have selected also the recommended value 10mm.

Therefore, the nominal cover shall be specified on the drawings. It is defined as,

$$c_{nom} = c_{min} + \Delta c_{dev}$$ …….EBCS-2 2015, (page 47).

where $C_{nom}$ :- Nominal cover.
$C_{min}$ :- Minimum cover.
$\Delta C_{dev}$:- Allowance in design for deviation.

**For roof floor**

**For example, for panel 1,**

- ✓ $C_{nom} = C_{min} + \Delta C_{dev}$ from the above table we have listed $c_{min}$ = 12mm, $\Delta c_{dev}$ = 10mm
- ✓ $C_{nom}$ = 10+12=**22mm**
- ✓ Standard Fire resistance =**20mm**
- ✓ Therefore, the govering Concrete design cover for this panel is =**22mm**

Computation of the rest of the panel for floor slab see on appendex in Tabular form.

### 3.2.2. Determination Effective depth of Solid slab

According to EBCS-2 2015(page 133) slab determination can be calculated by using the following formula and consideration.

$$\frac{l}{d} = N * K * F1 * F2 * F3$$

Where;

- ✓ $\frac{l}{d}$:- is the limit span/depth
- ✓ $N = \left[11 + 1.5\sqrt{f_{ck}}\frac{\rho_o}{\rho} + 3.2\sqrt{f_{ck}}\left(\frac{\rho_o}{\rho} - 1\right)^{\frac{3}{2}}\right]$ if $\rho \le \rho_o$
- ✓ $N = \left[11 + 1.5\sqrt{f_{ck}}\frac{\rho_o}{\rho - \rho'} + \frac{1}{12}\sqrt{f_{ck}}\sqrt{\frac{\rho'}{\rho_o}}\right]$ if $\rho > \rho_o$
- ✓ $N = \left[11 + 1.5\sqrt{f_{ck}}\right]$ if $\rho = \rho_o$
- ✓ K: -is the factor to take into account the different structural systems
  - ✓ $\rho_o$:-is the reference reinforcement ratio ,

$$\rho_o = \frac{\sqrt{f_{ck}}}{1000}$$

- ✓ ρ: - is the required tension reinforcement ratio at mid-span to resist the moment due to the design loads (at support for cantilevers)
- ✓ ρ': - is the required compression reinforcement ratio at mid-span to resist the moment due to design loads (at support for cantilevers)
- ✓ $F1 = \frac{500}{f_{yk}}$
- ✓ $F2 = \frac{As,prov}{Asreq}$ < 1.5 For first Trial : use F 2= 1

- ✓ $F3 = 1$ [rectangular section, solid slab and T- section with b/bw≤ 3 ]
- ✓ $F3 = 0.8$ for T section with b/bw> 3

**Depth determination: Serviceability Requirement for all panel**

**For roof floor**

- **For Panel 1**
  - ✓ $\rho_o = \frac{\sqrt{f_{ck}}}{1000} x100 = \frac{\sqrt{20}}{1000} x100 = \mathbf{0.447\%}$
  - ✓ $N = \left[11 + 1.5\sqrt{f_{ck}}\right]$ if $\rho = \rho_o$
  - ✓ $N = \left[11 + 1.5\sqrt{20}\right] =$**17.71**

K=1.3 for end span, K=1.5 for interior span according to EBCS-2, 2015 Table 7.4N (Page 134)

$$F1 = \frac{500}{f_{yk}} = \frac{500}{400} = 1.25 \qquad F2=1, F3=1$$

**Depth determination: Serviceability Requirement for panel 1 (k=1.3, L=Lx=5000mm)**

$$\frac{l}{d} = N * K * F1 * F2 * F3$$

$$\frac{l}{d} = 17.71 * 1.3 * 1.25 * 1 * 1 = \mathbf{28.779}$$

$$d \geq \frac{5000mm}{28.779} = \mathbf{173.739mm}$$

**Slab Depth determination**

Depth determination: Serviceability Requirement for end panel

Using Φ12mm bar and clear cover of 22mm

- Total depth
  - ✓ $D = 173.739 + \frac{12}{2} + 22 = \mathbf{201.739mm\ use\ 200mm}$
- Depth in shorter direction
  - ✓ $dx = 200 - 12/2 - 22 = \mathbf{172mm}$
- Depth in the longer direction
  - ✓ $dy = 200 - \frac{12}{2} - 12 - 22 = \mathbf{160mm}$

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form.

## 3.3. Design factored load on each floor

### 3.3.1. Design load (Pd) on the Roof floor

**STEP 1: Load determination**

**A. Dead Load**

- ✓ 200mm RC solid slab=0.2*25 = **5 kN/m$^2$**
- ✓ 30mm thick cement screed =0.03*23 = **0.69 kN/m$^2$**
- ✓ 20 mm plastering on one sides = 0.02*23 = **0.46kN/m$^2$**
- ✓ 2mm bitumen layer tile finishing material= 0.02*14 = **0.28 kN/m$^2$**

Total Dead Load, DL = 5+0.69+0.46+0.28 = **6.43 kN/m$^2$**

**B. Live Load**

The roof is not accessible except for normal maintenance, repair, painting and minor repairs. The characteristic values, qk, and Qk are given in ES EN1991-1-1.

- ✓ It is category H roof, hence
- ✓ The distributed live load, qk = **0.4KN/m$^2$**
- ✓ The concentrated live load, Qk = **1KN**

**C. Wind Load**

**For roof 1 at h = 16.25m**

- ✓ Wind Load (Suction) = **-1.056KN/m$^2$**

**STEP 2: Load combination**

1. **Combination -1 , Dead load + Live load**
   - ✓ Pd = 1.35DL + 1.50LL = 1.35(6.43) + 1.5(0.4) = **9.281 KN/m$^2$**
2. **Combination -2 , Dead load + Wind load**
   - ✓ Pd = 1.35DL + 1.50WL = 1.35(6.43) + 1.5(-1.056) **= 7.097 KN/m$^2$**
3. **Combination -3 , Dead load - Wind load**
   - ✓ Pd = 1.35DL - 1.50WL = 1.35(6.43) - 1.5(-1.056) = **10.265 KN/m$^2$**
4. **Combination -4 , Dead load + live load + Wind load**
   - ✓ Pd = 1.35DL + 1.50LL + 0.9WL= 1.35(6.43) + 1.5(0.4) + 0.9(-1.056) = **8.331 KN/m$^2$**
5. **Combination -5 , Dead load + live load - Wind load**
   - ✓ Pd = 1.35DL + 1.50LL + 0.9WL= 1.35(6.43) + 1.5(0.4) - 0.9(-1.056) = **10.231 KN/m$^2$**

The maximum design load from those various load combinations seem **10.231KN/m$^2$**

### 3.3.2. Design load (Pd) on the ground floor

- **Partition wall load on the ground floor slab**

**For Panel 2(S-2)**

- ✓ Dead load of HCB = ($L_{HCB} * t_{HCB} * H_{HCB} * \gamma_{HCB}$) = (5*0.15*3*14) =**31.5KN**
- ✓ Dead load of plaster = ($L_{HCB} * t_{Plaster} * H_{HCB} * \gamma_{Plaster}$) = (5*0.04*3*23) =**13.8KN**
- ✓ Total Dead load = Dead load of HCB +Dead load of plaster = 31.5+13.8= **45.3KN**
- ✓ Lx=5m, Ly=5m
- ✓ Area of the floor = Lx*Ly= 5m*5m =**25m²**
- ✓ Design load on the panel Pd = $\frac{\text{Total dead load}}{\text{Area of the floor}} = \frac{45.3}{25}$ =**1.812KN/m²**

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form

- **Self-weight of the ground floor based on panel function**

**For Corrider function**

- Dead Load = $t_{Marbelf} * \gamma_c$ = 0.02*24 =**0.54 KN/m²**
- Dead load of Cement sreed = $t_{cement\ screed} * \gamma_{cs}$ = 0.03*23 = **0.69 KN/m²**
- Dead load of RC slab= $t_{RC\ slab} * \gamma_c$ = 0.2*25 = 5 **KN/m²**
- Dead load of Bottom plastereing & painting = $t_{plaster} * \gamma_p$ = 0.02*23= **0.46**5 **KN/m²**
- Totaal Dead load = 0.54+0.69+5+0.46 = **6.69 KN/m²**

Computation of the rest of the panel for floor slab see on appendex in Tabular form.

**Design factored load on the ground floor**

- **For panel 1(S-1)**
- Pd = 1.35DL+1.5LL
  - ✓ DL = Self weight of slab + Partition wall load
    = 6.69+0 = **6.69KN/m²**
  - ✓ LL=5KN/m²
  - ✓ Pd= 1.35(6.69) + 1.5(5) =**16.53 KN/m²**

Computation of the rest of the panel for floor slab see on appendex in Tabular form.

## 3.4. Moment Analysis of Solid slabs for support & span moment

Slabs with side ratio less than 2 are treated as two way slabs and analysis can be made by means of coefficients on the basis of the following assumptions and procedures.

- ✓ The slab is composed of rectangular panels, supported at all four edges by walls or beams, stiff enough to be treated as an unyielding.
- ✓ Slabs are subjected to uniform load or concentrated load which can be converted to equivalent uniform load not exceeding 20% of the total load.

**Individual Moment Determination**

Moments for each panels with edge either simply supported or fully fixed are calculated from,

$$Mi = \beta iPdLx^2$$

Where: Mi = design moment per unit width at the point of reference

$\beta i$ = Coefficient given in table, as a function of Ly/Lx

Pd = Design uniform load (KN/m2)

Lx = shorter span of the panel
Ly = longer span of the panel

Subscripts for moments and moments' coefficients (αi) have the following meaning.

- s = support
- f = field (span)
- x = direction of shorter span
- y = direction of longer span

Notations for different critical moments and edge numbers are shown below;

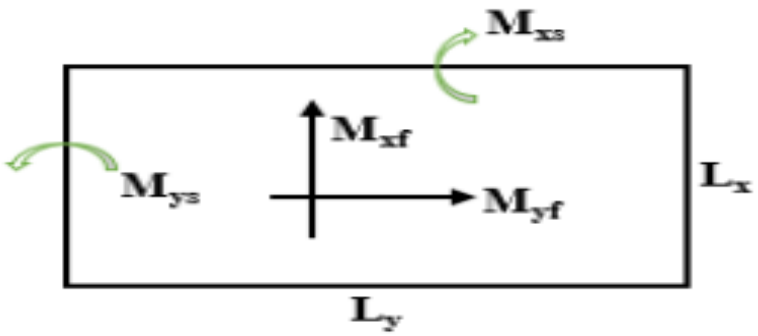



Figure 3. 6**:** Support and span moment notations

**Moments in Continuous Slabs**

**General**

1. The first stage of design is to determine support and span moments for all panels individually by treating their edges as either simply supported or fully fixed. External edges are generally considered as simply supported and continuous edges are considered as fully fixed in this stage.
2. If the slab is connected with an external wall or if any of its edges is partly fixed and partly simply supported, the following procedure may be adopted:

(a) The ratio of the actual support moment to the bending moment of fully fixed slab, or the ratio of the width of fixed part to the width of the simply supported part of the edge is evaluated.

(b) The bending moments of the slab are then computed by interpolating between different support conditions

**3.** For each support over which the slab is continuous there will thus generally be two different support moments. The difference may be distributed between the panels on either side of the support to equalize their moments, as in the moment distribution method for frames.

Before calculating the value of moment applied on the slab we have to get the moment coefficients according to EBCS-2, 2015 Table A-1.

### 3.4.1. Moment analysis for roof floor

#### 3.4.1.1. Calculation of moment for cantilever on the roof floor

**For roof 1 at Z =16.25m**

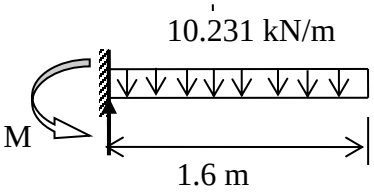
- $M = \frac{Pd * L_x^2}{2}$

Where:- Pd - Factored design load of the cantiliver

Lx – Shorter span of the panel

**For C-1**

- Pd = 10.231KN/m$^2$ , Lx =1.6m
- $M = \frac{Pd * L_x^2}{2} = \frac{10.231 * 1.6^2}{2}$ = **13.0957 KN/m**




**For the first floor C-1**

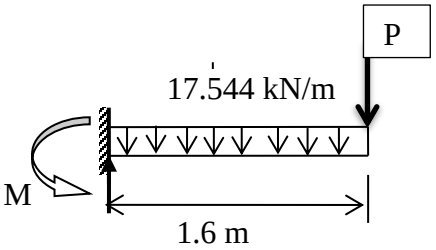
- $M = \frac{Pd * L_x^2}{2} + PLx$

Where:- Pd - Factored design load of the cantiliver

Lx – Shorter span of the panel

**For C-1**

- Pd = 17.544KN/m$^2$ , P= 11.16KN Lx =1.6m




- $M = \frac{Pd * L_x^2}{2} = \frac{17.544 * 1.6^2}{2} + 11.16 * 1.6$ = **40.3123 KN/m**

Computation of the rest of the panel for floor slab see on appendex A-B in Tabular form

### 3.4.1.2. Moment Analysis using strip method for roof floor

Strip method is a lower bound approach, based on the satisfaction of equilibrium requirements everywhere in the slab. By the strip method, a moment field is first determined that fulfills equilibrium requirements, after which the reinforcement of the slab at each point is designed for this moment field. If a distribution of moment can be found that satisfies both equilibrium and boundary conditions for a given external loading, and if the yield moment capacity of the slab is nowhere exceeded, then the given external loading will represent a lower bound of the true carrying capacity.

**Advantages of strip methods**

1. The strip method gives results on the safe side, which is certainly preferable in practice.
2. The strip method is a design method by which the needed reinforcement can be calculated.

**Choice of Load Distribution**

Theoretically, the load W can be divided arbitrarily between x- and y- directions. Different divisions will of course, lead to different patterns of reinforcement, and all will not be equally appropriate. The desired goal is to an arrangement of steel that is safe and economical and that will avoid problems at the service load level associated with excessive cracking or deflections. Knowledge of the moment field according to the elastic theory is thereby very helpful. In general, the designer may be guided by his knowledge of the general distribution of elastic moments.

**1. Quarter-circular**

**Step 1: Load on slab**

**Fo panel (S-1, S-8, S-9,S-17) at Z = 16.25m**

- For this panels we have checked and compared the moment using strip and equivalent method for the moment analysis so we have selected the best method for our structure to be more save so that we have selected that equivalent method due to large amount of moment.
- Factored design load on the roof floor, Pd= **10.231KN/m**

**A. Strip method**

The load dispersion direction can be predicted as shown in the figure below

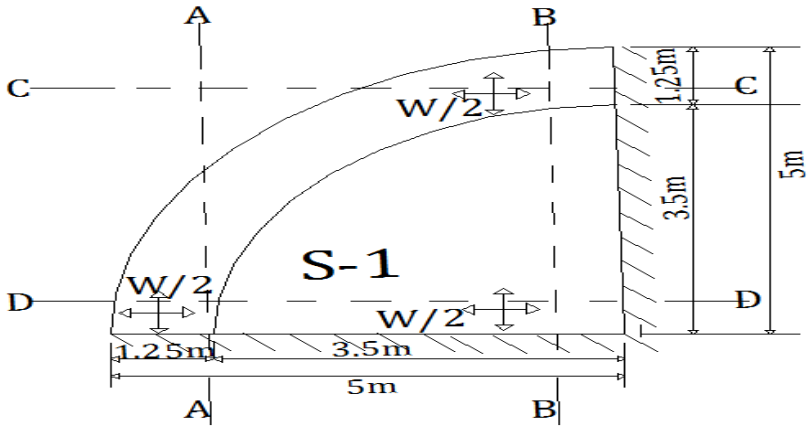
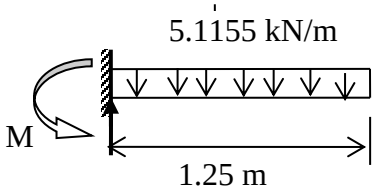



Figure 3. 7**:** Quarter circular slab

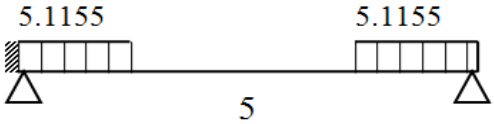
- ✓ In a corner load is divided equally in the two direction i'e elsewhere 100% of load is assigned to the direction indicated by the arrows.
- ✓ Edge strip width = $\frac{b}{4} = \frac{5}{2}$ = **1.25m**
- ✓ Load, W = $\frac{W}{2} = \frac{10.231}{2}$ = **5.1155KN/m**
- ✓ Ratio of support moment to span moment is assumed as 2

➢ **Calculation of moment Y-direction edge strip along section A-A**




- ✓ Simple support moment, $M_s = \frac{Wl^2}{2} = \frac{5.1155*1.25^2}{2}$ =**3.996 KN/m**
- ✓ Negative moment Mys = $\frac{2}{3}$ *M = $\frac{2}{3} * 3.996$ = **2.664 KN/m**
- ✓ Positive moment Myf = $\frac{1}{3} * M = \frac{1}{3} * 3.996$ = **1.332KN/m**

➢ **Calculation of moment Y-direction middle strip along section B-B**

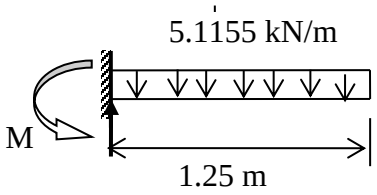



(a) $w_y$ and $m_y$ along B-B

- ✓ Cantilever moment: $m_x = \frac{W}{2} * \frac{b}{4} * \frac{b}{8} * = \frac{10.231}{2} * \frac{5}{4} * \frac{5}{8}$ = **3.996KNm**

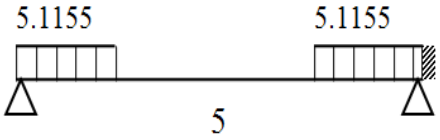
- ✓ Negative Moment: $m_{xs}$ = 3.996* 2/3 = **2.664 kNm**
- ✓ Positive moment: $m_{xf}$ = 3.996 * 1/3 = **1.332 kNm**

➢ **Calculation of moment X-direction edge strip along section C-C**




- ✓ Simple support moment, $M_s = \frac{Wl^2}{2} = \frac{5.1155*1.25^2}{2}$ = **3.996 KN/m**
- ✓ Negative moment Mys = $\frac{2}{3}$ *M = $\frac{2}{3} * 3.996$ = **2.664 KN/m**
- ✓ Positive moment Myf = $\frac{1}{3} * M = \frac{1}{3} * 3.996$ = **1.332KN/m**

➢ **Calculation of moment X-direction middle strip along section D-D**




(a) $w_x$ and $m_x$ along D-D

- ✓ Cantilever moment: $m_x = \frac{W}{2} * \frac{b}{4} * \frac{b}{8} * = \frac{10.231}{2} * \frac{5}{4} * \frac{5}{8}$ = **3.996KNm**
- ✓ Negative Moment: $m_{xs}$ = 3.996* 2/3 = **2.664 kNm**
- ✓ Positive moment: $m_{xf}$ = 3.996 * 1/3 = **1.332 kNm**

From the above moment analysis, take the governing span & support moment.

Table 3. 8: Governing span and support moment

| Direction | Moment | Value |
|---|---|---|
| X | Support | 2.664 |
| | Span | 1.332 |
| Y | Support | 2.664 |
| | Span | 1.332 |

**B. <u>Equivalent methods</u>**

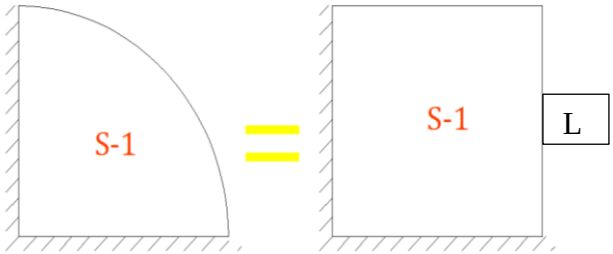



Figure 3. 8: Layout of panel 1(S-1)

- L=$\sqrt{\frac{\pi R^2}{4}}$
- R= 5m
- L=$\sqrt{\frac{\pi R^2}{4}}$ = L=$\sqrt{\frac{\pi(5)^2}{4}}$ =**4.43m**
  - ✓ Lx = **4.43m**
  - ✓ Ly = **4.43m**
  - ✓ Ly/Lx = **4.43m/4.43m**

Table 3. 9: Moment coefficients t for panel 1(S-1)

| Panel | Ly | Lx | $l_y/l_x$ | $\beta_{xs}$ | $\beta_{xf}$ | $\beta_{ys}$ | $\beta_{yf}$ |
|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |

### 3.4.1.3. Moment analysis using coefficients method for the roof floor

**Support and span moments of two-way slab**

- **Support moments**
  - ✓ $M_{ys} = \beta_{ys} \times P_d \times l_x^2$
  - ✓ $M_{xs} = \beta_{xs} \times P_d \times l_x^2$
- **Span moments**
  - ✓ $M_{yf} = \beta_{yf} \times P_d \times l_x^2$
  - ✓ $M_{xf} = \beta_{xf} \times P_d \times l_x^2$

**For panel 1(S-1)**

- **Support moments**
  - ✓ $M_{ys} = 0.045 \times 10.231 \times 4.43$ = **9.04KNm**
  - ✓ $M_{xs} = 0.047 \times 10.231 \times 4.43^2$ = **9.44KNm**
- **Span moments**
  - ✓ $M_{yf} = 0.034 \times 10.231 \times 4.43^2$ = **6.83KNm**
  - ✓ $M_{xf} = 0.036 \times 10.231 \times 4.43^2$ = **7.23KNm**

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form.

**Rectangular slab panel using strip method**

**For Panel 4(S-4)**

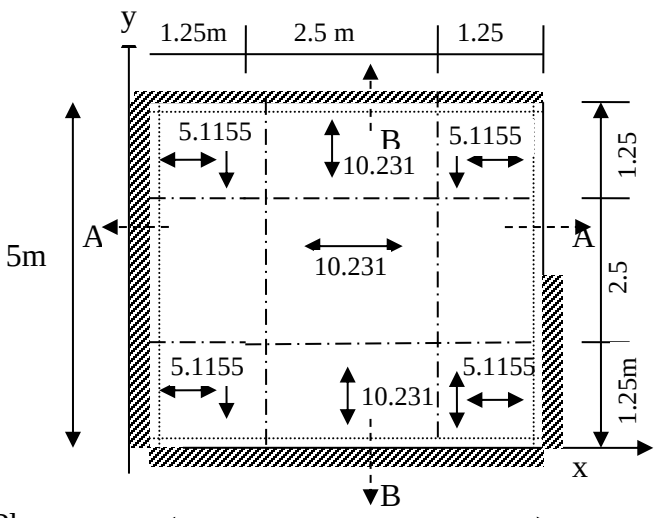
The discontinuity lines are selected as shown in the figure below.

Edge strip width = b/4 = 5/4 = 1.25 m

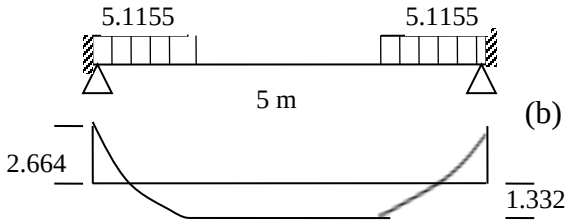
In the corners the load is divided equally in the two directions; elsewhere 100 percent of load is assigned to the direction indicated by the arrows.

A ratio of support moment to the span moment of 2 is used

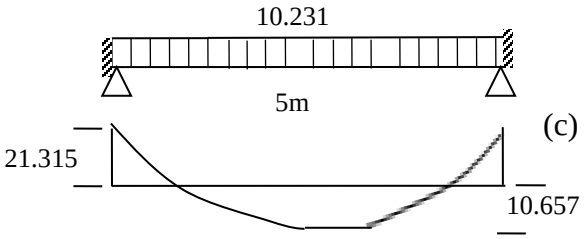
**W=10.231KN/M**



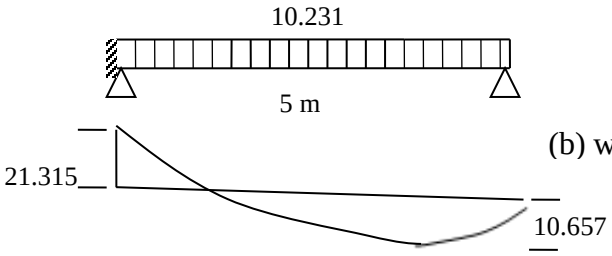

(a) Plan



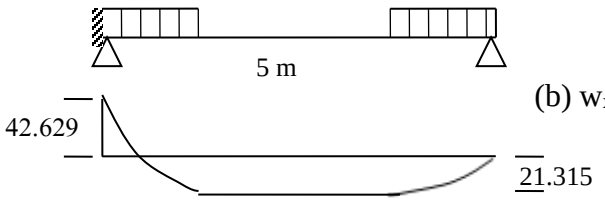

(b) $w_x$and $m_x$along Edge strip-1



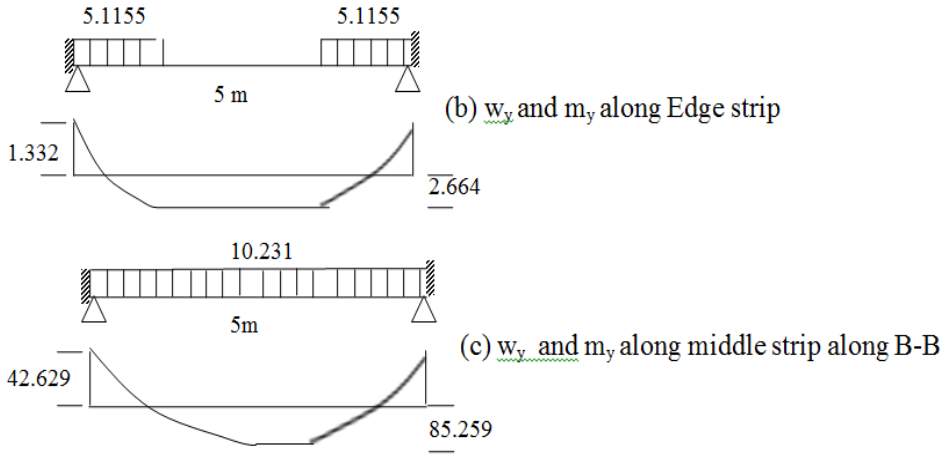

(c) $w_x$and $m_x$ along middle strip along A-A-1




(b) $w_x$and $m_x$ middle stripalong A-A-2




(b) $w_x$and $m_x$ along Edge strip-2

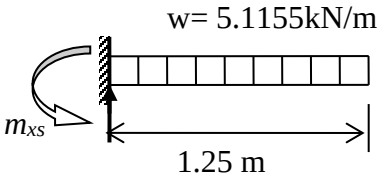



(b) $w_y$ and $m_y$ along Edge strip

(c) $w_y$ and $m_y$ along middle strip along B-B

- **Calculation of moments**

**X direction edge strip -1:**




Cantilever moment: $m_x = 5.1155 * 1.25^2/2 =$**3.996 kNm**

Negative Moment: $m_{xs} = 3.996 * 2/3 =$ **2.664 kNm**

Positive moment: $m_{xf} = 3.996 * 1/3 =$ **1.332 kNm**

**X direction middle strip along A-A-1:**

Simply supported span moment: $m_x = 10.231 * 5^2/8 =$ **31.972 kNm**

Negative Moment: $m_{xs} = 31.972 * 2/3 =$ **21.345 kNm**

Positive moment: $m_{xf} = 31.972 * 1/3 =$ **10.657 kNm**

**X direction middle strip along A-A-2:**

Simply supported span moment: $m_x = 10.231 * 5^2/8 =$ **31.972 kNm**

Negative Moment: $m_{xs} = 31.972 * 2/3 =$ **21.345 kNm**

Positive moment: $m_{xf} = 31.972 * 1/3 =$ **10.657 kNm**

**X direction Edge strip-2:**

Simply supported span moment: $m_x = 5.1155 * 5^2/2 =$ **63.944 kNm**

Negative Moment: $m_{xs} = 63.944 * 2/3 =$ **42.629 kNm**

Positive moment: $m_{xf} = 63.944 * 1/3 =$ **21.315 kNm**

**Y direction middle strip along B-B:**

Simply supported span moment: $m_y = 10.231 * 5^2/2 =$ **127.888kNm**

Negative Moment: $m_{ys} = 127.888* 2/3 =$ **85.259 kNm**

Positive moment: $m_{yf} = 127.888 * 1/3 =$ **42.629 kNm**

**Y direction edge strip:**

Cantilever moment: $m_y = 5.1155 * 1.25^2/2 =$ **3.996kNm**

Negative Moment: $m_{ys} = 3.996 * 2/3 =$ **2.664 kNm**

Positive moment: $m_{yf} = 3.996* 1/3 =$ **1.332 kNm**

**For Panel 5(S-6)**

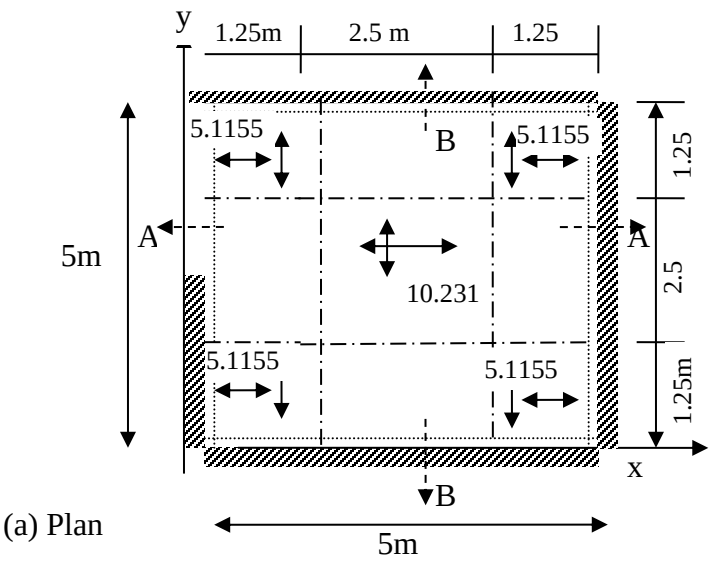
The discontinuity lines are selected as shown in the figure below.

Edge strip width = b/4 = 5/4 = 1.25 m

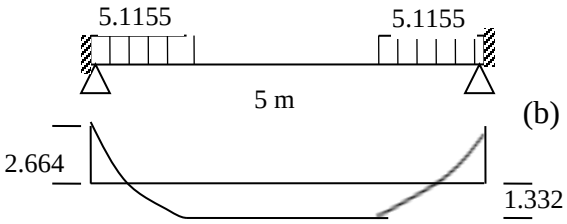
In the corners the load is divided equally in the two directions; elsewhere 100 percent of load is assigned to the direction indicated by the arrows.

A ratio of support moment to the span moment of 2 is used

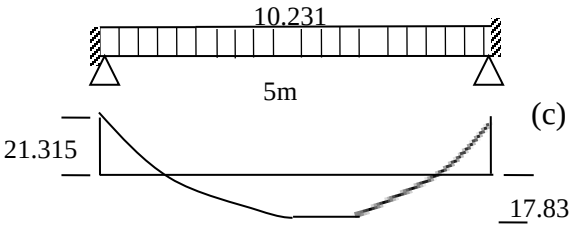
**W=10.231KN/M**



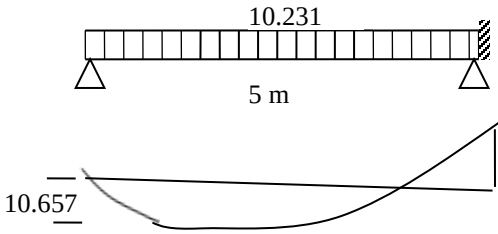

(a) Plan



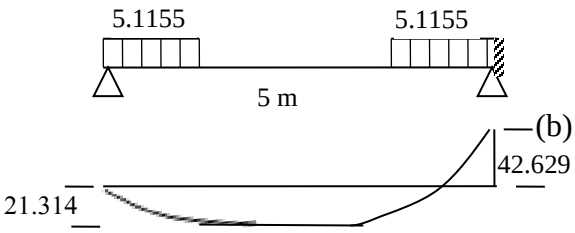

(b) $w_x$and $m_x$along Edge strip-1



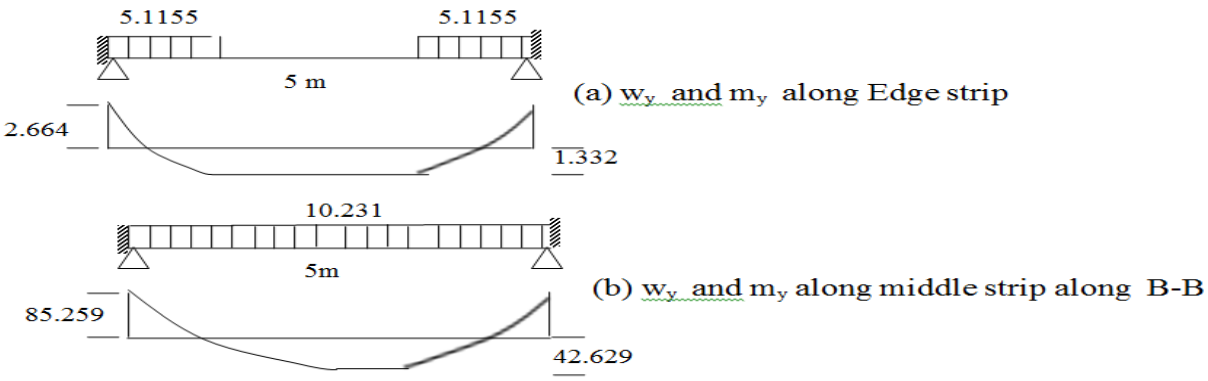

(c) $w_x$and $m_x$ along middle strip along A-A-1




(b) $w_x$and $m_x$ middle stripalong A-A-2

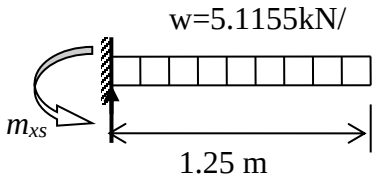



(b) $w_x$and $m_x$ along Edge strip-2




- **Calculation of moments**

**X direction edge strip -1:**




Cantilever moment: $m_x = 5.1155 * 1.25^2/2 =$ **3.996 kNm**

Negative Moment: $m_{xs} = 3.996* 2/3 =$ **2.664 kNm**

Positive moment: $m_{xf} = 3.996 * 1/3 =$ **1.332 kNm**

**X direction middle strip along A-A-1:**

Simply supported span moment: $m_x = 10.231 * 5^2/8 =$ **31.972 kNm**

Negative Moment: $m_{xs} = 31.972 * 2/3 =$ **21.315 kNm**

Positive moment: $m_{xf} = 31.972 * 1/3 =$ **10.657kNm**

**X direction middle strip along A-A-2:**

Simply supported span moment: $m_x = 10.231 * 5^2/8 =$ **31.972 kNm**

Negative Moment: $m_{xs} = 31.972 * 2/3 =$ **21.315 kNm**

Positive moment: $m_{xf} = 31.972 * 1/3 =$ **10.657kNm**

**X direction Edge strip-2:**

Simply supported span moment: $m_x = 5.1155 * 5^2/2 =$ **63.943kNm**

Negative Moment: $m_{xs} = 63.943 * 2/3 =$ **42.629 kNm**

Positive moment: $m_{xf} = 63.943 * 1/3 =$ **21.314 kNm**

**Y direction middle strip along B-B:**

Simply supported span moment: $m_y = 10.231 * 5^2/2 =$ **127.889kNm**

Negative Moment: $m_{ys} = 127.889* 2/3 =$ **85.259 kNm**

Positive moment: $m_{yf} = 127.889 * 1/3 =$ **42.629 kNm**

**Y direction edge strip:**

Cantilever moment: $m_y = 5.1155 * 1.25^2/2 =$ **3.996kNm**

Negative Moment: $m_{ys}$ = 3.996 * 2/3 = **2.664 kNm**

Positive moment: $m_{yf}$ = 3.996 * 1/3 = **1.332 kNm**

Computation of the rest of the panel for floor slab see on appendex A-B in Tabular form

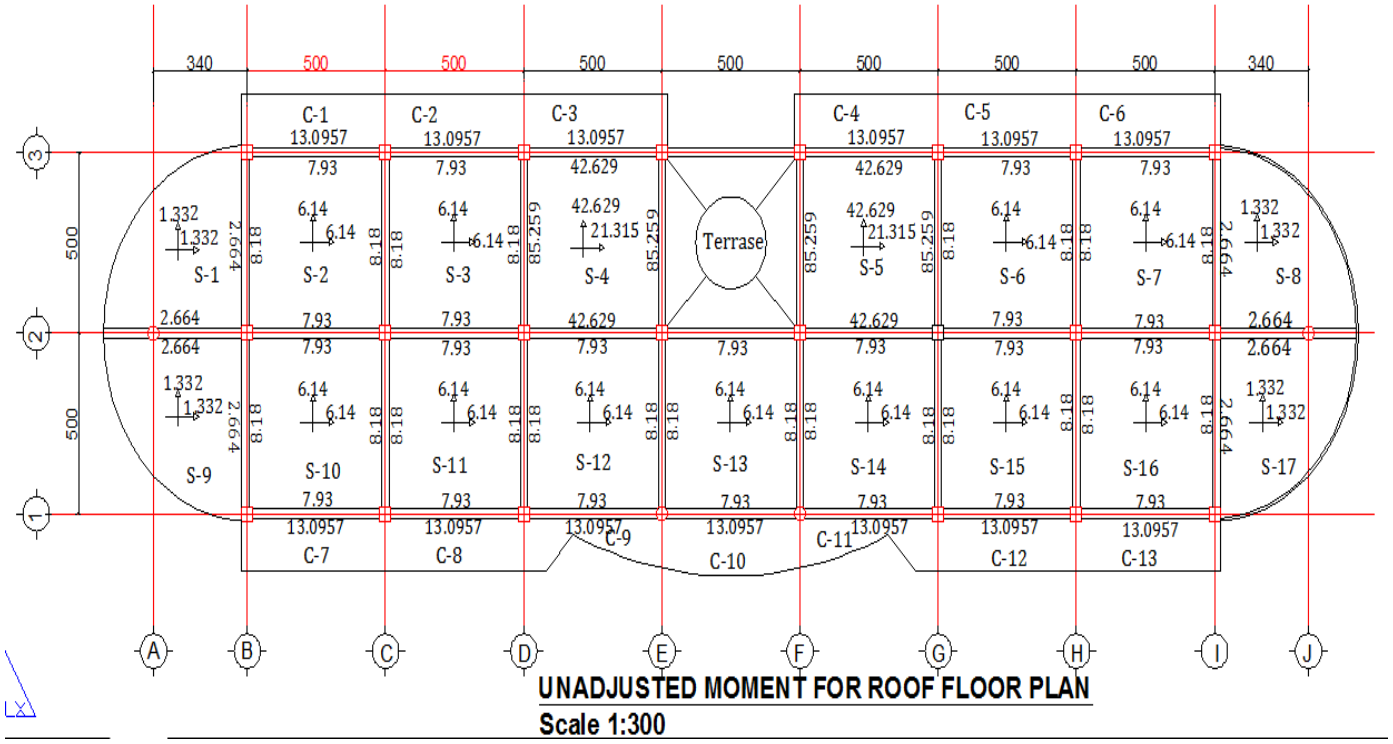



Figure 3. 9:Unadjusted Moment Analysis of roof slab

### 3.4.1.4. Moment adjustment roof floor

#### i. Support adjustment

- **Method-1** it may be used when difference between initial support moment are less than 10 percent of the larger moment. When such a case has occurred dimensioning is normally carried out either based on the average initial moment at the support.
- **Method-2** it may be used when difference between initial support moment are greater than 10 percent of the larger moment. When such a case has occurred dimensioning is carried out using the stiffness of the slab and the effective length. Here we use moment distribution method to adjust support moment.

$$M_d = M_R - \frac{K_R}{K_R + K_L} * \Delta M, \text{ taking the rightOr}$$

$$M_d = M_L + \frac{K_L}{K_R + K_L} * \Delta M, \text{ taking the left}$$

Where: $M_L$-be moment in the left

$M_R$-be the moment in the right

K-the stiffness of the slabs, $K = \frac{I}{L_X}$

**ii. Span moment adjustment**

If the moment in the adjusted support decreases, the span moment are increased to compensate for the changes in the support moments. The design moments for the spans are calculated as:

Mxd = Mxf + CxΔM

Myd= Myf + CyΔM

Where:ΔM = the change in moment in all supports.

Cx and Cy are coefficients for adjusting span moments, From EBCS 2, tabel-A-2

**Calculation of adjusted span moments based on changed support moments for the roof floor**

- ✓ Span moment adjustment is done only for those panels whose support moments has decreased upon adjustment.
- ✓ The panels in the table below are panels whose support moments have decreased, so their span moments have to be adjusted as shown in the table.
- ✓ Span moment adjustment is done using coefficients specified in EBCS 2-1995( page113).

➢ If the ratio $100 * \frac{Mi - Mi}{Mi}$ exceeds 20% we use moment distribution method, if not we use simple averaging to balance the moment between the supports.

➢ **Support and span moment adjustment for the roof floor**

✓ **Support moment adjustment for the roof floor**

**Adjustment for S-1 & S-2**

Mys (S-1) = 9.04KNM

Mys (S-2) = 8.18 KNM

$100 * \frac{Mxs-Mxs}{Mxs} = 100 * \frac{9.04-8.18}{9.04} = \mathbf{9.51\%}$

9.51% <20% so, we use Average method.

Ms (adjusted)=$\frac{9.04+8.18}{2} = \mathbf{8.61KNm}$

**Adjustment for S-1 & S-9**

Mxs (S-1) = 9.44KNM

Mxs (S-9) = 9.44 KNM

So, we use No adjustment Ms (adjusted)= **9.44KNm**

**Adjustment for S-3 & S-4**

Mys (S-3) = 85.259KNM

Mys (S-4) = 8.18 KNM

$100 * \frac{Mxs-Mxs}{Mxs} = 100 * \frac{85.259-8.18}{85.259} = \mathbf{90.41\%}$

90.41% >20% so, we use Moment distribution

$\Delta M = Mys - Mys = 85.259 - 8.18 = 77.079\,KNm$

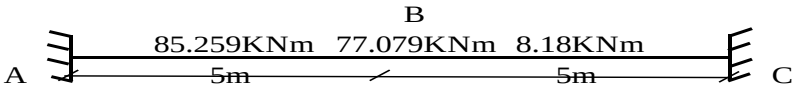



Figure 3. 10: moment distribution for panel S-1 & S-2

Table 3. 10: Support moment adjustment by distribution method

| Member | Relative stiffness(k) | Sum of k | DF |
|---|---|---|---|
| AB | KAB=$\frac{I}{L}=\frac{1}{5}=$**0.2** | **0.4** | DF=KAB/(KAB+KBC)=**0.5** |
| BC | KBC=$\frac{I}{L}=\frac{1}{5}=$**0.2** | | DF=KBC/(KBC+KAB)=**0.5** |

$M_d = M_R - \frac{K_R}{K_R + K_L} * \Delta M$, taking the right…….. $M_d = 85.259 - 0.5 * 77.079 = 46.72KNm$

Or

$M_d = M_L + \frac{K_L}{K_R + K_L} * \Delta M$, taking the left…… $M_d = 8.18 + 0.5 * 77.079 = 46.72 KNm$

Where: K = Relative stiffness

DF = distribution factor

Therefore, the adjusted moment For Panel S-3 & S-4 ΔMs=**46.72 KNm**

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form.

**Span moment adjustment for the roof floor**

Span moment is adjusted in the direction where maximum support moments exist. To adjust span moment, we add the maximum adjusted support moment and span moment in that direction then deduct the adjusted support moment.

**For panel S-1 for the roof floor**

| **Unadjusted moment (KNm)** | **Adjusted moment support moment (KNm)** |
|---|---|
| Mys= 9.04 KNm | Mxs = 9.44 KN-m |
| Myf = 6.83KNm | Mys = 8.61KN-m |
| Mxs = 9.44 KNm | |
| Mxf = 7.23 KNm | |

ΔMxs = 9.44–9.44 =**0 KNm**

ΔMys = 9.04– 8.61= **0.43KNm**

ΔMxf = Cx*ΔMxs + Cx*ΔMys = 0.38*0 + 0.28* (0.43)= **0.1204KNm**

Mxf adj = Mxf un adj+ ΔMxf = 7.23+0.1204 = **7.3504 KNm**

ΔMyf=Cy* ΔMxs+ Cy* ΔMys=0.28*0+ 0.38*(0.43)= **0.1634 KN-m**

Myf adj = Myf unadj + ΔMyf = 6.83+0.1634 =**6.9934 KNm**

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form.

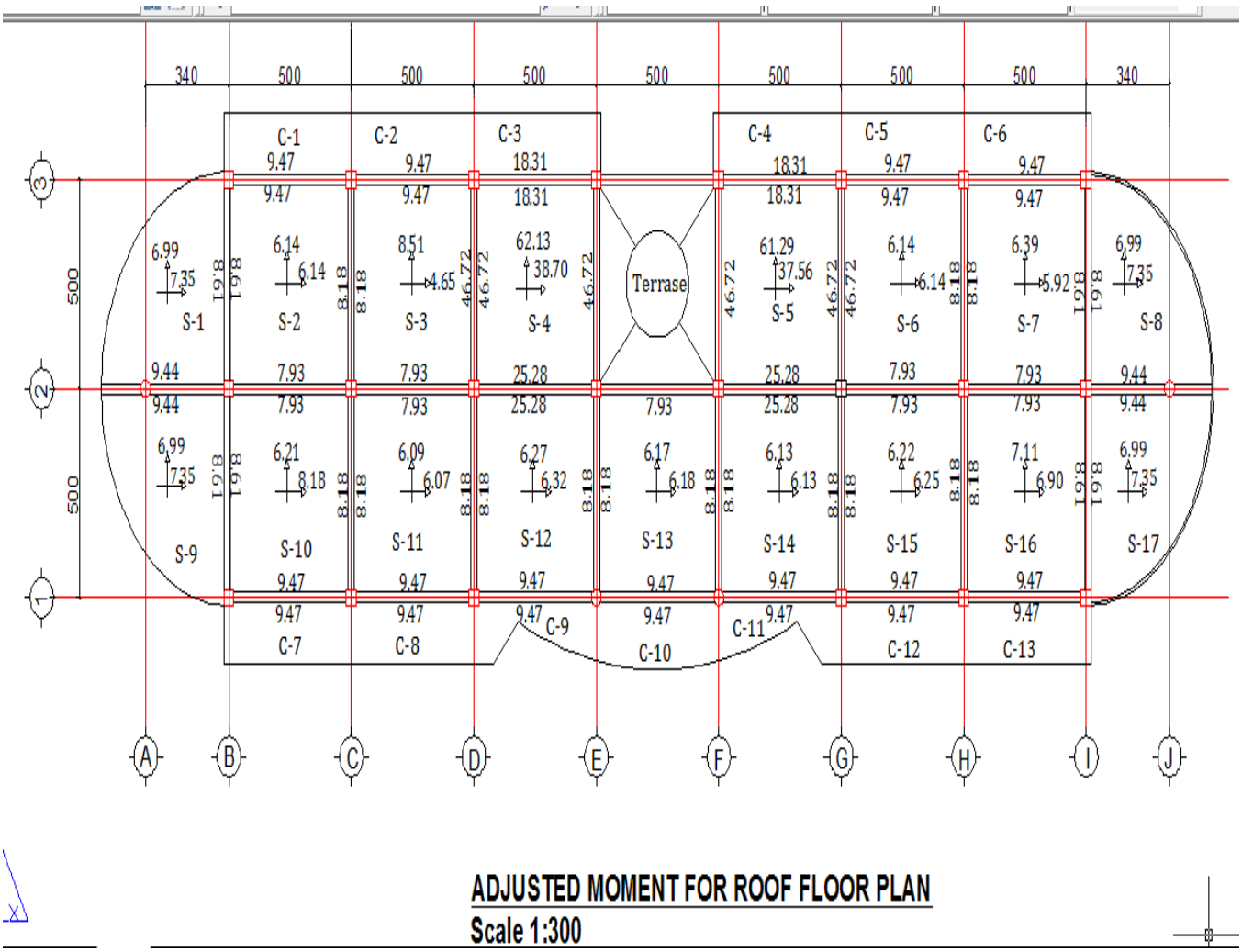



Figure 3. 11: Adjusted moment analysis of roof slab

### 3.4.1.5. Flexural Reinforcement calculation for the roof floor

**Design Data and Material Property specification we have considered**

- **Material**
  - ✓ Concrete**:** Class I workmanship.
  - ✓ Grade of concrete we used C-25(super-structure) and C-30(sub-structure).
  - ✓ Unit weight of concrete, ϒc = 25KN/$m^3$
  - ✓ Partial Safety factor for ordinary loading γc=1.5…...EBCS-2, 2015 Table 2.1N (Page 20).
- **Design strength value**

**i. Design strength of concrete(fcd)**

✓ **In compression**

$$fcd = 0.85 * \frac{fck}{\gamma c}$$ …….EBCS-2, 2015 Page 20.

Where: fck - Characteristic of compressive strength of concrete.

γc - Partial Safety factor for ordinary loading=1.5.

**Characteristic of compressive strength of concrete (fck)**

For C-25 fck =0.8*25Mpa=20Mpa or from EBCS-2, 2015 Table 3.1 (Page 25).

$$fcd = 0.85 * \frac{20}{1.5} =$$ **11.33 Mpa**

✓ **In tension**

$$fctd = \frac{fctk}{\gamma c}$$…….EBCS-2, 2015 Page 20

Where: fctd - Design of tensile strength of concrete.

fctk - Characteristic tensile strength of concrete.

γc - Partial Safety factor for ordinary loading=1.5.

**Characteristic of tensile strength of concrete(fctk),**

fctk =0.7*fctm……..EBCS-2, 2015 Page 25

Where: fctm -Characteristiccylinder compressive strength.

**Characteristic cylinder compressive strength(fctm),**

$fctm = 0.3*(fck)^{2/3}$……..EBCS-2, 2015 Table 3.1 (Page 25)

Where: fck - Characteristic compressive strength of concrete=20Mpa.

$fctm = 0.3*(20)^{2/3} = 0.3(20)^{2/3} =$ **2.2104Mpa**

$fctk = 0.7*(fctm)^{2/3} = 0.7(2.2104)^{2/3} =$ **1.547Mpa**

Then, $fctd = \frac{1.547}{1.5}$Mpa= **1.03 Mpa**

**ii. Design strength of steel(fyd)**

$$fyd = \frac{fyk}{\gamma s}$$

Where: fyk - Grade of steel, S-500 EBCS-2, 2015 (page 35)

γs-Reinforcing steel factor =1.15 Mpa for ordinary loading and class I work….EBCS-2, 1995 Table 3.1 (Page 22)

Then, $fyd = \frac{fyk}{\gamma s} = \frac{500}{1.15} =$ **434.78Mpa**

✓ Secant modulus of elasticity (Ecm)= 30Gpa….EBCS-2, 2015 Table 3.1 (Page25)

✓ Modulus of elasticity (Es)= 200Gpa….EBCS-2, 2015 (Page37)

- Total depth of slab= 200mm
  - ✓ Effective depth, d: in x-direction ;200-22-12/2=172

    in y-direction; 200-22-12-12/2=160
- Width, b= 1000mm

**Checking of depth for flexure for roof floor panel 1(S-1), Msd = 9.44KNm**

A. $\mu sd = \left(\frac{Msd}{d^2 * b * fck}\right) = \left(\frac{9.444 * 1000000}{172 * 172 * 1000 * 20}\right) =$ **0.016**

B. $d = \sqrt{m_{max}/(\mu sd * f_{ck} b)} = \sqrt{9.44 * \frac{10^6}{0.016 * 20 * 1000}} =$ **171.76 < 200mm…okey**

Therefore, depth of 200mm satisfy flexural requirement for all floors.

C. $Z = \left(d(0.5 + \sqrt{0.25 - \mu sd/1.134})\right)$

$= \left(172(0.5 + \sqrt{0.25 - 0.016/1.134})\right) =$ **169.55**

D. $As_{min} = Max\begin{Bmatrix} 0.26\left(\frac{fctm}{fyk}\right)bd > Asmax = 0.04bd \\ 0.00013btd \end{Bmatrix}$

$== Max\begin{Bmatrix} 0.26\left(\frac{2.2104}{500}\right) * 1000 * 172 = \mathbf{197.7mm^2} \\ 0.00013 * 1000 * 172 = \mathbf{22.36mm^2} \end{Bmatrix}$

$As_{min} =$ **$197.7mm^2$**

E. $As = \left(\frac{Msd}{0.87 * fyd * Z}\right) = \left(\frac{9.44 * 10^6}{0.87 * 434.78 * 169.55}\right) =$ **$147.2mm^2$**

F. $As_{req} = Max\begin{Bmatrix} Ascal = \mathbf{147.2mm^2} \\ Asmin = \mathbf{197.7mm^2} \end{Bmatrix}$

$As_{req} =$ **$197.7mm^2$**

G. $As_{max}$ =0.04bD = 0.04*1000*200 = **8000mm >197.7mm…….it is okey**

H. $as = \left(\frac{\pi \emptyset^2}{4}\right) = \left(\frac{3.14 * 12 * 12}{4}\right) =$ **$113.04m^2$**

I. $Specing = \frac{b * as}{As} = \frac{1000 * 113.04}{197.7} =$ **571.781mm**

J. $Sprovide = Min\begin{Bmatrix} 3.5d = 3.5 * 200 = 700mm \\ 450mm \\ specing = 571.781mm \end{Bmatrix}$

Therefore, Provide, Ø 12 C/C 450mm for panel 1(S-1).

Computation of the rest of the panel for floor slab see on appendex in Tabular form

### 3.4.1.6. Check for defelection and Serviceability Requirement for roof floor

**For panel 1(S-1) for the roof floor**

To check the depth for deflection weathers it satisfies the serviceability requirement we use the new codes ES EN 1991:2015.

**As an example for panel 1(S-1) Msd=9.44KNm**

Initially we assumed $\rho_o = \rho$.but we can calculate them as follows

- Percentage of required tension reinforcement,
  - ✓ $\rho = \frac{A_{S,req}}{bd}$
  - ✓ $AS_{,req} = \frac{b*as}{As,cal}$
  - ✓ $\text{fyd} = \frac{\text{fyk}}{\gamma s} = \frac{500}{1.15} = \mathbf{434.78Mpa}$
  - ✓ $\mu sd = \left(\frac{\text{Msd}}{d^2*b*fck}\right) = \left(\frac{9.444*1000000}{172*172*1000*20}\right) = \mathbf{0.016}$
  - ✓ $Z = \left(d\left(0.5 + \sqrt{0.25 - \mu sd/1.134}\right)\right)$

    $= \left(172\left(0.5 + \sqrt{0.25 - 0.016/1.134}\right)\right) = \mathbf{169.55}$
  - ✓ $As,cal = \left(\frac{\text{Msd}}{0.87*fyd*Z}\right) = \left(\frac{9.44*10^6}{0.87*434.78*169.55}\right) = \mathbf{147.2mm^2}$
  - ✓ $as = \left(\frac{\pi\emptyset^2}{4}\right) = \left(\frac{3.14*12*12}{4}\right) = \mathbf{113.04m^2}$
  - ✓ $AS_{,req} = \frac{b*as}{As,cal} = \frac{1000*113.04}{147.2} = \mathbf{768.0mm^2}$
  - ✓ $\rho = \frac{768.0}{1000*172} = \mathbf{0.004465}$
  - ✓ $\rho' = \frac{Ast}{b_w d} \leq 0.02 = \frac{282.6}{172*1000} = 0.001643$
- Reference reinforcement ratio,
  - ✓ $f_{ck} = 20\text{Mpa}$
  - ✓ $\rho_o = (f_{ck})^{1/2}*10^{-3} = (20)^{1/2}*10^{-3} = \mathbf{0.00447}$

Now , $\rho < \rho o$…….0.004465<0.00447, then

$$\frac{l}{d} = N * K * F1 * F2 * F3$$

Where;

- ✓ $\frac{l}{d}$:- is the limit span/depth

✓ $N = \left[11 + 1.5\sqrt{f_{ck}}\frac{\rho_o}{\rho} + 3.2\sqrt{f_{ck}}\left(\frac{\rho_o}{\rho} - 1\right)^{\frac{3}{2}}\right]$ if $\rho \leq \rho_o$

- $N = \left[11 + 1.5\sqrt{20}\frac{0.00447}{0.00446} + 3.2\sqrt{20}\left(\frac{0.00447}{0.00446} - 1\right)^{\frac{3}{2}}\right]$

  **N = 17.7215**
- K = 1.3
- F1=500/($f_{yk}$*$\frac{A_{S,cal}}{A_{S,req}}$)= 500/(500*$\frac{147.2}{768.0}$)=**5.22**
- F2=F3=1
- b=1000mm, d= 172mm, lx=4430mm
- $\frac{lx}{d} = 17.72 * 1.3 * 5.22 * 1 * 1$=**120.2**
- d= 4430/120.2 =**36.86mm < 200mm…..so its okey safe**

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form.

### 3.4.1.7. Load Transfer from Roof floor Slabs to Beams

- **Loads on Supporting Beams**

Since the design of the slab is done by coefficient method, loads are transferred to beam by load transferring mechanism. Dead load with wall load and live load is present. For the load transfer from the slab to the beams, un-factored slab DL and LL are computed separately. The design loads on beams supporting solid slabs spanning in two directions at right angles and supporting uniformly distributed loads may be assessed from the following equations obtained from Eurocode, BS 8110-1:1997 section 3.5.3.7

A. The design loads on beams supporting solid slabs spanning in two directions at right angles Supporting uniformly distributed loads may be assessed from the following equations.

Vx = Bvx*Pd*Lx

Vy = Bvy*Pd*Lx

B. From EBCS-2, 2015 Table A-3 gives values of load transfer coefficients.

C. The design load on a beam determined in accordance with (A) and (B) above may be taken as the maximum shear in the slab at the center of support.

- **Load transfer from roof floor slab to frame**
  - **Sample calculation for S-1**
- **Shear coefficient for panel 1(S-1)**

Lx=4.43m

Pd=10.231KN/$m^2$

Bvxc = 0.4

Bvxd = 0.26

Bvyc =0. 4

Bvyd = 0.26

- **load transferred for panel 1(S-1)**

Vxc =0.4*10.231*5= **18.13 KN**

Vxd = 0.26*10.231*5= **11.78 KN**

Vyc = 0.4*10.231*5= **18.13 KN**

Vyd =0.26*10.231*5= **11.78 KN**

- **Dead load on the beam for panel 1(S-1)**
- **For axis A (2&3)**
  - ✓ Height of parfait =**0.8m**
  - ✓ Thickness of HCB = **0.2m**
  - ✓ Thickness of plaster = **0.04m**
  - ✓ $\gamma_{plaster}$ **=23KN/$m^3$**
  - ✓ $\gamma_{HCB}$ **=14KN/$m^3$**

**Total dead load on the beam** = (($T_{HCB}$*$H_{parafit}$*$\gamma_{HCB}$)+( $T_{Plaster}$*$H_{parafit}$*$\gamma_{plaster}$))

= ((0.2*0.8*14)+(0.04*0.8*23)) =**2.976 KN/$m^2$**

**Shear transfer on the top tile beam beam**

- ✓ Beam cross section(25*30)
- ✓ $\gamma_{concrete}$ **=25KN/$m^3$**
- ✓ Vyd, Shear load =**11.78 KN**
- ✓ Dead load on the beam =**2.976 KN/$m^2$**
- ✓ Design factored load, pd = **10.231 KN/$m^2$**

**Beam self-weight** =(depth of beam $*$width of beam*$\gamma_{concrete}$)

= 0.3*0.25*25 = **1.875 KN**

**Total designed factored load, pd including parfait load on the beam**

Pd=10.231+2.976= **13.206 KN**

**Shear transfer on the top tile beam**

**Vyd= (**0.91*11.78)+1.875+13.206 **= 25.8 KN**

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form.

### 3.4.1.8. Shear reinforcement calculation

**For panel 1(S-1) for the roof floor**

The design value for the shear resistance VRd, c is given by:

- VRd,c= $[C_{Rd,c}K(100\ \rho 1 fck)^{1/3} + k1\sigma cp]\ b_w d$ with a minimum of VRd,c= $(Vmin + k1\sigma cp)\ b_w d$
  Where:
  - ✓ fck = 20Mpa
  - ✓ $k = 1+\sqrt{\frac{200}{d}} \geq 2.0 = 1+\sqrt{\frac{200}{172}} = 2.078 \geq 2.0$……Not okey therefore, k = **2**
  - ✓ $V_{min}=0.035*k^{3/2*}fck^{1/2} = 0.4427$
  - ✓ $Ast$ is the area of the tensile reinforcement = 282.6mm$^2$
  - ✓ $bw$ is the smallest width of the cross-section in the tensile area (mm) =1000mm
  - ✓ $\rho_1 = \frac{Ast}{b_w d} \leq 0.02 = \frac{282.6}{172*1000} = 0.001643 \leq 0.02$…… its okey therefore $\rho_1$= **0.001643**
  - ✓ $Ac$ is the area of concrete cross-section (mm2)
  - ✓ $\sigma_{cp}=\frac{N_{Ed}}{A_c}$ = **0N**
    $N_{Ed}$ is the axial force in the cross-section due to loading or prestressing [in N] ($N_{Ed}$> 0 for compression). The influence of imposed deformations on $N_{Ed}$may be ignored. $A_c$is the area of concrete cross section [mm$^2$].
  - ✓ VRd,c is in (N)
  - ✓ $C_{Rd,c} = \frac{0.18}{\gamma c} = \frac{0.18}{1.5}$ = **0.12**
  - ✓ $K1$= 0.15
- VRd,c = $[C_{Rd,c}K(100\ \rho 1 fck)^{1/3} + k1\sigma cp]\ b_w d$
  = $[0.12*2(100*0.001643 *20)^{1/3} + 0.15*0]\ 1000 * 172$ =**61371.14944N**
  = **61.371KN**
- Vmin= $(Vmin + k1\sigma cp)\ b_w d$
  = $(0.4427 + 0.15*0)\ 1000 * 172$ = **76144N**
  **= 76.144KN**
- Maximum shear acting take **76.144KN**
- Assuming the beam width to be 250 mm
  - ✓ $V_{sd}$= pd(0.5lxn-d)bw……Pd= 10.231KN/m$^2$ for the roof floor
  - ✓ Taking one-meter width of slab strip b=1000 mm, lx=5m and d=182 mm
  - ✓ Lxn = 5m-0.25m = 4.75m
- $V_{Ed}$= pd(0.5lxn-d)bw = 10.231(0.5*(4.75)-0.172)*1 = **22.54KN**
- Thus, VRd,c > $V_{Ed}$…. **76.144KN** > **22.54KN….it is okey the section is adequte for shear.**

➢ $As_{min} = Max\begin{Bmatrix}0.26(\frac{fctm}{fyk})bd > Asmax = 0.04bd \\ 0.00013btd\end{Bmatrix}$

$== Max\begin{Bmatrix}0.26(\frac{2.2104}{500}) * 1000 * 172 = \mathbf{197.7mm^2} \\ 0.00013 * 1000 * 172 = \mathbf{22.36mm^2}\end{Bmatrix}$

$As_{min}$ = **$197.7mm^2$**

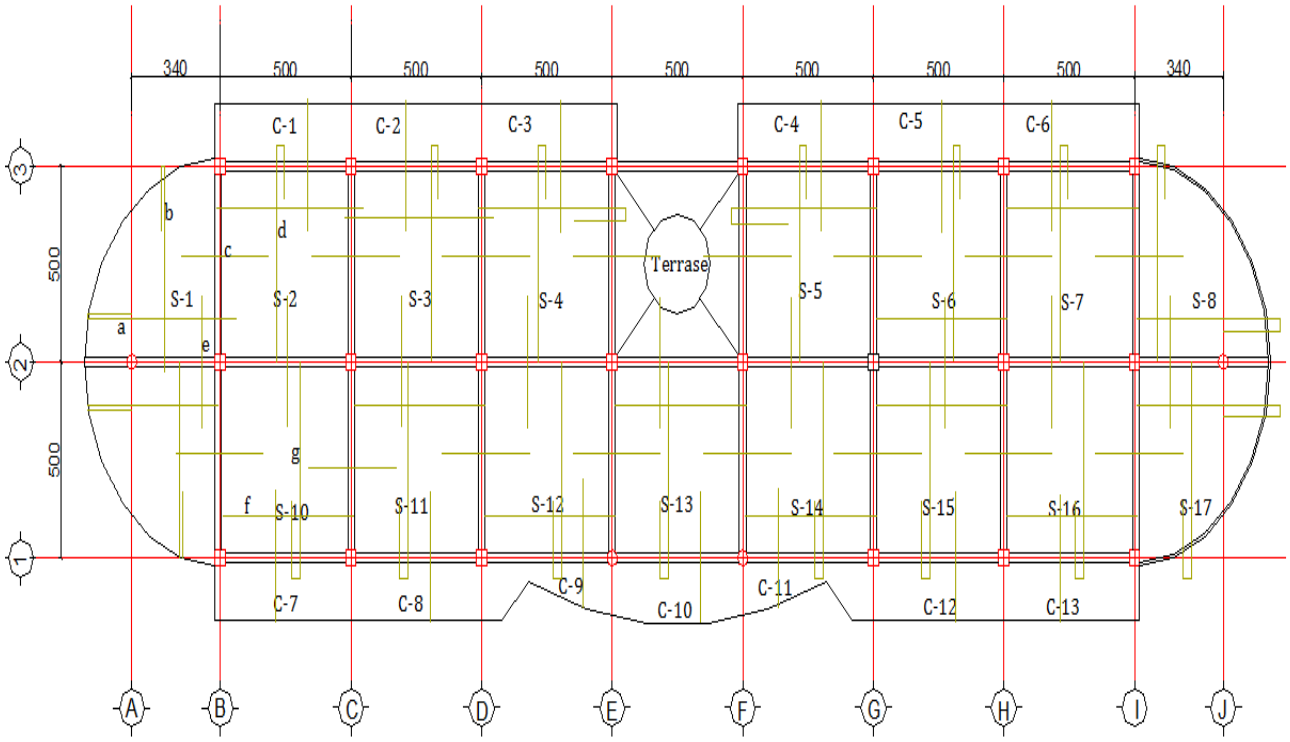
K. as $=(\frac{\pi\emptyset^2}{4}) = (\frac{3.14*12*12}{4})$ = **$113.04m^2$**

L. Specing = $\frac{b*as}{As} = \frac{1000*113.04}{197.7}$ = **571.781mm**

M. Sprovide = $Min\begin{Bmatrix}3.5d = 3.5 * 200 = 700mm \\ 400mm \\ specing = 571.781mm\end{Bmatrix}$

Therefore, Provide, Ø 12 C/C 400mm for panel 1(S-1).

Computation of the rest of the panel for floor slab see on appendex A-D in Tabular form.




**ROOF FLOOR PLAN DETAIL LAY OUT**
**Scale 1:300**

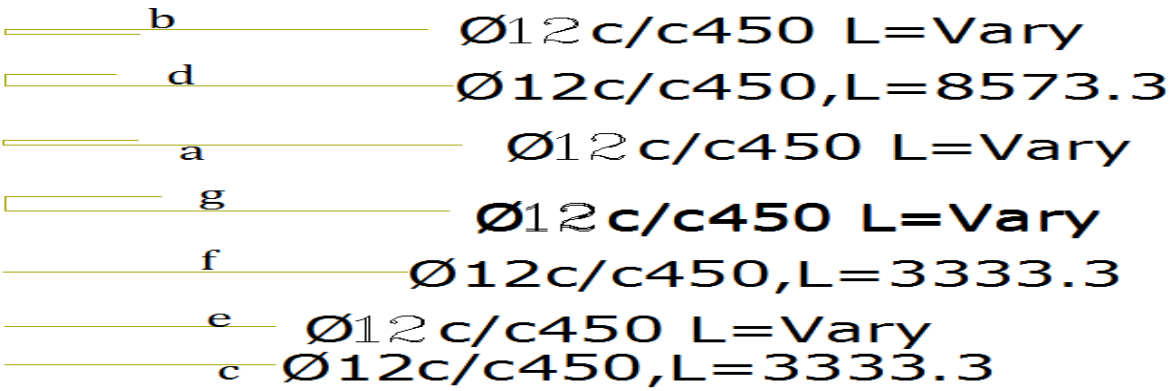



Figure 3. 12: Detail lay out of roof floor

# CHAPTER FOUR

# STAIR CASE ANALYSIS AND DESIGN

## 4.1. Structural Analysis of Stair case

Stairs are structures, which provide access to different floor levels. They are one of the structural elements constructed with steps rising to landing between floors with a serious of steps rising further from the landing to floor above. For the purpose of easy and comfortable passage over the different floor levels of the building, there is a staircase provision for the building.

## 4.2. Guide lines and types of stair

Staircases can be classified based on geometrical configurations, based on this our building has open-wall staircase. The type of stair and its layout is governed essentially by the available size of staircase room and positions beams and columns along the boundary of staircase. Following are some useful guidelines in deciding the layout and type of stair:

1.The stair slab, in general are heavy compared to floor slab because of

A. Heavy dead load due to inclined length of slab acting over horizontal span and due to additional weight of steps,

B. Greater live load in stair than on floors. Therefore, longer span for flight should be avoided as far as possible.

2.Stair flight shall be preferably being supported on beam or wall. Supporting on landing slab should be avoided as possible essentially when the span of the landing exceeds twice the width of stair, because this cause stress in the supporting landing slab at their junction. We have two kinds of stair based on their support condition.

- Pinned – pinned support
- Fixed - pinned support

We have two basic ways in which stairs are planned

1. A straight flight stair,which rises from floor to floor in one direction with or without landing.
2. Open well stairs, where a space or well exists between flights. The stairs mentioned above are generally free standing ones (simple straight flights of stairs).

## 4.3. Design procedure

- Determination of depth for deflection: This is a function of design tensile strength of steel, effective span length of the shortest span in which more load is expected to transfer and support condition.

- Loading: This determines the total load in the stair and landing.
- Analysis: determines moment and shear forces based on the analyzed moment.
- Check depth for flexure: this step helps to cross check the design depth as it is safe for flexure or not, if not revise the depth determined in step 1 and also the loads.
- Reinforcement provision: using the computed moments, number and area of reinforcement bars determined.
- Reinforcement Detailing : The arrangement of reinforcement.

**Stair case from basement to fourth floor**

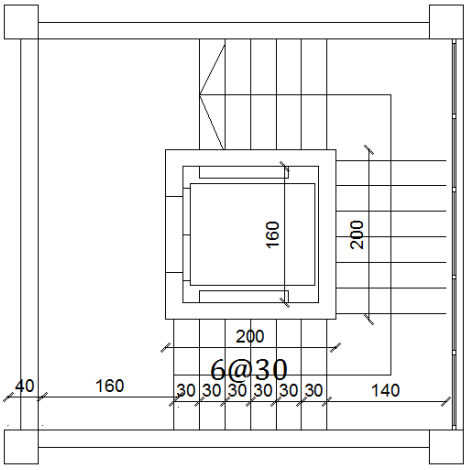



Figure 4. 1: Lay Out Of Stair

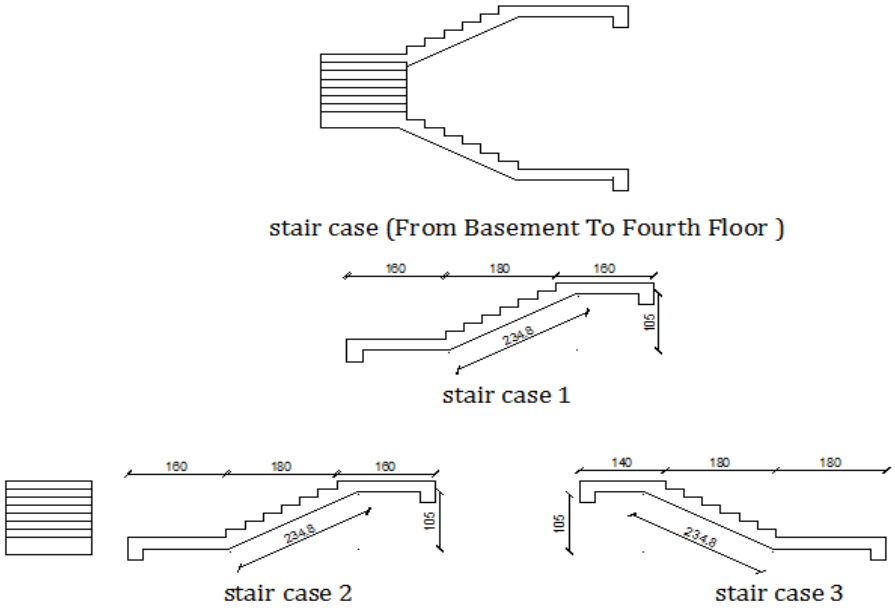



Figure 4. 2: lay out of stair from basement to fouth floor

**Staircase 1 , staircase 2 and staircase 3 because they are similar**

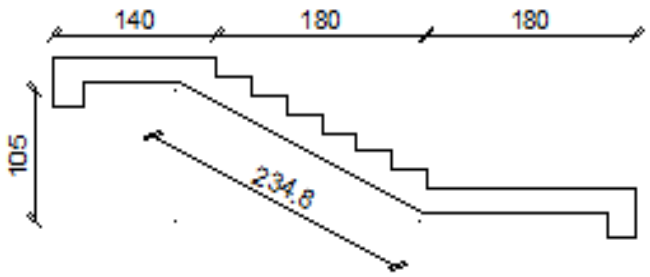



Figure 4. 3: Lay out of staircase 1,2 & 3

**STEP 1** Material Data

- Unit weight of cement screed = 23 KN/$m^3$
- Unit weight of concrete = 25KN/$m^3$
- Unit weight of plastering = 23 KN/$m^3$
- Thickness of cement screed = 2cm
- Thickness of plastering = 2cm
- fck = 20MPa
- fcd = 11.33MPa
- fyk=500MPa
- Take 1m width strip

**STEP 2** Concrete cover design

- Concrete cover 22mm similar procedure with the slab concrete cover.

**STEP 3** Geometrical Data

- Riser height(R) = 15cm
- Tread width(T) = 30cm
- Number of riser = 7
- Number of tread = 6
- Inclined length of each step or breadth of step along slope(B) =$\sqrt{R^2 + T^2}$ =$\sqrt{0.15^2 + 0.3^2}$ = **0.34m**
- Take noising (N)= 25mm
- Width of going=T-N =300-25mm=**275mm**

**STEP 4** Determination of minimum depth for deflection

According to EBCS-2 2015, (page 133) slab determination can be calculated by using the following formula and consideration.

$$\frac{l}{d} = N * K * F1 * F2 * F3$$

Where;

$\frac{l}{d}$:- is the limit span/depth

$$N = \left[11 + 1.5\sqrt{f_{ck}}\frac{\rho_o}{\rho} + 3.2\sqrt{f_{ck}}\left(\frac{\rho_o}{\rho} - 1\right)^{3/2}\right] \text{ if } \rho \leq \rho_o$$

$$N = \left[11 + 1.5\sqrt{f_{ck}}\frac{\rho_o}{\rho - \rho'} + \frac{1}{12}\sqrt{f_{ck}}\sqrt{\frac{\rho'}{\rho_o}}\right] \text{ if } \rho > \rho_o$$

$$N = \left[11 + 1.5\sqrt{f_{ck}}\right] \text{ if } \rho = \rho_o$$

K: -is the factor to take into account the different structural systems

$\rho_o$:-is the reference reinforcement ratio ,

$$\rho_o = \frac{\sqrt{f_{ck}}}{1000}$$

ρ: - is the required tension reinforcement ratio at mid-span to resist the moment due to the design loads (at support for cantilevers)

ρ': - is the required compression reinforcement ratio at mid-span to resist the moment due to design loads (at support for cantilevers)

$f_{ck}$: -is in MPa units

$$F1 = \frac{500}{f_{yk}}$$

$F2 = \frac{As,prov}{Asreq} < 1.5$ For first Trial : use F 2= 1

$F3$ = 1 [ r$ectangular$ section, solid slab and T- section with b/bw≤ 3 ]

$F3$= 0.8 for T section with b/bw> 3

- Governing effective depth of slab

$$D = dmin + cover + \frac{\Phi}{2}$$

Table 4. 1: Basic ratios of span/effective depth for reinforced concrete members without axial compression

| Structural System | K | Concrete highly stressed $\rho$ = 1.5% | Concrete lightly stressed ρ = 0.5% |
|---|---|---|---|
| Simply supported beam, one – or two-way spanning simply supported slab | 1.1 | 14 | 20 |
| End span of continuous beam or one-way continuous slab or two-way spanning slab continuous over one long side | 1.13 | 18 | 26 |
| Interior span of beam or one-way or two-way spanning slab | 1.15 | 20 | 30 |
| Slab supported on columns without beams (flat slab) (based on longer span) | 1.12 | 17 | 24 |
| Cantilever | 0.4 | 6 | 8 |

**Note 1:** The values given have been chosen to be generally conservative and calculation may frequently show that thinner members are possible.
**Note 2:** For 2-way spanning slabs, the check should be carried out on the basis of the shorter span. For flat slabs the longer span should be taken.
**Note 3:** The limits given for flat slabs correspond to a less severe limitation than a mid-span deflection of span/250 relative to the columns. Experience has shown this to be satisfactory

**Calculation of minimum depth for deflection**

- $\rho_o$:-is the reference reinforcement ratio

$$\rho_o = \frac{\sqrt{f_{ck}}}{1000} = \frac{\sqrt{20}}{1000} = \mathbf{0.00447}$$

- $N = \left[11 + 1.5\sqrt{f_{ck}}\right]$ =$N = \left[11 + 1.5\sqrt{20}\right]$ = **17.708**
- fyk - Grade of steel, S-500
- $F1 = \frac{500}{f_{yk}} = \frac{500}{500} = \mathbf{1}$
- F2= 1, F3= 1

**Depth determination: Serviceability Requirement For end panel (L=Lx=3200mm)**

$$\frac{l}{d} = N * K * F1 * F2 * F3$$

K= 1.3, N=17.708, F1= 1, F2=1, F3=1

$$\frac{l}{d} = 17.708 * 1.3 * 1 * 1 * 1 = \mathbf{23.0204}$$

$$d = \frac{3200mm}{23.0204} = \mathbf{139.007mm}$$

**Depth determination: Serviceability Requirement For Interior panel (L=Lx=3200mm)**

$$\frac{l}{d} = N * K * F1 * F2 * F3$$

K= 1.5, N=17.708, F1= 1, F2=1, F3=1

$$\frac{l}{d} = 17.708 * 1.5 * 1 * 1 * 1 = \mathbf{26.562}$$

$$d = \frac{3200mm}{26.562} = \mathbf{120.473mm}$$

**Depth determination**

- Depth determination: Serviceability Requirement For end panel

  Using Φ12mm bar and clear cover of 22mm

  Total depth

  - ✓ $D = 139.007 + \frac{12}{2} + 22 = \mathbf{167.007mm\ use\ 170mm}$

- Depth determination: Serviceability Requirement For interior panel

  Using Φ12mm bar and clear cover of 22mm

  Total depth

✓ $D = 120.473 + \frac{12}{2} + 22 = \mathbf{148.473mm\ use\ 150mm}$

Therefore, the depth provide for serviceability requirement for slab depth for deflection is **170mm**

**STEP 5** Load Determinations

Table 4. 2Materials data used in stair

| Material | Unit weight **(**$KN/M^3$) | Thickness(m) |
|---|---|---|
| Marbel | 27 | 0.02 |
| Cement screed | 23 | 0.03 |
| Concrete | 25 | 0.2 |
| Pastering | 23 | 0.02 |

**Live load**

The live loads for design of staircase are to be taken from table 2.10 EBCS-1 on loading standards. The value used is category A.

qk =5kN/$m^2$ total live load on stair case = 5kN/m2*1m = **5kN/m**

The live load given in codes assumes that it is acting along the horizontal span and directly used in calculation.

## 4.4. Load Computation on the stair

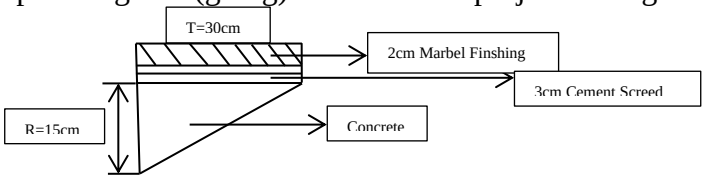
✓ **Dead load for flight (inclined slab)**

The live load for staircase given in codes is the loading on horizontal projection area. Hence, the dead load due to waist is calculated along the slope of the staircase and it is then converted to along the horizontal plane.

Take 1m width strip

➢ **Step dead load**

Dead load on each step of length G (going) on horizontal projection is given by



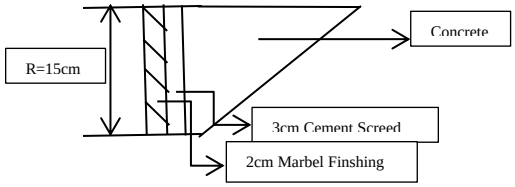

Dead load of cement screed= $t_{cement\ screed}*\delta_{cement\ screed}$ = 0.03*23 KN/$m^3$= **0.69 KN/m**

Dead load of finishing= $t_{finshing}*\delta_{finshing}$=0.02*27 KN/$m^3$= **0.54 KN/m**

Dead load of Concrete= 1/2*h*$\delta_{cement}$ =1/2*0.15m*25 KN/$m^3$ =**1.875 KN/m**

Therefore DL of step= 0.69 KN/m + 0.54 KN/m + 1.875 KN/m= **3.105 KN/m**

- **Riser Dead Load**

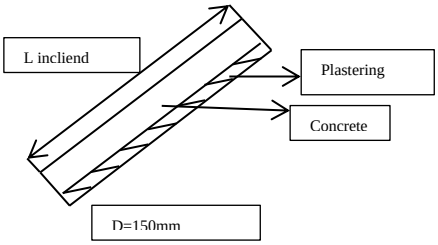


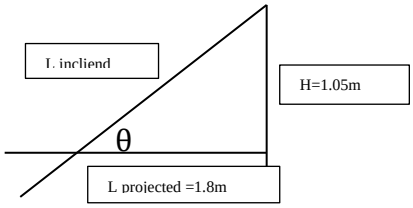

Riser Finishing= $\frac{\text{No of riser}(h_{cs}*t_{cs}*\delta_{cs})}{\text{Projected Length}} = \frac{7(0.15*0.03*23)}{6*0.3}$ = **0.4025 KN/m**

Riser cement screed = $\frac{\text{No of riser}(R_{cs}*t_{cs}*\delta_{cs})}{\text{Projected Length}} = \frac{7(0.15*0.02*27)}{6*0.3}$ = **0.315 KN/m**

Therefore D.L of riser (15cm) = 0.4025 KN/m + 0.315 KN/m = **0.7175KN/m**

- **Wasit Dead Load**




Tan θ = $\frac{1.05}{1.8}$ ⇨ θ = $\text{Tan}^{-1}(\frac{1.05}{1.8})$ , θ = **30.26°**

Sin $\theta = \frac{1.05}{L_{incliend}}$

$L_{incliend} = \frac{1.05}{\text{Sin }\theta} = \frac{1.05}{\text{Sin }30.26} = \mathbf{2.084m}$

Dead load of concrete = $\frac{D*L_{inc}*\delta_{concrete}}{\text{Length of projected}} = \frac{0.15*2.084*25}{1.8}$ = **4.32KN/m**

Dead load of plastering = $\frac{t_{plastering}*L_{inc}*\delta_{plastering}}{\text{Length of projected}} = \frac{0.02*2.084*23}{1.8}$ = **0.96KN/m**

Therefore Dead load of waist = 4.32KN/m + 0.96K/m = **5.28KN/m**

**Total Dead Load and design load for the inclined slab (steps)**

Total dead load = Dead load of Step + dead load of riser + dead load of waist

= 3.105 KN/m +0.7175KN/m + 5.28 KN/m

= **9.10 KN/m**

Live load=5 KN/$m^2$*1m = 5 KN/m

Design Load, Pd = 1.35 D.L + 1.5 L.L

= 1.35*9.10KN/m + 1.5*5 KN/m

Pd = **19.79KN/m**

✓ **Dead load for Landing**

D.L of landing = D.L of finishing + D.L of cement screed + D.L of concrete + D.L of plastering

= (tfin*$\gamma$fin)+(tcs*$\gamma$cs)+(tc*$\gamma$c)+(tpl*$\gamma$pl)

= (0.02m*27 KN/m3)+(0.03*23 KN/m3) +( 0.15m*25 KN/m3)+(0.02m*23 KN/m3)

= **5.44 KN/m**

Therefore D.L of Landing = **5.44 KN/m**

Total Dead Load and design load for the landing

D.L=5.44KN/m

L.L=5 KN/m2 * 1m = 5KN/m

Deisgn load, Pd = 1.35 D.L + 1.5 L.L

= 1.35*5.44 KN/m + 1.5*5 KN/m

Pd =**14.84 KN/m**

**Step 6:** Moment Analysis using Excel

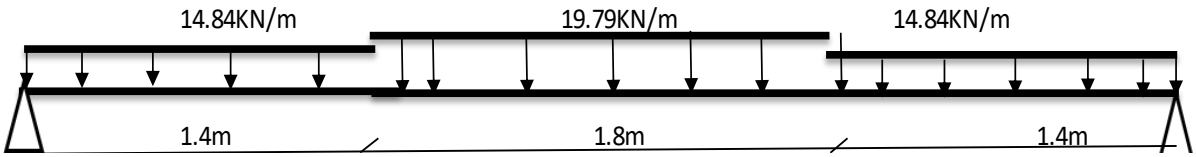



Figure 4. 4 :Load on the stair case

| Length | LOAD |
|---|---|
| 0 | 38.76 |
| 1.4 | 17.76 |
| 2.3 | 0 |
| 3.2 | -17.76 |
| 4.6 | -38.76 |

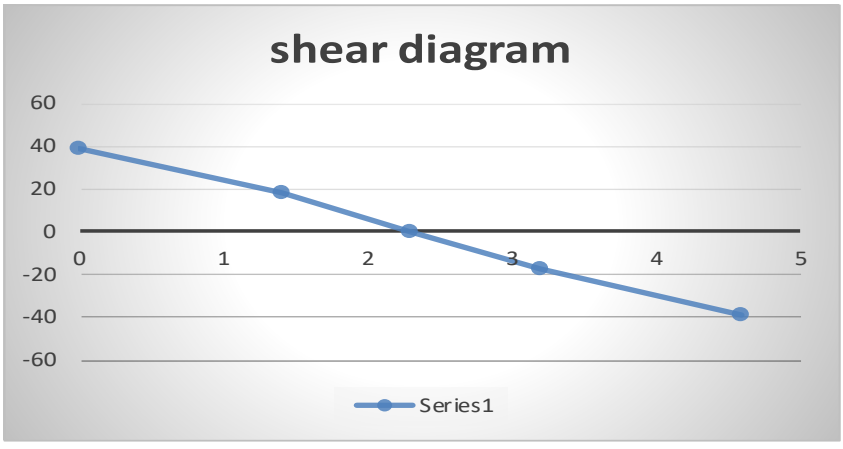



Figure 4. 5: Shear force diagram for stair case

| Length | Load |
|---|---|
| 0 | 0 |
| 1.4 | -39.41 |
| 2.3 | -47.39 |
| 3.2 | -39.41 |
| 4.6 | 0 |

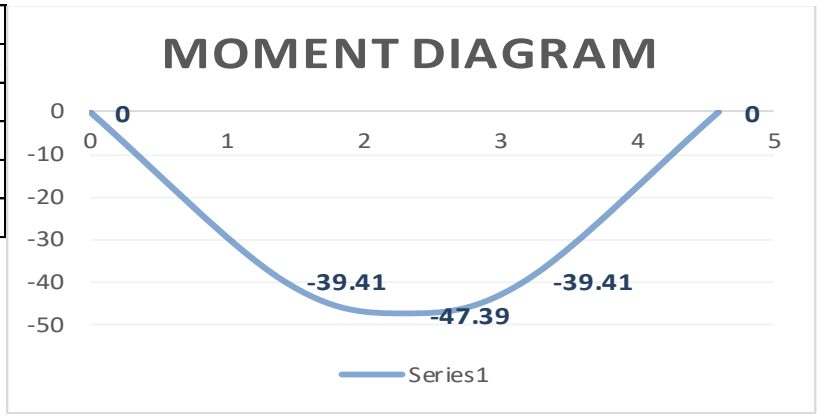



Figure 4. 6: Bending moment diagram for the stair case

**Step 5** Check depth for flexure

Maximum moment from all floor is 47.39 and take d=142

$$\mu sd = \left(\frac{Msd}{d^2 * b * fck}\right) = \left(\frac{47.39 * 1000000}{142 * 142 * 1000 * 20}\right) = \mathbf{0.1175}$$

$$d = \sqrt{m_{max}/(\mu sd * f_{ck} b)} = \sqrt{47.39 * \frac{10^6}{0.1175 * 20 * 1000}} = \mathbf{142.001 < 170mm \ldots okey}$$

Therefore, depth of 170 satisfy flexural requirement for staircase

**Step 6** Reinforcement

- $f_{cd}$ = 11.33MPa
- $f_{ctm}$ = 2.2104MPa
- $f_{yd}$ = 434.78 MPa
- b = 1000mm
- D= 170mm
- Effective depth = D-concrete cover- Ø/2 = 170-22-12/2 =**142mm**

A. $Z = \left(d(0.5 + \sqrt{0.25 - \mu sd/1.134})\right)$

$= \left(142(0.5 + \sqrt{0.25 - 0.1175/1.134})\right) =$**125.33**

B. $As = \left(\frac{Msd}{0.87 * fyd * Z}\right) = \left(\frac{47.39 * 10^6}{0.87 * 434.78 * 125.33}\right) =$ **992.78mm$^2$**

C. $as = \left(\frac{\pi \emptyset^2}{4}\right) = \left(\frac{3.14 * 12 * 12}{4}\right) =$ **113.04m$^2$**

D. $Specing = \frac{b * as}{As} = \frac{1000 * 113.04}{992.78} =$ **113.86mm**

- Spacing for the distribution bars,

E. Sprovide = $\text{Min}\begin{Bmatrix} 3.5d = 3.5 * 170 = 595mm \\ 450mm \\ \text{specing} = 113.86mm \end{Bmatrix}$

Therefore, Provide, Ø 12 C/C 150mm for stair case 1.

Finally, Let's check the minimum reinforcement recommendation as per ES EN 1992 – 2015

□□Principal reinforcement

F. $As_{min} = \text{Max}\begin{Bmatrix} 0.26(\frac{fctm}{fyk})bd > Asmax = 0.04bd \\ 0.00013btd \end{Bmatrix}$

$$== \text{Max}\begin{Bmatrix} 0.26\left(\frac{2.2104}{500}\right) * 1000 * 142 = \mathbf{163.21mm^2} \\ 0.00013 * 1000 * 142 = \mathbf{18.46mm^2} \end{Bmatrix}$$

$As_{min}$ = **$163.22mm^2$**

G. $As_{req} = \text{Max}\begin{Bmatrix} \text{Ascal} = \mathbf{992.78mm^2} \\ \text{Asmin} = \mathbf{163.22mm^2} \end{Bmatrix}$

$As_{req}$ =**$992.78mm^2$**

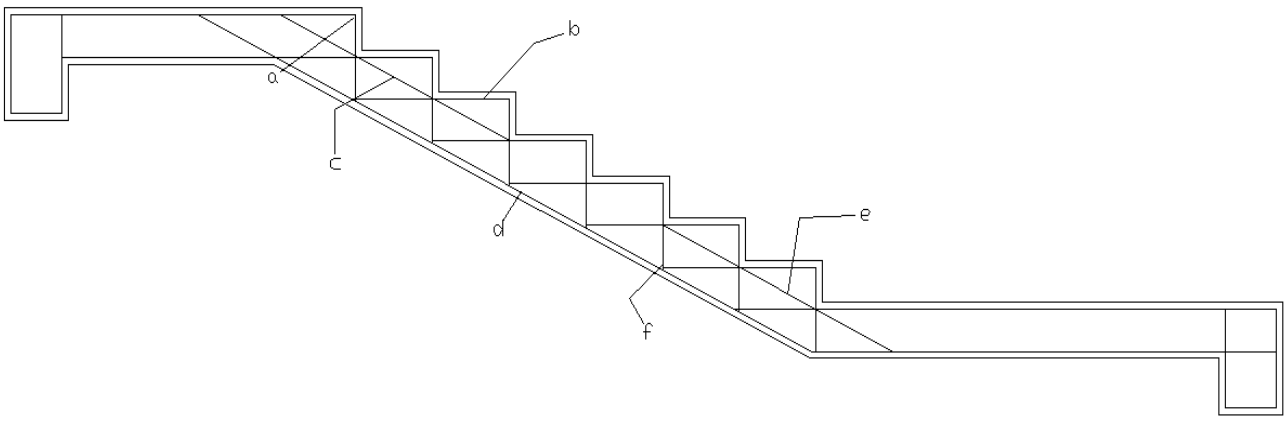
H. $As_{max}$ =0.04bD = 0.04*1000*200 = **8000mm >992.78mm…….it is okey**

The spacing of the bars shouldn't exceed S*max*. Recommended value in ES EN 1992-2015,

- For principal reinforcement, 3h = 400mm
- For secondary reinforcement, 3.5h < 450mm

Table 4. 3: Stair reinforcement

| stair | moment | d(mm) | K | Z | As | As,min | As,max | AS Provid | Spacing | Spacing provied |
|---|---|---|---|---|---|---|---|---|---|---|
| Support | 0.00 | 142 | 0 | 142.000 | 0.000 | 163.2 | 8000 | 0.0 | 0.000 | Ø12 C/C @ 150 |
| Span | 47.39 | 142 | 0.11751 | 125.328 | 999.657 | 163.2 | 8000 | 753.6 | 113.079 | Ø12 C/C @ 150 |
| support | 39.41 | 142 | 0.09772 | 128.475 | 810.961 | 163.2 | 8000 | 753.6 | 139.390 | Ø12 C/C @ 150 |



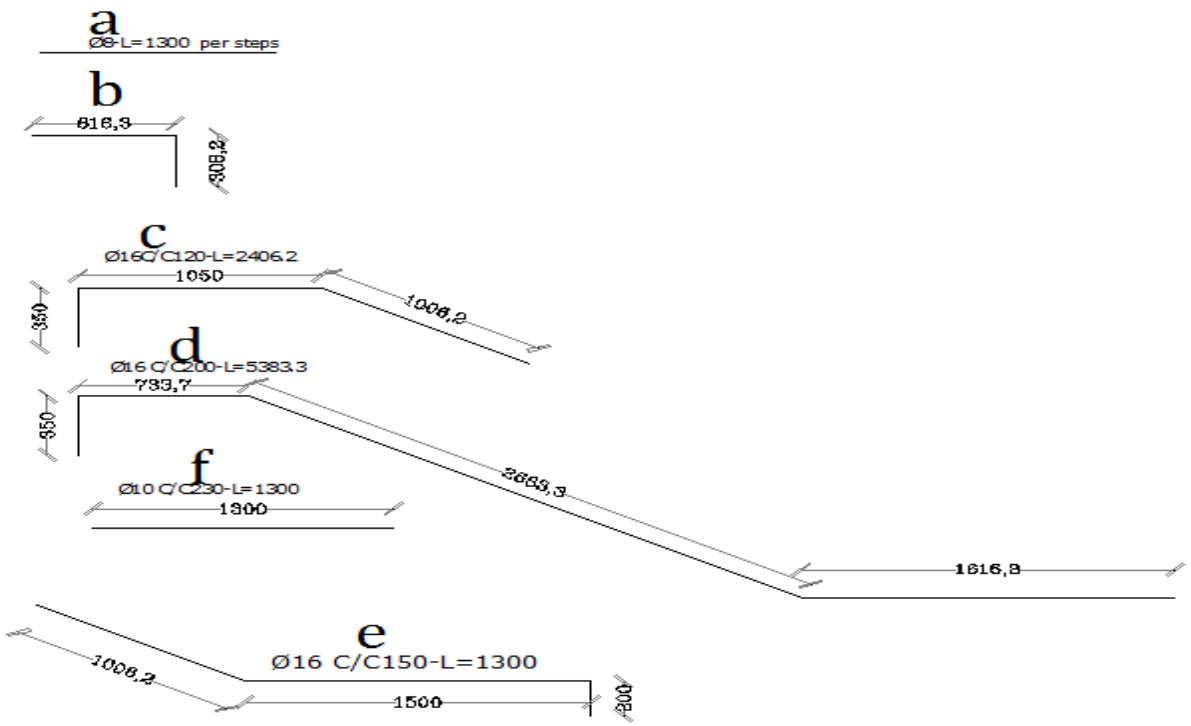



Figure 4. 7: Detail of the stair case 1 & 3

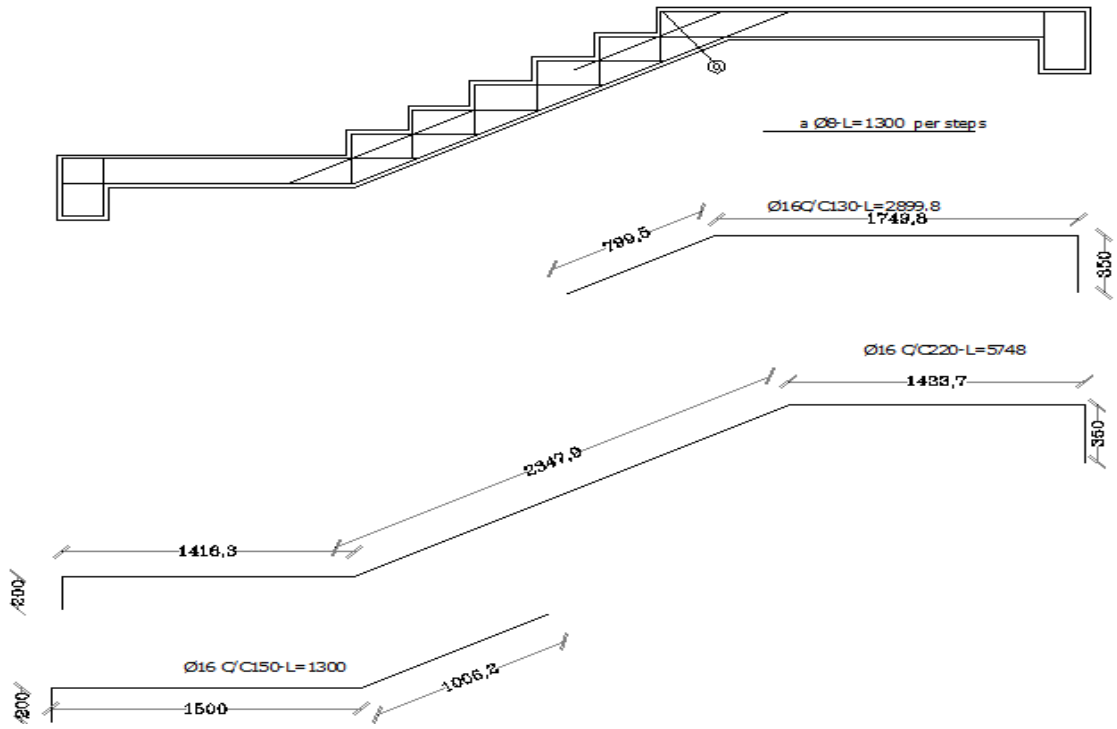



Figure 4. 8: Detail of stair case 2

# CHAPTER-FIVE
# LATERAL LOAD ANALAYSIS

## 5.1. General

In every building, the earth quake and wind load effect should be considered as a part of load in order to build a structure that can safely transfer the loads to the foundation and finally to the ground and absorb some of the energy present rather than suffering damage. The objective of seismic design in accordance with ES EN 1998-1:2015 is explicitly stated. Its purpose is to ensure that in the event of earthquakes. For Human lives are protected, Damage is limited and Structures important for civil protection remain operational. Since our structure is "regular structure" means, we assume that our building has uniform distribution of mass and stiffness; therefore, we select static analysis (coefficient method)

- Design Basis:
  - ✓ Ground condition: (Assume sub soil class B)
  - ✓ Seismic zone: (Dire dewa, Zone 3)

## 5.2. Earthquake load analysis

An earthquake is the vibration of earth produced by the rapid release of accumulated energy in elastically strained rock. The building is to be constructed in Dire Dewa, which is located in Longitude 9.5034-E and Latitude 41.8389-N. it is categorized seismic hazard zone four.

- **Analysis of earthquake loads on building on ES EN 2015**

The objective of seismic design in accordance with ES EN 1998-1:2015 is explicitly stated. Its purpose is to ensure that in the event of earthquakes. For human lives are protected, Damage is limited and Structures important for civil protection remain operational.

- **Distribution of the base shear over the height of the building**

The horizontal story shear force determined above shall be distributed to the lateral load resisting system based on the assumption that the slab floor at every level are rigid enough. The storey shear force will be distributed to each frame system according to their stiffness, the procedures in the story shear force distribution include:

- ✓ Determination of center of mass for each floors
- ✓ Determination of center of stiffness for each floors
- ✓ Determination of eccentricity for each floors
- ✓ Calculation of the direct shear force for each frame system

- ✓ Weight and Center of mass calculation
- ✓ Computation of weight of structure along with center of mass

### 5.2.1. Determination of Center of mass

Lateral forces which induced by an earthquake are proportional to the mass of the floor and the resultant force due to the earth quake passes through the centre of mass of the floor. So we have computed the centre of mass from the architectural drawing data below:

Table 5. 1: Cross section of column

| Members | Floor column | Floor beam | Grade beam | Top beam |
|---|---|---|---|---|
| Size | 40*40 | 25*40 | 30*40 | 25*30 |

**Centre of mass for basement floor**

Table 5. 2: Centre of mass each floor

| Foundation column on axis | Length | Width | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | w(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 0.4 | 0.4 | 3.5 | 13.44 | -17.5 | 0 | -235.2 | 0 |
| 2 | 0.4 | 0.4 | 3.5 | 13.44 | -17.5 | 5 | -235.2 | 67.2 |
| 3 | 0.4 | 0.4 | 3.5 | 13.44 | -17.5 | -5 | -235.2 | -67.2 |
| 4 | 0.4 | 0.4 | 3.5 | 13.44 | -12.5 | 0 | -168 | 0 |
| 5 | 0.4 | 0.4 | 3.5 | 13.44 | -12.5 | 5 | -168 | 67.2 |
| 6 | 0.4 | 0.4 | 3.5 | 13.44 | -12.5 | -5 | -168 | -67.2 |
| 7 | 0.4 | 0.4 | 3.5 | 13.44 | -7.5 | 0 | -100.8 | 0 |
| 8 | 0.4 | 0.4 | 3.5 | 13.44 | -7.5 | 5 | -100.8 | 67.2 |
| 9 | 0.4 | 0.4 | 3.5 | 13.44 | -7.5 | -5 | -100.8 | -67.2 |
| 10 | 0.4 | 0.4 | 3.5 | 13.44 | -2.5 | 0 | -33.6 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11 | 0.4 | 0.4 | 3.5 | 13.44 | -2.5 | 5 | -33.6 | 67.2 |
| 12 | 0.4 | 0.4 | 3.5 | 13.44 | -2.5 | -5 | -33.6 | -67.2 |
| 13 | 0.4 | 0.4 | 3.5 | 13.44 | 2.5 | 0 | 33.6 | 0 |
| 14 | 0.4 | 0.4 | 3.5 | 13.44 | 2.5 | 5 | 33.6 | 67.2 |
| 15 | 0.4 | 0.4 | 3.5 | 13.44 | 2.5 | -5 | 33.6 | -67.2 |
| 16 | 0.4 | 0.4 | 3.5 | 13.44 | 7.5 | 0 | 100.8 | 0 |
| 17 | 0.4 | 0.4 | 3.5 | 13.44 | 7.5 | 5 | 100.8 | 67.2 |
| 18 | 0.4 | 0.4 | 3.5 | 13.44 | 7.5 | -5 | 100.8 | -67.2 |
| 19 | 0.4 | 0.4 | 3.5 | 13.44 | 12.5 | 0 | 168 | 0 |
| 20 | 0.4 | 0.4 | 3.5 | 13.44 | 12.5 | 5 | 168 | 67.2 |
| 21 | 0.4 | 0.4 | 3.5 | 13.44 | 12.5 | -5 | 168 | -67.2 |
| 22 | 0.4 | 0.4 | 3.5 | 13.44 | 17.5 | 0 | 235.2 | 0 |
| 23 | 0.4 | 0.4 | 3.5 | 13.44 | 17.5 | 5 | 235.2 | 67.2 |
| 24 | 0.4 | 0.4 | 3.5 | 13.44 | 17.5 | -5 | 235.2 | -67.2 |
| 25 | 0.4 | 0.4 | 3.5 | 13.44 | -22.5 | 0 | -302.4 | 0 |
| 26 | 0.4 | 0.4 | 3.5 | 13.44 | 22.5 | 0 | 302.4 | 0 |
| Total Weight due to foundation column = | | | | 349.44 | Sum = | | 0 | 0 |

| Beam on axis | Length | Width | Depth | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | w(m) | d(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| B4 | 5 | 0.3 | 0.4 | 14.4 | -17.5 | 2.5 | -252 | 36 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B5 | 5 | 0.3 | 0.4 | 14.4 | -17.5 | -2.5 | -252 | -36 |
| B6 | 5 | 0.3 | 0.4 | 14.4 | -15 | 0 | -216 | 0 |
| B7 | 5 | 0.3 | 0.4 | 14.4 | -15 | 5 | -216 | 72 |
| B8 | 5 | 0.3 | 0.4 | 14.4 | -15 | -5 | -216 | -72 |
| B9 | 5 | 0.3 | 0.4 | 14.4 | -12.5 | 2.5 | -180 | 36 |
| B10 | 5 | 0.3 | 0.4 | 14.4 | -12.5 | -2.5 | -180 | -36 |
| B11 | 5 | 0.3 | 0.4 | 14.4 | -10 | 0 | -144 | 0 |
| B12 | 5 | 0.3 | 0.4 | 14.4 | -10 | 5 | -144 | 72 |
| B13 | 5 | 0.3 | 0.4 | 14.4 | -10 | -5 | -144 | -72 |
| B14 | 5 | 0.3 | 0.4 | 14.4 | -7.5 | 2.5 | -108 | 36 |
| B15 | 5 | 0.3 | 0.4 | 14.4 | -7.5 | -2.5 | -108 | -36 |
| B16 | 5 | 0.3 | 0.4 | 14.4 | -5 | 0 | -72 | 0 |
| B17 | 5 | 0.3 | 0.4 | 14.4 | -5 | 5 | -72 | 72 |
| B18 | 5 | 0.3 | 0.4 | 14.4 | -5 | -5 | -72 | -72 |
| B19 | 5 | 0.3 | 0.4 | 14.4 | -2.5 | 2.5 | -36 | 36 |
| B20 | 5 | 0.3 | 0.4 | 14.4 | -2.5 | -2.5 | -36 | -36 |
| B21 | 5 | 0.3 | 0.4 | 14.4 | 0 | 5 | 0 | 72 |
| B22 | 5 | 0.3 | 0.4 | 14.4 | 0 | 0 | 0 | 0 |
| B23 | 5 | 0.3 | 0.4 | 14.4 | 0 | -5 | 0 | -72 |
| B24 | 5 | 0.3 | 0.4 | 14.4 | 2.5 | 2.5 | 36 | 36 |
| B25 | 5 | 0.3 | 0.4 | 14.4 | 2.5 | -2.5 | 36 | -36 |
| B26 | 5 | 0.3 | 0.4 | 14.4 | 5 | 0 | 72 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B27 | 5 | 0.3 | 0.4 | 14.4 | 5 | -5 | 72 | -72 |
| B28 | 5 | 0.3 | 0.4 | 14.4 | 5 | 5 | 72 | 72 |
| B29 | 5 | 0.3 | 0.4 | 14.4 | 7.5 | 2.5 | 108 | 36 |
| B30 | 5 | 0.3 | 0.4 | 14.4 | 7.5 | -2.5 | 108 | -36 |
| B31 | 5 | 0.3 | 0.4 | 14.4 | 10 | 0 | 144 | 0 |
| B32 | 5 | 0.3 | 0.4 | 14.4 | 10 | -5 | 144 | -72 |
| B33 | 5 | 0.3 | 0.4 | 14.4 | 10 | 5 | 144 | 72 |
| B34 | 5 | 0.3 | 0.4 | 14.4 | 12.5 | 2.5 | 180 | 36 |
| B35 | 5 | 0.3 | 0.4 | 14.4 | 12.5 | -2.5 | 180 | -36 |
| B36 | 5 | 0.3 | 0.4 | 14.4 | 15 | -5 | 216 | -72 |
| B37 | 5 | 0.3 | 0.4 | 14.4 | 15 | 0 | 216 | 0 |
| B38 | 5 | 0.3 | 0.4 | 14.4 | 15 | 5 | 216 | 72 |
| B39 | 5 | 0.3 | 0.4 | 14.4 | 17.5 | 2.5 | 252 | 36 |
| B40 | 5 | 0.3 | 0.4 | 14.4 | 17.5 | -2.5 | 252 | -36 |
| Total Weight due to beam = | | | | 532.8 | Sum = | | -3.979E-13 | 0 |

| | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| Shear wall | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 2 | 0.2 | 22.75 | 218.4 | 0 | 3.6 | 0 | 786.24 |
| 2 | 1.6 | 0.2 | 22.75 | 174.72 | -0.9 | 2.7 | -157.248 | 471.744 |
| 3 | 1.6 | 0.2 | 22.75 | 174.72 | 0.9 | 2.7 | 157.248 | 471.744 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | 0.55 | 0.2 | 22.75 | 60.06 | -0.725 | 1.8 | -43.5435 | 108.108 |
| 5 | 0.55 | 0.2 | 22.75 | 60.06 | 0.725 | 1.8 | 43.5435 | 108.108 |
| Total Weight due to shear wall = | | | | 687.96 | Sum = | | 0 | 1945.944 |

| Wall identification | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 5 | 0.2 | 1.5 | 21 | -17.5 | 2.5 | -367.5 | 52.5 |
| 2 | 5 | 0.2 | 1.5 | 21 | -17.5 | -2.5 | -367.5 | -52.5 |
| 3 | 5 | 0.2 | 1.5 | 21 | -15 | 5 | -315 | 105 |
| 4 | 5 | 0.2 | 1.5 | 21 | -15 | -5 | -315 | -105 |
| 5 | 5 | 0.2 | 1.5 | 21 | -10 | 5 | -210 | 105 |
| 6 | 5 | 0.2 | 1.5 | 21 | -10 | -5 | -210 | -105 |
| 7 | 5 | 0.2 | 1.5 | 21 | -5 | 5 | -105 | 105 |
| 8 | 5 | 0.2 | 1.5 | 21 | -5 | -5 | -105 | -105 |
| 9 | 3.33 | 0.15 | 1.5 | 10.4895 | -2.5 | 3.335 | -26.22375 | 34.9824825 |
| 10 | 5 | 0.15 | 1.5 | 15.75 | -2.5 | -2.5 | -39.375 | -39.375 |
| 11 | 5 | 0.2 | 1.5 | 21 | 0 | 5 | 0 | 105 |
| 12 | 3.3 | 0.15 | 1.5 | 10.395 | -0.85 | 0 | -8.83575 | 0 |
| 13 | 5 | 0.2 | 1.5 | 21 | 0 | -5 | 0 | -105 |
| 14 | 3.33 | 0.15 | 1.5 | 10.4895 | 2.5 | 3.335 | 26.22375 | 34.9824825 |
| 15 | 5 | 0.15 | 1.5 | 15.75 | 2.5 | -2.5 | 39.375 | -39.375 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 16 | 5 | 0.2 | 1.5 | 21 | 5 | 5 | 105 | 105 |
| 17 | 5 | 0.2 | 1.5 | 21 | 5 | -5 | 105 | -105 |
| 18 | 5 | 0.2 | 1.5 | 21 | 10 | 5 | 210 | 105 |
| 19 | 5 | 0.2 | 1.5 | 21 | 10 | -5 | 210 | -105 |
| 20 | 5 | 0.2 | 1.5 | 21 | 15 | 5 | 315 | 105 |
| 21 | 5 | 0.2 | 1.5 | 21 | 15 | -5 | 315 | -105 |
| 22 | 5 | 0.2 | 1.5 | 21 | 17.5 | 2.5 | 367.5 | 52.5 |
| 23 | 5 | 0.2 | 1.5 | 21 | 17.5 | -2.5 | 367.5 | -52.5 |
| Weight of wall at this floor = | | | | 440.874 | Sum = | | -8.83575 | -8.785035 |

| Staircase | | Length | DL | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | | L(m) | (KN/m2) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| Staircase 2 | flight 1 | 1.8 | 10.894 | 19.6092 | 1.85 | 3.14 | 36.27702 | 61.572888 |
| | landing 1 | 1.4 | 8.44 | 11.816 | 1.7 | 4.3 | 20.0872 | 50.8088 |
| Staircase 3 | flight 2 | 1.8 | 10.894 | 19.6092 | 0 | 4.35 | 0 | 85.30002 |
| | landing 2 | 1.6 | 8.44 | 13.504 | -1.7 | 4.3 | -22.9568 | 58.0672 |
| Weight of stair at this floor = | | | | 64.5384 | Sum = | | 33.40742 | 255.748908 |

| | Length | Width | DL | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| Panel no. | L(m) | w(m) | (KN/m2) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 5 | 5 | 5.29 | 132.25 | -15 | 2.5 | -1983.75 | 330.625 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | 5 | 5 | 5.29 | 132.25 | -15 | -2.5 | -1983.75 | -330.625 |
| 3 | 5 | 5 | 5.29 | 132.25 | -10 | 2.5 | -1322.5 | 330.625 |
| 4 | 5 | 5 | 5.29 | 132.25 | -10 | -2.5 | -1322.5 | -330.625 |
| 5 | 5 | 5 | 5.29 | 132.25 | -5 | 2.5 | -661.25 | 330.625 |
| 6 | 5 | 5 | 5.29 | 132.25 | -5 | -2.5 | -661.25 | -330.625 |
| 8 | 5 | 5 | 5.29 | 132.25 | 0 | -2.5 | 0 | -330.625 |
| 9 | 5 | 5 | 5.29 | 132.25 | 5 | 2.5 | 661.25 | 330.625 |
| 10 | 5 | 5 | 5.29 | 132.25 | 5 | -2.5 | 661.25 | -330.625 |
| 11 | 5 | 5 | 5.29 | 132.25 | 10 | 2.5 | 1322.5 | 330.625 |
| 12 | 5 | 5 | 5.29 | 132.25 | 10 | -2.5 | 1322.5 | -330.625 |
| 13 | 5 | 5 | 5.29 | 132.25 | 15 | 2.5 | 1983.75 | 330.625 |
| 14 | 5 | 5 | 5.29 | 132.25 | 15 | -2.5 | 1983.75 | -330.625 |
| Total Weight due to slab = | | | | 1719.25 | Sum = | | 0 | -330.625 |
| Total weight of basement floor = | | | | 3794.862 | | | | |
| | | | | | ∑W*X | 24.57167 | Xm = | 0.00647498 |
| | | | | | ∑W*Y | 1862.283 | Ym = | 0.49073792 |

**Centre of mass for Ground floor**

| Panel no. | Length L(m) | Width w(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 5 | 5.29 | 132.25 | -15 | 2.5 | -1983.75 | 330.625 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | 5 | 5 | 5.29 | 132.25 | -15 | -2.5 | -1983.75 | -330.625 |
| 3 | 5 | 5 | 5.29 | 132.25 | -10 | 2.5 | -1322.5 | 330.625 |
| 4 | 5 | 5 | 5.29 | 132.25 | -10 | -2.5 | -1322.5 | -330.625 |
| 5 | 5 | 5 | 5.29 | 132.25 | -5 | 2.5 | -661.25 | 330.625 |
| 6 | 5 | 5 | 5.29 | 132.25 | -5 | -2.5 | -661.25 | -330.625 |
| 8 | 5 | 5 | 5.29 | 132.25 | 0 | -2.5 | 0 | -330.625 |
| 9 | 5 | 5 | 5.29 | 132.25 | 5 | 2.5 | 661.25 | 330.625 |
| 10 | 5 | 5 | 5.29 | 132.25 | 5 | -2.5 | 661.25 | -330.625 |
| 11 | 5 | 5 | 5.29 | 132.25 | 10 | 2.5 | 1322.5 | 330.625 |
| 12 | 5 | 5 | 5.29 | 132.25 | 10 | -2.5 | 1322.5 | -330.625 |
| 13 | 5 | 5 | 5.29 | 132.25 | 15 | 2.5 | 1983.75 | 330.625 |
| 14 | 5 | 5 | 5.29 | 132.25 | 15 | -2.5 | 1983.75 | -330.625 |
| 15 | 5.2 | 5.2 | 5.29 | 143.041 | -20.1 | 2.6 | -2875.13616 | 371.90816 |
| 16 | 5.2 | 5.2 | 5.29 | 143.04 | -20.1 | -2.6 | -2875.136 | -371.9081 |
| 17 | 5.2 | 5.2 | 5.29 | 143.04 | 20.1 | 2.6 | 2875.136 | 371.9081 |
| 18 | 5.2 | 5.2 | 5.29 | 143.04 | 20.1 | -2.6 | 2875.136 | -371.908 |
| Total Weight due to slab = | | | | 2291.4 | Sum = | | 0 | -330.625 |

| Beam on axis | Length | Width | Depth | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | w(m) | d(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| B4 | 5 | 0.25 | 0.4 | 12 | -17.5 | 2.5 | -210 | 30 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B5 | 5 | 0.25 | 0.4 | 12 | -17.5 | -2.5 | -210 | -30 |
| B6 | 5 | 0.25 | 0.4 | 12 | -15 | 0 | -180 | 0 |
| B7 | 5 | 0.25 | 0.4 | 12 | -15 | 5 | -180 | 60 |
| B8 | 5 | 0.25 | 0.4 | 12 | -15 | -5 | -180 | -60 |
| B9 | 5 | 0.25 | 0.4 | 12 | -12.5 | 2.5 | -150 | 30 |
| B10 | 5 | 0.25 | 0.4 | 12 | -12.5 | -2.5 | -150 | -30 |
| B11 | 5 | 0.25 | 0.4 | 12 | -10 | 0 | -120 | 0 |
| B12 | 5 | 0.25 | 0.4 | 12 | -10 | 5 | -120 | 60 |
| B13 | 5 | 0.25 | 0.4 | 12 | -10 | -5 | -120 | -60 |
| B14 | 5 | 0.25 | 0.4 | 12 | -7.5 | 2.5 | -90 | 30 |
| B15 | 5 | 0.25 | 0.4 | 12 | -7.5 | -2.5 | -90 | -30 |
| B16 | 5 | 0.25 | 0.4 | 12 | -5 | 0 | -60 | 0 |
| B17 | 5 | 0.25 | 0.4 | 12 | -5 | 5 | -60 | 60 |
| B18 | 5 | 0.25 | 0.4 | 12 | -5 | -5 | -60 | -60 |
| B19 | 5 | 0.25 | 0.4 | 12 | -2.5 | 2.5 | -30 | 30 |
| B20 | 5 | 0.25 | 0.4 | 12 | -2.5 | -2.5 | -30 | -30 |
| B21 | 5 | 0.25 | 0.4 | 12 | 0 | 5 | 0 | 60 |
| B22 | 5 | 0.25 | 0.4 | 12 | 0 | 0 | 0 | 0 |
| B23 | 5 | 0.25 | 0.4 | 12 | 0 | -5 | 0 | -60 |
| B24 | 5 | 0.25 | 0.4 | 12 | 2.5 | 2.5 | 30 | 30 |
| B25 | 5 | 0.25 | 0.4 | 12 | 2.5 | -2.5 | 30 | -30 |
| B26 | 5 | 0.25 | 0.4 | 12 | 5 | 0 | 60 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B27 | 5 | 0.25 | 0.4 | 12 | 5 | -5 | 60 | -60 |
| B28 | 5 | 0.25 | 0.4 | 12 | 5 | 5 | 60 | 60 |
| B29 | 5 | 0.25 | 0.4 | 12 | 7.5 | 2.5 | 90 | 30 |
| B30 | 5 | 0.25 | 0.4 | 12 | 7.5 | -2.5 | 90 | -30 |
| B31 | 5 | 0.25 | 0.4 | 12 | 10 | 0 | 120 | 0 |
| B32 | 5 | 0.25 | 0.4 | 12 | 10 | -5 | 120 | -60 |
| B33 | 5 | 0.25 | 0.4 | 12 | 10 | 5 | 120 | 60 |
| B34 | 5 | 0.25 | 0.4 | 12 | 12.5 | 2.5 | 150 | 30 |
| B35 | 5 | 0.25 | 0.4 | 12 | 12.5 | -2.5 | 150 | -30 |
| B36 | 5 | 0.25 | 0.4 | 12 | 15 | -5 | 180 | -60 |
| B37 | 5 | 0.25 | 0.4 | 12 | 15 | 0 | 180 | 0 |
| B38 | 5 | 0.25 | 0.4 | 12 | 15 | 5 | 180 | 60 |
| B39 | 5 | 0.25 | 0.4 | 12 | 17.5 | 2.5 | 210 | 30 |
| B40 | 5 | 0.25 | 0.4 | 12 | 17.5 | -2.5 | 210 | -30 |
| Total Weight due to beam = | | | | 483.21 | Sum = | | 890.2032 | 0 |

| Column on axis | Depth | Width | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | D(m) | w(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 0.4 | 0.4 | 3.15 | 12.096 | -17.5 | 0 | -211.68 | 0 |
| 2 | 0.4 | 0.4 | 3.15 | 12.096 | -17.5 | 5 | -211.68 | 60.48 |
| 3 | 0.4 | 0.4 | 3.15 | 12.096 | -17.5 | -5 | -211.68 | -60.48 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | 0.4 | 0.4 | 3.15 | 12.096 | -12.5 | 0 | -151.2 | 0 |
| 5 | 0.4 | 0.4 | 3.15 | 12.096 | -12.5 | 5 | -151.2 | 60.48 |
| 6 | 0.4 | 0.4 | 3.15 | 12.096 | -12.5 | -5 | -151.2 | -60.48 |
| 7 | 0.4 | 0.4 | 3.15 | 12.096 | -7.5 | 0 | -90.72 | 0 |
| 8 | 0.4 | 0.4 | 3.15 | 12.096 | -7.5 | 5 | -90.72 | 60.48 |
| 9 | 0.4 | 0.4 | 3.15 | 12.096 | -7.5 | -5 | -90.72 | -60.48 |
| 10 | 0.4 | 0.4 | 3.15 | 12.096 | -2.5 | 0 | -30.24 | 0 |
| 11 | 0.4 | 0.4 | 3.15 | 12.096 | -2.5 | 5 | -30.24 | 60.48 |
| 12 | 0.4 | 0.4 | 3.15 | 12.096 | -2.5 | -5 | -30.24 | -60.48 |
| 13 | 0.4 | 0.4 | 3.15 | 12.096 | 2.5 | 0 | 30.24 | 0 |
| 14 | 0.4 | 0.4 | 3.15 | 12.096 | 2.5 | 5 | 30.24 | 60.48 |
| 15 | 0.4 | 0.4 | 3.15 | 12.096 | 2.5 | -5 | 30.24 | -60.48 |
| 16 | 0.4 | 0.4 | 3.15 | 12.096 | 7.5 | 0 | 90.72 | 0 |
| 17 | 0.4 | 0.4 | 3.15 | 12.096 | 7.5 | 5 | 90.72 | 60.48 |
| 18 | 0.4 | 0.4 | 3.15 | 12.096 | 7.5 | -5 | 90.72 | -60.48 |
| 19 | 0.4 | 0.4 | 3.15 | 12.096 | 12.5 | 0 | 151.2 | 0 |
| 20 | 0.4 | 0.4 | 3.15 | 12.096 | 12.5 | 5 | 151.2 | 60.48 |
| 21 | 0.4 | 0.4 | 3.15 | 12.096 | 12.5 | -5 | 151.2 | -60.48 |
| 22 | 0.4 | 0.4 | 3.15 | 12.096 | 17.5 | 0 | 211.68 | 0 |
| 23 | 0.4 | 0.4 | 3.15 | 12.096 | 17.5 | 5 | 211.68 | 60.48 |
| 24 | 0.4 | 0.4 | 3.15 | 12.096 | 17.5 | -5 | 211.68 | -60.48 |
| 25 | 0.4 | 0.4 | 3.15 | 12.096 | -22.5 | 0 | -272.16 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 26 | 0.4 | 0.4 | 3.15 | 12.096 | 22.5 | 0 | 272.16 | 0 |
| Total Weight due to column = | | | | 314.496 | Sum = | | 0 | 0 |

| Wall identification | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 5 | 0.2 | 1.65 | 23.1 | -17.5 | 2.5 | -404.25 | 57.75 |
| 2 | 5 | 0.2 | 1.65 | 23.1 | -17.5 | -2.5 | -404.25 | -57.75 |
| 3 | 5 | 0.2 | 1.65 | 23.1 | -15 | 5 | -346.5 | 115.5 |
| 4 | 5 | 0.2 | 1.65 | 23.1 | -15 | 0 | -346.5 | 0 |
| 5 | 5 | 0.2 | 1.65 | 23.1 | -15 | -5 | -346.5 | -115.5 |
| 6 | 5 | 0.2 | 1.65 | 23.1 | -12.5 | 2.5 | -288.75 | 57.75 |
| 7 | 5 | 0.2 | 1.65 | 23.1 | -12.5 | -2.5 | -288.75 | -57.75 |
| 8 | 5 | 0.2 | 1.65 | 23.1 | -10 | 5 | -231 | 115.5 |
| 9 | 5 | 0.2 | 1.65 | 23.1 | -10 | 0 | -231 | 0 |
| 10 | 5 | 0.2 | 1.65 | 23.1 | -10 | -5 | -231 | -115.5 |
| 11 | 5 | 0.2 | 1.65 | 23.1 | -7.5 | 3.3 | -173.25 | 76.23 |
| 12 | 5 | 0.2 | 1.65 | 23.1 | -7.5 | -2.5 | -173.25 | -57.75 |
| 13 | 5 | 0.2 | 1.65 | 23.1 | -5 | 5 | -115.5 | 115.5 |
| 14 | 5 | 0.2 | 1.65 | 23.1 | -5 | 0 | -115.5 | 0 |
| 15 | 5 | 0.2 | 1.65 | 23.1 | -5 | -5 | -115.5 | -115.5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 16 | 5 | 0.2 | 1.65 | 23.1 | -2.5 | 3.3 | -57.75 | 76.23 |
| 17 | 5 | 0.2 | 1.65 | 23.1 | -2.5 | -2.5 | -57.75 | -57.75 |
| 18 | 5 | 0.2 | 1.65 | 23.1 | 0 | 5 | 0 | 115.5 |
| 19 | 5 | 0.2 | 1.65 | 23.1 | 0 | 0 | 0 | 0 |
| 20 | 5 | 0.2 | 1.65 | 23.1 | 0 | -5 | 0 | -115.5 |
| 21 | 5 | 0.2 | 1.65 | 23.1 | 2.5 | 3.3 | 57.75 | 76.23 |
| 22 | 5 | 0.2 | 1.65 | 23.1 | 2.5 | -2.5 | 57.75 | -57.75 |
| 23 | 5 | 0.2 | 1.65 | 23.1 | 5 | 5 | 115.5 | 115.5 |
| 24 | 5 | 0.2 | 1.65 | 23.1 | 5 | 0 | 115.5 | 0 |
| 25 | 5 | 0.2 | 1.65 | 23.1 | 5 | -5 | 115.5 | -115.5 |
| 26 | 5 | 0.2 | 1.65 | 23.1 | 7.5 | 3.3 | 173.25 | 76.23 |
| 27 | 5 | 0.2 | 1.65 | 23.1 | 7.5 | -2.5 | 173.25 | -57.75 |
| 28 | 5 | 0.2 | 1.65 | 23.1 | 10 | 5 | 231 | 115.5 |
| 29 | 5 | 0.2 | 1.65 | 23.1 | 10 | 0 | 231 | 0 |
| 30 | 5 | 0.2 | 1.65 | 23.1 | 10 | -5 | 231 | -115.5 |
| 31 | 5 | 0.2 | 1.65 | 23.1 | 12.5 | 3.3 | 288.75 | 76.23 |
| 32 | 5 | 0.2 | 1.65 | 23.1 | 12.5 | -2.5 | 288.75 | -57.75 |
| 33 | 5 | 0.2 | 1.65 | 23.1 | 15 | 5 | 346.5 | 115.5 |
| 34 | 5 | 0.2 | 1.65 | 23.1 | 15 | 0 | 346.5 | 0 |
| 35 | 5 | 0.2 | 1.65 | 23.1 | 15 | -5 | 346.5 | -115.5 |
| 36 | 5 | 0.2 | 1.65 | 23.1 | 17.5 | 2.5 | 404.25 | 57.75 |
| 37 | 5 | 0.2 | 1.65 | 23.1 | 17.5 | -2.5 | 404.25 | -57.75 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 38 | 14 | 0.15 | 1.65 | 48.51 | -10.5 | 1.8 | -509.355 | 87.318 |
| 39 | 14 | 0.15 | 1.65 | 48.51 | 10.5 | 1.8 | 509.355 | 87.318 |
| 40 | 3.3 | 0.15 | 1.65 | 11.434 | -5.05 | 3.35 | -57.74422 | 38.30557 |
| 41 | 3.3 | 0.15 | 1.65 | 11.434 | 5.05 | 3.35 | 57.74422 | 38.30557 |
| 42 | 1.4 | 0.15 | 1.65 | 4.851 | -3.2 | 4.205 | -15.5232 | 20.39845 |
| 43 | 1.4 | 0.15 | 1.65 | 4.851 | -3.2 | 3.205 | -15.5232 | 15.54745 |
| 44 | 3.3 | 0.15 | 1.65 | 11.434 | 5.05 | 3.35 | 57.74422 | 38.30557 |
| 45 | 1.4 | 0.15 | 1.65 | 4.851 | 3.2 | 3.205 | 15.5232 | 15.54745 |
| 46 | 1.1 | 0.15 | 1.65 | 3.8115 | -13.8 | -0.55 | -52.7892 | -2.09632 |
| 47 | 1.35 | 0.15 | 1.65 | 4.6777 | -13.7 | -1.875 | -64.31906 | -8.77078 |
| 48 | 1.1 | 0.15 | 1.65 | 3.8115 | -8.85 | -0.55 | -33.73177 | -2.09632 |
| 49 | 1.35 | 0.15 | 1.65 | 4.6777 | -8.75 | -1.875 | -40.93031 | -8.77078 |
| 50 | 1.1 | 0.15 | 1.65 | 3.8115 | -6.22 | -0.55 | -23.72658 | -2.09632 |
| 51 | 1.35 | 0.15 | 1.65 | 4.6777 | -6.82 | -1.875 | -31.92564 | -8.77078 |
| 52 | 1.1 | 0.15 | 1.65 | 3.8115 | 6.22 | -0.55 | 23.72658 | -2.09632 |
| 53 | 1.35 | 0.15 | 1.65 | 4.6777 | 6.82 | -1.875 | 31.92564 | -8.77078 |
| 54 | 1.1 | 0.15 | 1.65 | 3.8115 | 8.85 | -0.55 | 33.73177 | -2.09632 |
| 55 | 1.35 | 0.15 | 1.65 | 4.6777 | 8.75 | -1.875 | 40.93031 | -8.77078 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 56 | 1.1 | 0.15 | 1.65 | 3.8115 | 13.8 | -0.55 | 52.78927 | -2.09632 |
| 57 | 1.35 | 0.15 | 1.65 | 4.6777 | 13.7 | -1.875 | 64.31906 | -8.77078 |
| Weight of wall at this floor = | | | | 1051.5 | Sum = | | 42.22102 | 368.2434 |
| Weight of wall from previous floor = | | | | 440.874 | | | | |
| Total weight due to wall = | | | | 1492.38 | | | | |

| Staircase | | Length | DL | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | | L(m) | (KN/m2) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| staircase 3 | flight 3 | 1.8 | 10.894 | 19.6092 | 1.85 | 3.14 | 36.27702 | 61.572888 |
| | landing 3 | 1.6 | 8.44 | 13.504 | 1.7 | 4.3 | 22.9568 | 58.0672 |
| Staircase 4 | flight 4 | 1.5 | 10.894 | 16.341 | 0 | 4.35 | 0 | 71.08335 |
| | landing 4 | 2.1 | 8.44 | 17.724 | -1.7 | 4.3 | -30.1308 | 76.2132 |
| staircase 5 | flight 5 | 1.8 | 10.894 | 19.6092 | 0 | 4.35 | 0 | 85.30002 |
| | landing 5 | 1.4 | 8.44 | 11.816 | -1.7 | 4.3 | -20.0872 | 50.8088 |
| Weight of stair at this floor = | | | | 98.6034 | Sum = | | 9.01582 | 403.04545 |

| | | | | | |
|---|---|---|---|---|---|
| Total weight of ground floor = | 4680.12 | | | | |
| | | ∑W*X | 941.44 | Xm = | 0.2011573 |
| | | ∑W*Y | 440.664 | Ym = | 0.0941565 |

**Centre of mass for First floor**

| Panel no. | Length L(m) | Width w(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| C1 | 15 | 1.6 | 5.29 | 126.96 | -10 | 5.8 | -1269.6 | 736.368 |
| C2 | 15 | 1.6 | 5.29 | 126.96 | 10 | 5.8 | 1269.6 | 736.368 |
| C3 | 5.8 | 1.6 | 5.29 | 49.0912 | -9.6 | -5.8 | -471.27552 | -284.72896 |
| C4 | 5.8 | 1.6 | 5.29 | 49.0912 | 9.6 | -5.8 | 471.27552 | -284.72896 |
| C5 | 13.4 | 0.3 | 5.29 | 21.2658 | 0 | -5.15 | 0 | -109.51887 |
| 1 | 5 | 5 | 5.29 | 132.25 | -15 | 2.5 | -1983.75 | 330.625 |
| 2 | 5 | 5 | 5.29 | 132.25 | -15 | -2.5 | -1983.75 | -330.625 |
| 3 | 5 | 5 | 5.29 | 132.25 | -10 | 2.5 | -1322.5 | 330.625 |
| 4 | 5 | 5 | 5.29 | 132.25 | -10 | -2.5 | -1322.5 | -330.625 |
| 5 | 5 | 5 | 5.29 | 132.25 | -5 | 2.5 | -661.25 | 330.625 |
| 6 | 5 | 5 | 5.29 | 132.25 | -5 | -2.5 | -661.25 | -330.625 |
| 8 | 5 | 5 | 5.29 | 132.25 | 0 | -2.5 | 0 | -330.625 |
| 9 | 5 | 5 | 5.29 | 132.25 | 5 | 2.5 | 661.25 | 330.625 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10 | 5 | 5 | 5.29 | 132.25 | 5 | -2.5 | 661.25 | -330.625 |
| 11 | 5 | 5 | 5.29 | 132.25 | 10 | 2.5 | 1322.5 | 330.625 |
| 12 | 5 | 5 | 5.29 | 132.25 | 10 | -2.5 | 1322.5 | -330.625 |
| 13 | 5 | 5 | 5.29 | 132.25 | 15 | 2.5 | 1983.75 | 330.625 |
| 14 | 5 | 5 | 5.29 | 132.25 | 15 | -2.5 | 1983.75 | -330.625 |
| 15 | 5.2 | 5.2 | 5.29 | 143.041 | -20.1 | 2.6 | -2875.1361 | 371.90816 |
| 16 | 5.2 | 5.2 | 5.29 | 143.041 | -20.1 | -2.6 | -2875.1361 | -371.90816 |
| 17 | 5.2 | 5.2 | 5.29 | 143.041 | 20.1 | 2.6 | 2875.13616 | 371.90816 |
| 18 | 5.2 | 5.2 | 5.29 | 143.041 | 20.1 | -2.6 | 2875.13616 | -371.90816 |
| | | | | 2664.78 | Sum = | | 0 | 463.13421 |

| Beam on axis | Length | Width | Depth | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | w(m) | d(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| B1 | 5.2 | 0.25 | 0.4 | 12.48 | -20.1 | 0 | -250.848 | 0 |
| B2 | 8.17 | 0.25 | 0.4 | 19.608 | -22.7 | -5.2 | -445.1016 | -101.9616 |
| B3 | 8.17 | 0.25 | 0.4 | 19.608 | -22.7 | 5.2 | -445.1016 | 101.9616 |
| B4 | 5 | 0.25 | 0.4 | 12 | -17.5 | 2.5 | -210 | 30 |
| B5 | 5 | 0.25 | 0.4 | 12 | -17.5 | -2.5 | -210 | -30 |
| B6 | 5 | 0.25 | 0.4 | 12 | -15 | 0 | -180 | 0 |
| B7 | 5 | 0.25 | 0.4 | 12 | -15 | 5 | -180 | 60 |
| B8 | 5 | 0.25 | 0.4 | 12 | -15 | -5 | -180 | -60 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B9 | 5 | 0.25 | 0.4 | 12 | -12.5 | 2.5 | -150 | 30 |
| B10 | 5 | 0.25 | 0.4 | 12 | -12.5 | -2.5 | -150 | -30 |
| B11 | 5 | 0.25 | 0.4 | 12 | -10 | 0 | -120 | 0 |
| B12 | 5 | 0.25 | 0.4 | 12 | -10 | 5 | -120 | 60 |
| B13 | 5 | 0.25 | 0.4 | 12 | -10 | -5 | -120 | -60 |
| B14 | 5 | 0.25 | 0.4 | 12 | -7.5 | 2.5 | -90 | 30 |
| B15 | 5 | 0.25 | 0.4 | 12 | -7.5 | -2.5 | -90 | -30 |
| B16 | 5 | 0.25 | 0.4 | 12 | -5 | 0 | -60 | 0 |
| B17 | 5 | 0.25 | 0.4 | 12 | -5 | 5 | -60 | 60 |
| B18 | 5 | 0.25 | 0.4 | 12 | -5 | -5 | -60 | -60 |
| B19 | 5 | 0.25 | 0.4 | 12 | -2.5 | 2.5 | -30 | 30 |
| B20 | 5 | 0.25 | 0.4 | 12 | -2.5 | -2.5 | -30 | -30 |
| B21 | 5 | 0.25 | 0.4 | 12 | 0 | 5 | 0 | 60 |
| B22 | 5 | 0.25 | 0.4 | 12 | 0 | 0 | 0 | 0 |
| B23 | 5 | 0.25 | 0.4 | 12 | 0 | -5 | 0 | -60 |
| B24 | 5 | 0.25 | 0.4 | 12 | 2.5 | 2.5 | 30 | 30 |
| B25 | 5 | 0.25 | 0.4 | 12 | 2.5 | -2.5 | 30 | -30 |
| B26 | 5 | 0.25 | 0.4 | 12 | 5 | 0 | 60 | 0 |
| B27 | 5 | 0.25 | 0.4 | 12 | 5 | -5 | 60 | -60 |
| B28 | 5 | 0.25 | 0.4 | 12 | 5 | 5 | 60 | 60 |
| B29 | 5 | 0.25 | 0.4 | 12 | 7.5 | 2.5 | 90 | 30 |
| B30 | 5 | 0.25 | 0.4 | 12 | 7.5 | -2.5 | 90 | -30 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B31 | 5 | 0.25 | 0.4 | 12 | 10 | 0 | 120 | 0 |
| B32 | 5 | 0.25 | 0.4 | 12 | 10 | -5 | 120 | -60 |
| B33 | 5 | 0.25 | 0.4 | 12 | 10 | 5 | 120 | 60 |
| B34 | 5 | 0.25 | 0.4 | 12 | 12.5 | 2.5 | 150 | 30 |
| B35 | 5 | 0.25 | 0.4 | 12 | 12.5 | -2.5 | 150 | -30 |
| B36 | 5 | 0.25 | 0.4 | 12 | 15 | -5 | 180 | -60 |
| B37 | 5 | 0.25 | 0.4 | 12 | 15 | 0 | 180 | 0 |
| B38 | 5 | 0.25 | 0.4 | 12 | 15 | 5 | 180 | 60 |
| B39 | 5 | 0.25 | 0.4 | 12 | 17.5 | 2.5 | 210 | 30 |
| B40 | 5 | 0.25 | 0.4 | 12 | 17.5 | -2.5 | 210 | -30 |
| B41 | 5.2 | 0.25 | 0.4 | 12.48 | 20.1 | 0 | 250.848 | 0 |
| B42 | 8.17 | 0.25 | 0.4 | 19.608 | 22.7 | -5.2 | 445.1016 | -101.9616 |
| B43 | 8.17 | 0.25 | 0.4 | 19.608 | 22.7 | 5.2 | 445.1016 | 101.9616 |
| Total Weight due to beam = | | | | 547.392 | Sum = | | 0 | 0 |

| Column on axis | Depth | Width | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | D(m) | w(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 0.4 | 0.4 | 3.15 | 12.096 | -17.5 | 0 | -211.68 | 0 |
| 2 | 0.4 | 0.4 | 3.15 | 12.096 | -17.5 | 5 | -211.68 | 60.48 |
| 3 | 0.4 | 0.4 | 3.15 | 12.096 | -17.5 | -5 | -211.68 | -60.48 |
| 4 | 0.4 | 0.4 | 3.15 | 12.096 | -12.5 | 0 | -151.2 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 0.4 | 0.4 | 3.15 | 12.096 | -12.5 | 5 | -151.2 | 60.48 |
| 6 | 0.4 | 0.4 | 3.15 | 12.096 | -12.5 | -5 | -151.2 | -60.48 |
| 7 | 0.4 | 0.4 | 3.15 | 12.096 | -7.5 | 0 | -90.72 | 0 |
| 8 | 0.4 | 0.4 | 3.15 | 12.096 | -7.5 | 5 | -90.72 | 60.48 |
| 9 | 0.4 | 0.4 | 3.15 | 12.096 | -7.5 | -5 | -90.72 | -60.48 |
| 10 | 0.4 | 0.4 | 3.15 | 12.096 | -2.5 | 0 | -30.24 | 0 |
| 11 | 0.4 | 0.4 | 3.15 | 12.096 | -2.5 | 5 | -30.24 | 60.48 |
| 12 | 0.4 | 0.4 | 3.15 | 12.096 | -2.5 | -5 | -30.24 | -60.48 |
| 13 | 0.4 | 0.4 | 3.15 | 12.096 | 2.5 | 0 | 30.24 | 0 |
| 14 | 0.4 | 0.4 | 3.15 | 12.096 | 2.5 | 5 | 30.24 | 60.48 |
| 15 | 0.4 | 0.4 | 3.15 | 12.096 | 2.5 | -5 | 30.24 | -60.48 |
| 16 | 0.4 | 0.4 | 3.15 | 12.096 | 7.5 | 0 | 90.72 | 0 |
| 17 | 0.4 | 0.4 | 3.15 | 12.096 | 7.5 | 5 | 90.72 | 60.48 |
| 18 | 0.4 | 0.4 | 3.15 | 12.096 | 7.5 | -5 | 90.72 | -60.48 |
| 19 | 0.4 | 0.4 | 3.15 | 12.096 | 12.5 | 0 | 151.2 | 0 |
| 20 | 0.4 | 0.4 | 3.15 | 12.096 | 12.5 | 5 | 151.2 | 60.48 |
| 21 | 0.4 | 0.4 | 3.15 | 12.096 | 12.5 | -5 | 151.2 | -60.48 |
| 22 | 0.4 | 0.4 | 3.15 | 12.096 | 17.5 | 0 | 211.68 | 0 |
| 23 | 0.4 | 0.4 | 3.15 | 12.096 | 17.5 | 5 | 211.68 | 60.48 |
| 24 | 0.4 | 0.4 | 3.15 | 12.096 | 17.5 | -5 | 211.68 | -60.48 |
| 25 | 0.4 | 0.4 | 3.15 | 12.096 | -22.5 | 0 | -272.16 | 0 |
| 26 | 0.4 | 0.4 | 3.15 | 12.096 | 22.5 | 0 | 272.16 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| Total Weight due to column = | 314.496 | Sum = | 0 | 0 |

| Wall identification | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 5 | 0.2 | 1.5 | 21 | -17.5 | 2.5 | -367.5 | 52.5 |
| 2 | 5 | 0.2 | 1.5 | 21 | -17.5 | -2.5 | -367.5 | -52.5 |
| 3 | 7.95 | 0.2 | 1.5 | 33.39 | -21.2 | 3.9 | -707.868 | 130.221 |
| 4 | 7.95 | 0.2 | 1.5 | 33.39 | -21.2 | -3.9 | -707.868 | -130.221 |
| 5 | 5 | 0.2 | 1.5 | 21 | -15 | -5 | -315 | -105 |
| 6 | 7.95 | 0.2 | 1.5 | 33.39 | -20.1 | 0 | -671.139 | 0 |
| 7 | 1.6 | 0.2 | 1.5 | 6.72 | -17.5 | 0.8 | -117.6 | 5.376 |
| 8 | 15 | 0.2 | 1.5 | 63 | -10 | 6.6 | -630 | 415.8 |
| 9 | 5 | 0.2 | 1.5 | 21 | -10 | 0 | -210 | 0 |
| 10 | 15 | 0.15 | 1.5 | 47.25 | -10 | 1.75 | -472.5 | 82.6875 |
| 11 | 4.9 | 0.15 | 1.5 | 15.435 | -12.5 | 4.15 | -192.9375 | 64.05525 |
| 12 | 4.9 | 0.15 | 1.5 | 15.435 | -7.5 | 4.15 | -115.7625 | 64.05525 |
| 13 | 4.9 | 0.15 | 1.5 | 15.435 | -5.05 | 4.15 | -77.94675 | 64.05525 |
| 14 | 5 | 0.2 | 1.5 | 21 | -5 | 0 | -105 | 0 |
| 15 | 4.9 | 0.15 | 1.5 | 15.435 | -2.5 | 4.15 | -38.5875 | 64.05525 |
| 16 | 3.4 | 0.15 | 1.5 | 10.71 | -15.87 | -1.7 | -170.02125 | -18.207 |
| 17 | 3.375 | 0.15 | 1.5 | 10.6312 | -14.18 | 0 | -150.75112 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 18 | 13.375 | 0.15 | 1.5 | 42.1312 | -9.18 | -3.4 | -386.76487 | -143.24625 |
| 19 | 3.4 | 0.15 | 1.5 | 10.71 | -12.5 | -1.7 | -133.875 | -18.207 |
| 20 | 3.4 | 0.15 | 1.5 | 10.71 | -7.5 | -1.7 | -80.325 | -18.207 |
| 21 | 3.4 | 0.15 | 1.5 | 10.71 | -2.5 | -1.7 | -26.775 | -18.207 |
| 22 | 5 | 0.15 | 1.5 | 15.75 | 0 | -3.4 | 0 | -53.55 |
| 23 | 4.9 | 0.15 | 1.5 | 15.435 | 2.5 | 4.15 | 38.5875 | 64.05525 |
| 24 | 5 | 0.2 | 1.5 | 21 | 5 | 0 | 105 | 0 |
| 25 | 15 | 0.2 | 1.5 | 63 | 10 | 6.6 | 630 | 415.8 |
| 26 | 4.9 | 0.15 | 1.5 | 15.435 | 5.05 | 4.15 | 77.94675 | 64.05525 |
| 27 | 4.9 | 0.15 | 1.5 | 15.435 | 7.5 | 4.15 | 115.7625 | 64.05525 |
| 28 | 4.9 | 0.15 | 1.5 | 15.435 | 12.5 | 4.15 | 192.9375 | 64.05525 |
| 29 | 5 | 0.2 | 1.5 | 21 | 10 | 0 | 210 | 0 |
| 30 | 15 | 0.15 | 1.5 | 47.25 | 10 | 1.75 | 472.5 | 82.6875 |
| 31 | 1.6 | 0.2 | 1.5 | 6.72 | 17.5 | 0.8 | 117.6 | 5.376 |
| 32 | 3.375 | 0.15 | 1.5 | 10.6312 | 14.18 | 0 | 150.751125 | 0 |
| 33 | 13.375 | 0.15 | 1.5 | 42.1312 | 9.18 | 3.4 | 386.764875 | 143.24625 |
| 34 | 3.4 | 0.15 | 1.5 | 10.71 | 2.5 | -1.7 | 26.775 | -18.207 |
| 35 | 5 | 0.2 | 1.5 | 21 | 15 | -5 | 315 | -105 |
| 36 | 5 | 0.2 | 1.5 | 21 | 17.5 | 2.5 | 367.5 | 52.5 |
| 37 | 5 | 0.2 | 1.5 | 21 | 17.5 | -2.5 | 367.5 | -52.5 |
| 38 | 3.4 | 0.15 | 1.5 | 10.71 | 15.875 | 1.7 | 170.02125 | 18.207 |
| 39 | 7.95 | 0.2 | 1.5 | 33.39 | 20.1 | 0 | 671.139 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 40 | 7.95 | 0.2 | 1.5 | 33.39 | 21.2 | 3.9 | 707.868 | 130.221 |
| 41 | 7.95 | 0.2 | 1.5 | 33.39 | 21.2 | -3.9 | 707.868 | -130.221 |
| 42 | 3.5 | 0.2 | 1.5 | 14.7 | -9.25 | -6.6 | -135.975 | -97.02 |
| 43 | 3.5 | 0.2 | 1.5 | 14.7 | 9.25 | -6.6 | 135.975 | -97.02 |
| 44 | 1.6 | 0.2 | 1.5 | 6.72 | 10.2 | -5.8 | 68.544 | -38.976 |
| 45 | 1.6 | 0.2 | 1.5 | 6.72 | 6.7 | -5.8 | 45.024 | -38.976 |
| 46 | 1.6 | 0.2 | 1.5 | 6.72 | 10.2 | -5.8 | 68.544 | -38.976 |
| 47 | 1.6 | 0.2 | 1.5 | 6.72 | 6.7 | -5.8 | 45.024 | -38.976 |
| 48 | 13.4 | 0.2 | 1.5 | 56.28 | 0 | -5.8 | 0 | -326.424 |
| Weight of wall at this floor = | | | | 1065.85 | Sum = | | 12.936 | 507.423 |
| Weight of wall from previous floor = | | | | 1051.51 | | | | |
| Total weight due to wall = | | | | 2117.36 | | | | |

| Staircase | | Length | DL | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | | L(m) | (KN/m2) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| staircase 3 | flight 3 | 1.8 | 10.894 | 19.6092 | 1.85 | 3.14 | 36.27702 | 61.572888 |
| | landing 3 | 1.6 | 8.44 | 13.504 | 1.7 | 4.3 | 22.9568 | 58.0672 |
| Staircase 4 | flight 4 | 1.5 | 10.894 | 16.341 | 0 | 4.35 | 0 | 71.08335 |
| | landing 4 | 2.1 | 8.44 | 17.724 | -1.7 | 4.3 | -30.1308 | 76.2132 |
| staircase 5 | flight 5 | 1.8 | 10.894 | 19.6092 | 0 | 4.35 | 0 | 85.30002 |
| | landing 5 | 1.4 | 8.44 | 11.816 | -1.7 | 4.3 | -20.0872 | 50.8088 |

| | | | | | |
|---|---|---|---|---|---|
| Weight of stair at this floor = | 98.6034 | Sum = | | 9.01582 | 403.045458 |
| Total weight of first floor = | 5742.643 | | | | |
| | | ∑W*X | 21.9518 | Xm = | 0.00382259 |
| | | ∑W*Y | 448.080 | Ym = | 0.07802684 |

**Centre of mass for second floor**

| Panel no. | Length L(m) | Width w(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| C1 | 15 | 1.6 | 5.29 | 126.96 | -10 | 5.8 | -1269.6 | 736.368 |
| C2 | 15 | 1.6 | 5.29 | 126.96 | 10 | 5.8 | 1269.6 | 736.368 |
| C3 | 5.8 | 1.6 | 5.29 | 49.0912 | -10.2 | -5.8 | -500.73024 | -284.72896 |
| C4 | 5.8 | 1.6 | 5.29 | 49.0912 | -10.2 | -5.8 | -500.73024 | -284.72896 |
| C5 | 1.6 | 0.895 | 5.29 | 7.57528 | -7.05 | -5.8 | -53.405724 | -43.936624 |
| 1 | 5 | 5 | 5.29 | 132.25 | -15 | 2.5 | -1983.75 | 330.625 |
| 2 | 5 | 5 | 5.29 | 132.25 | -15 | -2.5 | -1983.75 | -330.625 |
| 3 | 5 | 5 | 5.29 | 132.25 | -10 | 2.5 | -1322.5 | 330.625 |
| 4 | 5 | 5 | 5.29 | 132.25 | -10 | -2.5 | -1322.5 | -330.625 |
| 5 | 5 | 5 | 5.29 | 132.25 | -5 | 2.5 | -661.25 | 330.625 |
| 6 | 5 | 5 | 5.29 | 132.25 | -5 | -2.5 | -661.25 | -330.625 |
| 8 | 5 | 3.9 | 5.29 | 103.155 | 0 | -1.95 | 0 | -201.15225 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9 | 5 | 5 | 5.29 | 132.25 | 5 | 2.5 | 661.25 | 330.625 |
| 10 | 5 | 5 | 5.29 | 132.25 | 5 | -2.5 | 661.25 | -330.625 |
| 11 | 5 | 5 | 5.29 | 132.25 | 10 | 2.5 | 1322.5 | 330.625 |
| 12 | 5 | 5 | 5.29 | 132.25 | 10 | -2.5 | 1322.5 | -330.625 |
| 13 | 5 | 5 | 5.29 | 132.25 | 15 | 2.5 | 1983.75 | 330.625 |
| 14 | 5 | 5 | 5.29 | 132.25 | 15 | -2.5 | 1983.75 | -330.625 |
| 15 | 5.2 | 5.2 | 5.29 | 143.042 | -20.1 | 2.6 | -2875.1362 | 371.90816 |
| 16 | 5.2 | 5.2 | 5.29 | 143.042 | -20.1 | -2.6 | -2875.1362 | -371.90816 |
| 17 | 5.2 | 5.2 | 5.29 | 143.042 | 20.1 | 2.6 | 2875.13616 | 371.90816 |
| 18 | 5.2 | 5.2 | 5.29 | 143.042 | 20.1 | -2.6 | 2875.13616 | -371.90816 |
| C6 | 1.6 | 0.895 | 5.29 | 7.57528 | 7.05 | -5.8 | 53.405724 | -43.936624 |
| Total Weight due to slab = | | | | 2629.57 | Sum = | | -1001.46 | 614.2525 |

| Beam on axis | Length | Width | Depth | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | w(m) | d(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| B1 | 5.2 | 0.25 | 0.4 | 12.48 | -20.1 | 0 | -250.848 | 0 |
| B2 | 8.17 | 0.25 | 0.4 | 19.608 | -22.7 | -5.2 | -445.1016 | -101.9616 |
| B3 | 8.17 | 0.25 | 0.4 | 19.608 | -22.7 | 5.2 | -445.1016 | 101.9616 |
| B4 | 5 | 0.25 | 0.4 | 12 | -17.5 | 2.5 | -210 | 30 |
| B5 | 5 | 0.25 | 0.4 | 12 | -17.5 | -2.5 | -210 | -30 |
| B6 | 5 | 0.25 | 0.4 | 12 | -15 | 0 | -180 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B7 | 5 | 0.25 | 0.4 | 12 | -15 | 5 | -180 | 60 |
| B8 | 5 | 0.25 | 0.4 | 12 | -15 | -5 | -180 | -60 |
| B9 | 5 | 0.25 | 0.4 | 12 | -12.5 | 2.5 | -150 | 30 |
| B10 | 5 | 0.25 | 0.4 | 12 | -12.5 | -2.5 | -150 | -30 |
| B11 | 5 | 0.25 | 0.4 | 12 | -10 | 0 | -120 | 0 |
| B12 | 5 | 0.25 | 0.4 | 12 | -10 | 5 | -120 | 60 |
| B13 | 5 | 0.25 | 0.4 | 12 | -10 | -5 | -120 | -60 |
| B14 | 5 | 0.25 | 0.4 | 12 | -7.5 | 2.5 | -90 | 30 |
| B15 | 5 | 0.25 | 0.4 | 12 | -7.5 | -2.5 | -90 | -30 |
| B16 | 5 | 0.25 | 0.4 | 12 | -5 | 0 | -60 | 0 |
| B17 | 5 | 0.25 | 0.4 | 12 | -5 | 5 | -60 | 60 |
| B18 | 5 | 0.25 | 0.4 | 12 | -5 | -5 | -60 | -60 |
| B19 | 5 | 0.25 | 0.4 | 12 | -2.5 | 2.5 | -30 | 30 |
| B20 | 5 | 0.25 | 0.4 | 12 | -2.5 | -2.5 | -30 | -30 |
| B21 | 5 | 0.25 | 0.4 | 12 | 0 | 5 | 0 | 60 |
| B22 | 5 | 0.25 | 0.4 | 12 | 0 | 0 | 0 | 0 |
| B24 | 5 | 0.25 | 0.4 | 12 | 2.5 | 2.5 | 30 | 30 |
| B25 | 5 | 0.25 | 0.4 | 12 | 2.5 | -2.5 | 30 | -30 |
| B26 | 5 | 0.25 | 0.4 | 12 | 5 | 0 | 60 | 0 |
| B27 | 5 | 0.25 | 0.4 | 12 | 5 | -5 | 60 | -60 |
| B28 | 5 | 0.25 | 0.4 | 12 | 5 | 5 | 60 | 60 |
| B29 | 5 | 0.25 | 0.4 | 12 | 7.5 | 2.5 | 90 | 30 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B30 | 5 | 0.25 | 0.4 | 12 | 7.5 | -2.5 | 90 | -30 |
| B31 | 5 | 0.25 | 0.4 | 12 | 10 | 0 | 120 | 0 |
| B32 | 5 | 0.25 | 0.4 | 12 | 10 | -5 | 120 | -60 |
| B33 | 5 | 0.25 | 0.4 | 12 | 10 | 5 | 120 | 60 |
| B34 | 5 | 0.25 | 0.4 | 12 | 12.5 | 2.5 | 150 | 30 |
| B35 | 5 | 0.25 | 0.4 | 12 | 12.5 | -2.5 | 150 | -30 |
| B36 | 5 | 0.25 | 0.4 | 12 | 15 | -5 | 180 | -60 |
| B37 | 5 | 0.25 | 0.4 | 12 | 15 | 0 | 180 | 0 |
| B38 | 5 | 0.25 | 0.4 | 12 | 15 | 5 | 180 | 60 |
| B39 | 5 | 0.25 | 0.4 | 12 | 17.5 | 2.5 | 210 | 30 |
| B40 | 5 | 0.25 | 0.4 | 12 | 17.5 | -2.5 | 210 | -30 |
| B41 | 5.2 | 0.25 | 0.4 | 12.48 | 20.1 | 0 | 250.848 | 0 |
| B42 | 8.17 | 0.25 | 0.4 | 19.608 | 22.7 | -5.2 | 445.1016 | -101.9616 |
| B43 | 8.17 | 0.25 | 0.4 | 19.608 | 22.7 | 5.2 | 445.1016 | 101.9616 |
| Total Weight due to beam = | | | | 535.392 | Sum = | | 0 | 60 |
| | | | | | | | | |

| Column on axis | Depth D(m) | Width w(m) | Height h(m) | Weight W (KN) | Distance X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | 0 | -201.6 | 0 |
| 2 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | 5 | -201.6 | 57.6 |
| 3 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | -5 | -201.6 | -57.6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | 0 | -144 | 0 |
| 5 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | 5 | -144 | 57.6 |
| 6 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | -5 | -144 | -57.6 |
| 7 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | 0 | -86.4 | 0 |
| 8 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | 5 | -86.4 | 57.6 |
| 9 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | -5 | -86.4 | -57.6 |
| 10 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | 0 | -28.8 | 0 |
| 11 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | 5 | -28.8 | 57.6 |
| 12 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | -5 | -28.8 | -57.6 |
| 13 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | 0 | 28.8 | 0 |
| 14 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | 5 | 28.8 | 57.6 |
| 15 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | -5 | 28.8 | -57.6 |
| 16 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | 0 | 86.4 | 0 |
| 17 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | 5 | 86.4 | 57.6 |
| 18 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | -5 | 86.4 | -57.6 |
| 19 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | 0 | 144 | 0 |
| 20 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | 5 | 144 | 57.6 |
| 21 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | -5 | 144 | -57.6 |
| 22 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | 0 | 201.6 | 0 |
| 23 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | 5 | 201.6 | 57.6 |
| 24 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | -5 | 201.6 | -57.6 |
| 25 | 0.4 | 0.4 | 3 | 11.52 | -22.5 | 0 | -259.2 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 26 | 0.4 | 0.4 | 3 | 11.52 | 22.5 | 0 | 259.2 | 0 |
| Total Weight due to column = | | | | 299.52 | Sum = | | 0 | 0 |

| Wall identification | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 5 | 0.2 | 1.5 | 21 | -17.5 | 2.5 | -367.5 | 52.5 |
| 2 | 5 | 0.2 | 1.5 | 21 | -17.5 | -2.5 | -367.5 | -52.5 |
| 3 | 7.95 | 0.2 | 1.5 | 33.39 | -21.2 | 3.9 | -707.868 | 130.221 |
| 4 | 7.95 | 0.2 | 1.5 | 33.39 | -21.2 | -3.9 | -707.868 | -130.221 |
| 5 | 5 | 0.2 | 1.5 | 21 | -15 | -5 | -315 | -105 |
| 6 | 7.95 | 0.2 | 1.5 | 33.39 | -20.1 | 0 | -671.139 | 0 |
| 7 | 1.6 | 0.2 | 1.5 | 6.72 | -17.5 | 0.8 | -117.6 | 5.376 |
| 8 | 15 | 0.2 | 1.5 | 63 | -10 | 6.6 | -630 | 415.8 |
| 9 | 5 | 0.2 | 1.5 | 21 | -10 | 0 | -210 | 0 |
| 10 | 15 | 0.15 | 1.5 | 47.25 | -10 | 1.75 | -472.5 | 82.6875 |
| 11 | 4.9 | 0.15 | 1.5 | 15.435 | -12.5 | 4.15 | -192.9375 | 64.05525 |
| 13 | 4.9 | 0.15 | 1.5 | 15.435 | -5.05 | 4.15 | -77.94675 | 64.05525 |
| 14 | 5 | 0.2 | 1.5 | 21 | -5 | 0 | -105 | 0 |
| 15 | 4.9 | 0.15 | 1.5 | 15.435 | -2.5 | 4.15 | -38.5875 | 64.05525 |
| 16 | 3.4 | 0.15 | 1.5 | 10.71 | -2.5 | -1.7 | -26.775 | -18.207 |
| 17 | 3.4 | 0.15 | 1.5 | 10.71 | 2.5 | -1.7 | 26.775 | -18.207 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 18 | 5 | 0.2 | 1.5 | 21 | 0 | 5 | 0 | 105 |
| 19 | 5 | 0.2 | 1.5 | 21 | 0 | 0 | 0 | 0 |
| 20 | 7.2 | 0.15 | 1.5 | 22.68 | 0 | -3.75 | 0 | -85.05 |
| 23 | 4.9 | 0.15 | 1.5 | 15.435 | 2.5 | 4.15 | 38.5875 | 64.05525 |
| 24 | 5 | 0.2 | 1.5 | 21 | 5 | 0 | 105 | 0 |
| 25 | 15 | 0.2 | 1.5 | 63 | 10 | 6.6 | 630 | 415.8 |
| 26 | 4.9 | 0.15 | 1.5 | 15.435 | 5.05 | 4.15 | 77.94675 | 64.05525 |
| 27 | 5 | 0.2 | 1.5 | 21 | 7.5 | -2.5 | 157.5 | -52.5 |
| 28 | 4.9 | 0.15 | 1.5 | 15.435 | 12.5 | 4.15 | 192.9375 | 64.05525 |
| 29 | 5 | 0.2 | 1.5 | 21 | 10 | 0 | 210 | 0 |
| 30 | 15 | 0.15 | 1.5 | 47.25 | 10 | 1.75 | 472.5 | 82.6875 |
| 31 | 1.6 | 0.2 | 1.5 | 6.72 | 17.5 | 0.8 | 117.6 | 5.376 |
| 32 | 5 | 0.2 | 1.5 | 21 | 12.5 | -2.5 | 262.5 | -52.5 |
| 35 | 5 | 0.2 | 1.5 | 21 | 15 | -5 | 315 | -105 |
| 36 | 5 | 0.2 | 1.5 | 21 | 17.5 | 2.5 | 367.5 | 52.5 |
| 37 | 5 | 0.2 | 1.5 | 21 | 17.5 | -2.5 | 367.5 | -52.5 |
| 39 | 7.95 | 0.2 | 1.5 | 33.39 | 20.1 | 0 | 671.139 | 0 |
| 40 | 7.95 | 0.2 | 1.5 | 33.39 | 21.2 | 3.9 | 707.868 | 130.221 |
| 41 | 7.95 | 0.2 | 1.5 | 33.39 | 21.2 | -3.9 | 707.868 | -130.221 |
| 43 | 5 | 0.2 | 1.5 | 21 | 10.5 | -6.6 | 220.5 | -138.6 |
| 44 | 1.6 | 0.2 | 1.5 | 6.72 | 12.5 | -5.8 | 84 | -38.976 |
| 45 | 1.6 | 0.2 | 1.5 | 6.72 | 7.5 | -5.8 | 50.4 | -38.976 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 46 | 1.6 | 0.2 | 1.5 | 6.72 | -12.5 | -5.8 | -84 | -38.976 |
| 47 | 5 | 0.2 | 1.5 | 21 | -10.5 | -6.6 | -220.5 | -138.6 |
| 48 | 1.6 | 0.2 | 1.5 | 6.72 | -7.5 | -5.8 | -50.4 | -38.976 |
| 49 | 4.35 | 0.2 | 1.5 | 18.27 | -4 | -5.8 | -73.08 | -105.966 |
| 50 | 4.35 | 0.2 | 1.5 | 18.27 | 4 | -5.8 | 73.08 | -105.966 |
| Weight of wall at this floor = | | | | 970.41 | Sum = | | 420 | 415.5585 |
| Weight of wall from previous floor = | | | | 1065.86 | | | | |
| Total weight due to wall = | | | | 2036.27 | | | | |

| Staircase | | Length | DL | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | | L(m) | (KN/m2) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| staircase 3 | flight 3 | 1.8 | 10.894 | 19.6092 | 1.85 | 3.14 | 36.27702 | 61.572888 |
| | landing 3 | 1.6 | 8.44 | 13.504 | 1.7 | 4.3 | 22.9568 | 58.0672 |
| Staircase 4 | flight 4 | 1.5 | 10.894 | 16.341 | 0 | 4.35 | 0 | 71.08335 |
| | landing 4 | 2.1 | 8.44 | 17.724 | -1.7 | 4.3 | -30.1308 | 76.2132 |
| stair case 5 | flight 5 | 1.8 | 10.894 | 19.6092 | 0 | 4.35 | 0 | 85.30002 |
| | landing 5 | 1.4 | 8.44 | 11.816 | -1.7 | 4.3 | -20.0872 | 50.8088 |
| Weight of stair at this floor = | | | | 98.6034 | Sum = | | 9.01582 | 403.045458 |
| Total weight of second floor = | | | | 5599.35 | | | | |
| | | | | | ∑W*X | -572.44 | Xm = | -0.102234 |
| | | | | | ∑W*Y | 1492.8 | Ym = | 0.266612 |

**Centre of mass for third floor**

| Panel no. | Length L(m) | Width w(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Distance Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| C1 | 15 | 1.6 | 5.29 | 126.96 | -10 | 5.8 | -1269.6 | 736.368 |
| C2 | 15 | 1.6 | 5.29 | 126.96 | 10 | 5.8 | 1269.6 | 736.368 |
| C3 | 5.8 | 1.6 | 5.29 | 49.0912 | -10.2 | -5.8 | -500.73024 | -284.72896 |
| C4 | 5.8 | 1.6 | 5.29 | 49.0912 | -10.2 | -5.8 | -500.73024 | -284.72896 |
| C5 | 1.6 | 0.895 | 5.29 | 7.57528 | -7.05 | -5.8 | -53.405724 | -43.936624 |
| 1 | 5 | 5 | 5.29 | 132.25 | -15 | 2.5 | -1983.75 | 330.625 |
| 2 | 5 | 5 | 5.29 | 132.25 | -15 | -2.5 | -1983.75 | -330.625 |
| 3 | 5 | 5 | 5.29 | 132.25 | -10 | 2.5 | -1322.5 | 330.625 |
| 4 | 5 | 5 | 5.29 | 132.25 | -10 | -2.5 | -1322.5 | -330.625 |
| 5 | 5 | 5 | 5.29 | 132.25 | -5 | 2.5 | -661.25 | 330.625 |
| 6 | 5 | 5 | 5.29 | 132.25 | -5 | -2.5 | -661.25 | -330.625 |
| 8 | 5 | 5 | 5.29 | 132.25 | 0 | -2.5 | 0 | -330.625 |
| 9 | 5 | 5 | 5.29 | 132.25 | 5 | 2.5 | 661.25 | 330.625 |
| 10 | 5 | 5 | 5.29 | 132.25 | 5 | -2.5 | 661.25 | -330.625 |
| 11 | 5 | 5 | 5.29 | 132.25 | 10 | 2.5 | 1322.5 | 330.625 |
| 12 | 5 | 5 | 5.29 | 132.25 | 10 | -2.5 | 1322.5 | -330.625 |
| 13 | 5 | 5 | 5.29 | 132.25 | 15 | 2.5 | 1983.75 | 330.625 |
| 14 | 5 | 5 | 5.29 | 132.25 | 15 | -2.5 | 1983.75 | -330.625 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 15 | 5.2 | 5.2 | 5.29 | 143.041 | -20.1 | 2.6 | -2875.13616 | 371.90816 |
| 16 | 5.2 | 5.2 | 5.29 | 143.041 | -20.1 | -2.6 | -2875.13616 | -371.90816 |
| 17 | 5.2 | 5.2 | 5.29 | 143.416 | 20.1 | 2.6 | 2875.13616 | 371.90816 |
| 18 | 5.2 | 5.2 | 5.29 | 143.041 | 20.1 | -2.6 | 2875.13616 | -371.90816 |
| C6 | 1.6 | 0.895 | 5.29 | 7.57528 | 7.05 | -5.8 | 53.405724 | -43.936624 |
| C7 | 2.5 | 1.6 | 5.29 | 21.16 | -13.75 | -5.8 | -290.95 | -122.728 |
| C8 | 2.5 | 1.6 | 5.29 | 21.16 | 13.75 | -5.8 | 290.95 | -122.728 |
| Total Weight due to slab = | | | | 2700.98 | Sum = | | -1001.46048 | 239.323832 |

| Beam on axis | Length | Width | Depth | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | w(m) | d(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| B1 | 5.2 | 0.25 | 0.4 | 12.48 | -20.1 | 0 | -250.848 | 0 |
| B2 | 8.17 | 0.25 | 0.4 | 19.608 | -22.7 | -5.2 | -445.1016 | -101.9616 |
| B3 | 8.17 | 0.25 | 0.4 | 19.608 | -22.7 | 5.2 | -445.1016 | 101.9616 |
| B4 | 5 | 0.25 | 0.4 | 12 | -17.5 | 2.5 | -210 | 30 |
| B5 | 5 | 0.25 | 0.4 | 12 | -17.5 | -2.5 | -210 | -30 |
| B6 | 5 | 0.25 | 0.4 | 12 | -15 | 0 | -180 | 0 |
| B7 | 5 | 0.25 | 0.4 | 12 | -15 | 5 | -180 | 60 |
| B8 | 5 | 0.25 | 0.4 | 12 | -15 | -5 | -180 | -60 |
| B9 | 5 | 0.25 | 0.4 | 12 | -12.5 | 2.5 | -150 | 30 |
| B10 | 5 | 0.25 | 0.4 | 12 | -12.5 | -2.5 | -150 | -30 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B11 | 5 | 0.25 | 0.4 | 12 | -10 | 0 | -120 | 0 |
| B12 | 5 | 0.25 | 0.4 | 12 | -10 | 5 | -120 | 60 |
| B13 | 5 | 0.25 | 0.4 | 12 | -10 | -5 | -120 | -60 |
| B14 | 5 | 0.25 | 0.4 | 12 | -7.5 | 2.5 | -90 | 30 |
| B15 | 5 | 0.25 | 0.4 | 12 | -7.5 | -2.5 | -90 | -30 |
| B16 | 5 | 0.25 | 0.4 | 12 | -5 | 0 | -60 | 0 |
| B17 | 5 | 0.25 | 0.4 | 12 | -5 | 5 | -60 | 60 |
| B18 | 5 | 0.25 | 0.4 | 12 | -5 | -5 | -60 | -60 |
| B19 | 5 | 0.25 | 0.4 | 12 | -2.5 | 2.5 | -30 | 30 |
| B20 | 5 | 0.25 | 0.4 | 12 | -2.5 | -2.5 | -30 | -30 |
| B21 | 5 | 0.25 | 0.4 | 12 | 0 | 5 | 0 | 60 |
| B22 | 5 | 0.25 | 0.4 | 12 | 0 | 0 | 0 | 0 |
| B23 | 5 | 0.25 | 0.4 | 12 | 0 | -5 | 0 | -60 |
| B24 | 5 | 0.25 | 0.4 | 12 | 2.5 | 2.5 | 30 | 30 |
| B25 | 5 | 0.25 | 0.4 | 12 | 2.5 | -2.5 | 30 | -30 |
| B26 | 5 | 0.25 | 0.4 | 12 | 5 | 0 | 60 | 0 |
| B27 | 5 | 0.25 | 0.4 | 12 | 5 | -5 | 60 | -60 |
| B28 | 5 | 0.25 | 0.4 | 12 | 5 | 5 | 60 | 60 |
| B29 | 5 | 0.25 | 0.4 | 12 | 7.5 | 2.5 | 90 | 30 |
| B30 | 5 | 0.25 | 0.4 | 12 | 7.5 | -2.5 | 90 | -30 |
| B31 | 5 | 0.25 | 0.4 | 12 | 10 | 0 | 120 | 0 |
| B32 | 5 | 0.25 | 0.4 | 12 | 10 | -5 | 120 | -60 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B33 | 5 | 0.25 | 0.4 | 12 | 10 | 5 | 120 | 60 |
| B34 | 5 | 0.25 | 0.4 | 12 | 12.5 | 2.5 | 150 | 30 |
| B35 | 5 | 0.25 | 0.4 | 12 | 12.5 | -2.5 | 150 | -30 |
| B36 | 5 | 0.25 | 0.4 | 12 | 15 | -5 | 180 | -60 |
| B37 | 5 | 0.25 | 0.4 | 12 | 15 | 0 | 180 | 0 |
| B38 | 5 | 0.25 | 0.4 | 12 | 15 | 5 | 180 | 60 |
| B39 | 5 | 0.25 | 0.4 | 12 | 17.5 | 2.5 | 210 | 30 |
| B40 | 5 | 0.25 | 0.4 | 12 | 17.5 | -2.5 | 210 | -30 |
| B41 | 5.2 | 0.25 | 0.4 | 12.48 | 20.1 | 0 | 250.848 | 0 |
| B42 | 8.17 | 0.25 | 0.4 | 19.608 | 22.7 | -5.2 | 445.1016 | -101.9616 |
| B43 | 8.17 | 0.25 | 0.4 | 19.608 | 22.7 | 5.2 | 445.1016 | 101.9616 |
| Total Weight due to beam = | | | | 547.392 | Sum = | | 0 | 0 |

| Column on axis | Depth | Width | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | D(m) | w(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | 0 | -201.6 | 0 |
| 2 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | 5 | -201.6 | 57.6 |
| 3 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | -5 | -201.6 | -57.6 |
| 4 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | 0 | -144 | 0 |
| 5 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | 5 | -144 | 57.6 |
| 6 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | -5 | -144 | -57.6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | 0 | -86.4 | 0 |
| 8 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | 5 | -86.4 | 57.6 |
| 9 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | -5 | -86.4 | -57.6 |
| 10 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | 0 | -28.8 | 0 |
| 11 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | 5 | -28.8 | 57.6 |
| 12 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | -5 | -28.8 | -57.6 |
| 13 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | 0 | 28.8 | 0 |
| 14 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | 5 | 28.8 | 57.6 |
| 15 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | -5 | 28.8 | -57.6 |
| 16 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | 0 | 86.4 | 0 |
| 17 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | 5 | 86.4 | 57.6 |
| 18 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | -5 | 86.4 | -57.6 |
| 19 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | 0 | 144 | 0 |
| 20 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | 5 | 144 | 57.6 |
| 21 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | -5 | 144 | -57.6 |
| 22 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | 0 | 201.6 | 0 |
| 23 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | 5 | 201.6 | 57.6 |
| 24 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | -5 | 201.6 | -57.6 |
| 25 | 0.4 | 0.4 | 3 | 11.52 | -22.5 | 0 | -259.2 | 0 |
| 26 | 0.4 | 0.4 | 3 | 11.52 | 22.5 | 0 | 259.2 | 0 |
| Total Weight due to column = | | | | 299.52 | Sum = | | 0 | 0 |

| Wall identification | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 2 | 5 | 0.2 | 1.5 | 21 | -17.5 | -2.5 | -367.5 | -52.5 |
| 3 | 7.95 | 0.2 | 1.5 | 33.39 | -21.2 | 3.9 | -707.868 | 130.221 |
| 4 | 7.95 | 0.2 | 1.5 | 33.39 | -21.2 | -3.9 | -707.868 | -130.221 |
| 6 | 7.95 | 0.2 | 1.5 | 33.39 | -20.1 | 0 | -671.139 | 0 |
| 7 | 1.6 | 0.2 | 1.5 | 6.72 | -17.5 | 0.8 | -117.6 | 5.376 |
| 8 | 15 | 0.2 | 1.5 | 63 | -10 | 6.6 | -630 | 415.8 |
| 9 | 5 | 0.2 | 1.5 | 21 | -10 | 0 | -210 | 0 |
| 10 | 15 | 0.15 | 1.5 | 47.25 | -10 | 1.75 | -472.5 | 82.6875 |
| 11 | 4.9 | 0.15 | 1.5 | 15.435 | -12.5 | 4.15 | -192.9375 | 64.05525 |
| 12 | 4.9 | 0.15 | 1.5 | 15.435 | -7.5 | 4.15 | -115.7625 | 64.05525 |
| 14 | 5 | 0.2 | 1.5 | 21 | -5 | 0 | -105 | 0 |
| 15 | 4.9 | 0.15 | 1.5 | 15.435 | -2.5 | 4.15 | -38.5875 | 64.05525 |
| 18 | 5 | 0.2 | 1.5 | 21 | 0 | 5 | 0 | 105 |
| 19 | 5 | 0.2 | 1.5 | 21 | 0 | 0 | 0 | 0 |
| 23 | 4.9 | 0.15 | 1.5 | 15.435 | 2.5 | 4.15 | 38.5875 | 64.05525 |
| 24 | 5 | 0.2 | 1.5 | 21 | 5 | 0 | 105 | 0 |
| 25 | 15 | 0.2 | 1.5 | 63 | 10 | 6.6 | 630 | 415.8 |
| 27 | 4.9 | 0.15 | 1.5 | 15.435 | 7.5 | 4.15 | 115.7625 | 64.05525 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 28 | 4.9 | 0.15 | 1.5 | 15.435 | 12.5 | 4.15 | 192.9375 | 64.05525 |
| 29 | 5 | 0.2 | 1.5 | 21 | 10 | 0 | 210 | 0 |
| 30 | 15 | 0.15 | 1.5 | 47.25 | 10 | 1.75 | 472.5 | 82.6875 |
| 31 | 1.6 | 0.2 | 1.5 | 6.72 | 17.5 | 0.8 | 117.6 | 5.376 |
| 32 | 5 | 0.2 | 1.5 | 21 | 12.5 | -2.5 | 262.5 | -52.5 |
| 34 | 3.4 | 0.15 | 1.5 | 10.71 | 2.5 | -1.7 | 26.775 | -18.207 |
| 36 | 5 | 0.2 | 1.5 | 21 | 17.5 | 2.5 | 367.5 | 52.5 |
| 37 | 5 | 0.2 | 1.5 | 21 | 17.5 | -2.5 | 367.5 | -52.5 |
| 39 | 7.95 | 0.2 | 1.5 | 33.39 | 20.1 | 0 | 671.139 | 0 |
| 40 | 7.95 | 0.2 | 1.5 | 33.39 | 21.2 | 3.9 | 707.868 | 130.221 |
| 41 | 7.95 | 0.2 | 1.5 | 33.39 | 21.2 | -3.9 | 707.868 | -130.221 |
| 43 | 5 | 0.2 | 1.5 | 21 | 10.5 | -6.6 | 220.5 | -138.6 |
| 44 | 1.6 | 0.2 | 1.5 | 6.72 | 12.5 | -5.8 | 84 | -38.976 |
| 45 | 1.6 | 0.2 | 1.5 | 6.72 | 7.5 | -5.8 | 50.4 | -38.976 |
| 46 | 1.6 | 0.2 | 1.5 | 6.72 | -12.5 | -5.8 | -84 | -38.976 |
| 47 | 5 | 0.2 | 1.5 | 21 | -10.5 | -6.6 | -220.5 | -138.6 |
| 48 | 1.6 | 0.2 | 1.5 | 6.72 | -7.5 | -5.8 | -50.4 | -38.976 |
| 49 | 4.35 | 0.2 | 1.5 | 18.27 | -4 | -5.8 | -73.08 | -105.966 |
| 50 | 4.35 | 0.2 | 1.5 | 18.27 | 4 | -5.8 | 73.08 | -105.966 |
| 51 | 1.45 | 0.15 | 1.5 | 4.5675 | -18.225 | 1.7 | -83.2426875 | 7.76475 |
| 52 | 1.45 | 0.15 | 1.5 | 4.5675 | -18.225 | -1.7 | -83.2426875 | -7.76475 |
| 53 | 3.5 | 0.15 | 1.5 | 11.025 | -22.5 | 0 | -248.0625 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 54 | 3.5 | 0.15 | 1.5 | 11.025 | -18.75 | 0 | -206.71875 | 0 |
| 55 | 1.35 | 0.15 | 1.5 | 4.2525 | -18.175 | 1.85 | -77.2891875 | 7.867125 |
| 57 | 3.1 | 0.15 | 1.5 | 9.765 | -17.5 | 3.05 | -170.8875 | 29.78325 |
| 58 | 1.35 | 0.15 | 1.5 | 4.2525 | -18.175 | -1.85 | -77.2891875 | -7.867125 |
| 59 | 1.6 | 0.15 | 1.5 | 5.04 | -15 | 5.6 | -75.6 | 28.224 |
| 60 | 1.85 | 0.15 | 1.5 | 5.8275 | -14.5 | 4.4 | -84.49875 | 25.641 |
| 61 | 1.65 | 0.15 | 1.5 | 5.1975 | -13.325 | 3.6 | -69.2566875 | 18.711 |
| 62 | 1.65 | 0.15 | 1.5 | 5.1975 | -9.85 | 5.6 | -51.195375 | 29.106 |
| 63 | 1.85 | 0.15 | 1.5 | 5.8275 | -10.4 | 4.4 | -60.606 | 25.641 |
| 64 | 1.65 | 0.15 | 1.5 | 5.1975 | -11.9 | 3.6 | -61.85025 | 18.711 |
| 65 | 1.65 | 0.15 | 1.5 | 5.1975 | -4.95 | 5.6 | -25.727625 | 29.106 |
| 66 | 1.85 | 0.15 | 1.5 | 5.8275 | -4.5 | 4.4 | -26.22375 | 25.641 |
| 67 | 1.65 | 0.15 | 1.5 | 5.1975 | -3.75 | 3.6 | -19.490625 | 18.711 |
| 68 | 1.65 | 0.15 | 1.5 | 5.1975 | 4.95 | 5.6 | 25.727625 | 29.106 |
| 69 | 1.85 | 0.15 | 1.5 | 5.8275 | 4.5 | 4.4 | 26.22375 | 25.641 |
| 70 | 1.65 | 0.15 | 1.5 | 5.1975 | 3.75 | 3.6 | 19.490625 | 18.711 |
| 71 | 1.65 | 0.15 | 1.5 | 5.1975 | 11.9 | 3.6 | 61.85025 | 18.711 |
| 72 | 1.85 | 0.15 | 1.5 | 5.8275 | 10.4 | 4.4 | 60.606 | 25.641 |
| 73 | 1.65 | 0.15 | 1.5 | 5.1975 | 9.85 | 5.6 | 51.195375 | 29.106 |
| 74 | 1.6 | 0.15 | 1.5 | 5.04 | 15 | 5.6 | 75.6 | 28.224 |
| 75 | 1.85 | 0.15 | 1.5 | 5.8275 | 14.5 | 4.4 | 84.49875 | 25.641 |
| 76 | 1.65 | 0.15 | 1.5 | 5.1975 | 13.325 | 3.6 | 69.2566875 | 18.711 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 77 | 1.35 | 0.15 | 1.5 | 4.2525 | 18.175 | 1.85 | 77.2891875 | 7.867125 |
| 78 | 3.5 | 0.15 | 1.5 | 11.025 | 18.75 | 0 | 206.71875 | 0 |
| 80 | 1.35 | 0.15 | 1.5 | 4.2525 | 18.175 | -1.85 | 77.2891875 | -7.867125 |
| 81 | 1.45 | 0.15 | 1.5 | 4.5675 | 18.225 | -1.7 | 83.2426875 | -7.76475 |
| 82 | 1.45 | 0.15 | 1.5 | 4.5675 | 18.225 | 1.7 | 83.2426875 | 7.76475 |
| 83 | 3.5 | 0.15 | 1.5 | 11.025 | 22.5 | 0 | 248.0625 | 0 |
| 85 | 2.48 | 0.2 | 1.5 | 10.416 | 13.74 | -6.6 | 143.11584 | -68.7456 |
| 86 | 1.6 | 0.15 | 1.5 | 5.04 | 14.98 | -5.8 | 75.4992 | -29.232 |
| 87 | 1.7 | 0.15 | 1.5 | 5.355 | 14.36 | -4.38 | 76.8978 | -23.4549 |
| 88 | 1.3 | 0.15 | 1.5 | 4.095 | 8.15 | -3.7 | 33.37425 | -15.1515 |
| 89 | 1.3 | 0.15 | 1.5 | 4.095 | 6.85 | -3.7 | 28.05075 | -15.1515 |
| 90 | 1.7 | 0.15 | 1.5 | 5.355 | 11.84 | -4.38 | 63.4032 | -23.4549 |
| 91 | 1.6 | 0.15 | 1.5 | 5.04 | 9.85 | -5.8 | 49.644 | -29.232 |
| 92 | 2.48 | 0.2 | 1.5 | 10.416 | -13.74 | -6.6 | -143.11584 | -68.7456 |
| 93 | 1.6 | 0.15 | 1.5 | 5.04 | -14.98 | -5.8 | -75.4992 | -29.232 |
| 94 | 1.7 | 0.15 | 1.5 | 5.355 | -14.36 | -4.38 | -76.8978 | -23.4549 |
| 95 | 1.3 | 0.15 | 1.5 | 4.095 | -8.15 | -3.7 | -33.37425 | -15.1515 |
| 96 | 1.3 | 0.15 | 1.5 | 4.095 | -6.85 | -3.7 | -28.05075 | -15.1515 |
| 97 | 1.7 | 0.15 | 1.5 | 5.355 | -11.84 | -4.38 | -63.4032 | -23.4549 |
| 98 | 1.6 | 0.15 | 1.5 | 5.04 | -9.85 | -5.8 | -49.644 | -29.232 |
| 99 | 9.8 | 0.15 | 1.5 | 30.87 | 0 | -5.5 | 0 | -169.785 |
| 100 | 5 | 0.15 | 1.5 | 15.75 | 0 | -2.5 | 0 | -39.375 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 101 | 5 | 0.15 | 1.5 | 15.75 | 0 | -2 | 0 | -31.5 |
| 102 | 2 | 0.15 | 1.5 | 6.3 | 2.5 | -1 | 15.75 | -6.3 |
| 103 | 2 | 0.15 | 1.5 | 6.3 | -2.5 | -1 | -15.75 | -6.3 |
| 104 | 2.1 | 0.2 | 1.5 | 8.82 | 16.45 | -5 | 145.089 | -44.1 |
| 105 | 2.1 | 0.2 | 1.5 | 8.82 | -16.45 | -5 | -145.089 | -44.1 |
| Weight of wall at this floor = | | | | 1210.58 | Sum = | | 485.8875 | 447.27795 |
| Weight of wall from previous floor = | | | | 420 | | | | |
| Total weight due to wall = | | | | 1630.58 | | | | |

| Staircase | | Length L(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Distance Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| staircase 3 | flight 3 | 1.8 | 10.894 | 19.6092 | 1.85 | 3.14 | 36.27702 | 61.572888 |
| | landing 3 | 1.6 | 8.44 | 13.504 | 1.7 | 4.3 | 22.9568 | 58.0672 |
| Staircase 4 | flight 4 | 1.5 | 10.894 | 16.341 | 0 | 4.35 | 0 | 71.08335 |
| | landing 4 | 2.1 | 8.44 | 17.724 | -1.7 | 4.3 | -30.1308 | 76.2132 |
| staircase 5 | flight 5 | 1.8 | 10.894 | 19.6092 | 0 | 4.35 | 0 | 85.30002 |
| | landing 5 | 1.4 | 8.44 | 11.816 | -1.7 | 4.3 | -20.0872 | 50.8088 |
| Weight of stair at this floor = | | | | 98.6034 | Sum = | | 9.01582 | 403.045458 |
| Total weight of third floor = | | | | 5277.09 | | | | |
| | | | | | ∑W*X | -151.137 | Xm = | -0.02864022 |

| | | | | |
|---|---|---|---|---|
| | ∑W*Y | 1089.64 | Ym = | 0.20648631 |

**Centre of mass for fourth floor**

| Panel no. | Length L(m) | Width w(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Distance Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| C1 | 15 | 1.6 | 5.29 | 126.96 | -10 | 5.8 | -1269.6 | 736.368 |
| C2 | 15 | 1.6 | 5.29 | 126.96 | 10 | 5.8 | 1269.6 | 736.368 |
| C3 | 10 | 1.6 | 5.29 | 84.64 | -12.5 | -5.85 | -1058 | -495.144 |
| C4 | 10 | 1.6 | 5.29 | 84.64 | 12.5 | -5.85 | 1058 | -495.144 |
| C5 | 11.45 | 1.6 | 5.29 | 96.9128 | 0 | -5.85 | 0 | -566.93988 |
| C6 | 1.6 | 1.3 | 5.29 | 11.0032 | -6.85 | -5.85 | -75.37192 | -64.36872 |
| C7 | 1.6 | 1.3 | 5.29 | 11.0032 | 6.85 | -5.85 | 75.37192 | -64.36872 |
| 1 | 5 | 5 | 5.29 | 132.25 | -15 | 2.5 | -1983.75 | 330.625 |
| 2 | 5 | 5 | 5.29 | 132.25 | -15 | -2.5 | -1983.75 | -330.625 |
| 3 | 5 | 5 | 5.29 | 132.25 | -10 | 2.5 | -1322.5 | 330.625 |
| 4 | 5 | 5 | 5.29 | 132.25 | -10 | -2.5 | -1322.5 | -330.625 |
| 5 | 5 | 5 | 5.29 | 132.25 | -5 | 2.5 | -661.25 | 330.625 |
| 6 | 5 | 5 | 5.29 | 132.25 | -5 | -2.5 | -661.25 | -330.625 |
| 8 | 5 | 5 | 5.29 | 132.25 | 0 | -2.5 | 0 | -330.625 |
| 9 | 5 | 5 | 5.29 | 132.25 | 5 | 2.5 | 661.25 | 330.625 |
| 10 | 5 | 5 | 5.29 | 132.25 | 5 | -2.5 | 661.25 | -330.625 |
| 11 | 5 | 5 | 5.29 | 132.25 | 10 | 2.5 | 1322.5 | 330.625 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 5 | 5 | 5.29 | 132.25 | 10 | -2.5 | 1322.5 | -330.625 |
| 13 | 5 | 5 | 5.29 | 132.25 | 15 | 2.5 | 1983.75 | 330.625 |
| 14 | 5 | 5 | 5.29 | 132.25 | 15 | -2.5 | 1983.75 | -330.625 |
| 15 | 5.2 | 5.2 | 5.29 | 143.0416 | -20.1 | 2.6 | -2875.13616 | 371.90816 |
| 16 | 5.2 | 5.2 | 5.29 | 143.0416 | -20.1 | -2.6 | -2875.13616 | -371.90816 |
| 17 | 5.2 | 5.2 | 5.29 | 143.0416 | 20.1 | 2.6 | 2875.13616 | 371.90816 |
| 18 | 5.2 | 5.2 | 5.29 | 143.0416 | 20.1 | -2.6 | 2875.13616 | -371.90816 |
| Total Weight due to slab = | | | | 2833.536 | Sum = | | 0 | -543.85432 |

| Beam on axis | Length L(m) | Width w(m) | Depth d(m) | Weight W (KN) | Distance X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| B1 | 5.2 | 0.25 | 0.4 | 12.48 | -20.1 | 0 | -250.848 | 0 |
| B2 | 8.17 | 0.25 | 0.4 | 19.608 | -22.7 | -5.2 | -445.1016 | -101.9616 |
| B3 | 8.17 | 0.25 | 0.4 | 19.608 | -22.7 | 5.2 | -445.1016 | 101.9616 |
| B4 | 5 | 0.25 | 0.4 | 12 | -17.5 | 2.5 | -210 | 30 |
| B5 | 5 | 0.25 | 0.4 | 12 | -17.5 | -2.5 | -210 | -30 |
| B6 | 5 | 0.25 | 0.4 | 12 | -15 | 0 | -180 | 0 |
| B7 | 5 | 0.25 | 0.4 | 12 | -15 | 5 | -180 | 60 |
| B8 | 5 | 0.25 | 0.4 | 12 | -15 | -5 | -180 | -60 |
| B9 | 5 | 0.25 | 0.4 | 12 | -12.5 | 2.5 | -150 | 30 |
| B10 | 5 | 0.25 | 0.4 | 12 | -12.5 | -2.5 | -150 | -30 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B11 | 5 | 0.25 | 0.4 | 12 | -10 | 0 | -120 | 0 |
| B12 | 5 | 0.25 | 0.4 | 12 | -10 | 5 | -120 | 60 |
| B13 | 5 | 0.25 | 0.4 | 12 | -10 | -5 | -120 | -60 |
| B14 | 5 | 0.25 | 0.4 | 12 | -7.5 | 2.5 | -90 | 30 |
| B15 | 5 | 0.25 | 0.4 | 12 | -7.5 | -2.5 | -90 | -30 |
| B16 | 5 | 0.25 | 0.4 | 12 | -5 | 0 | -60 | 0 |
| B17 | 5 | 0.25 | 0.4 | 12 | -5 | 5 | -60 | 60 |
| B18 | 5 | 0.25 | 0.4 | 12 | -5 | -5 | -60 | -60 |
| B19 | 5 | 0.25 | 0.4 | 12 | -2.5 | 2.5 | -30 | 30 |
| B20 | 5 | 0.25 | 0.4 | 12 | -2.5 | -2.5 | -30 | -30 |
| B21 | 5 | 0.25 | 0.4 | 12 | 0 | 5 | 0 | 60 |
| B22 | 5 | 0.25 | 0.4 | 12 | 0 | 0 | 0 | 0 |
| B23 | 5 | 0.25 | 0.4 | 12 | 0 | -5 | 0 | -60 |
| B24 | 5 | 0.25 | 0.4 | 12 | 2.5 | 2.5 | 30 | 30 |
| B25 | 5 | 0.25 | 0.4 | 12 | 2.5 | -2.5 | 30 | -30 |
| B26 | 5 | 0.25 | 0.4 | 12 | 5 | 0 | 60 | 0 |
| B27 | 5 | 0.25 | 0.4 | 12 | 5 | -5 | 60 | -60 |
| B28 | 5 | 0.25 | 0.4 | 12 | 5 | 5 | 60 | 60 |
| B29 | 5 | 0.25 | 0.4 | 12 | 7.5 | 2.5 | 90 | 30 |
| B30 | 5 | 0.25 | 0.4 | 12 | 7.5 | -2.5 | 90 | -30 |
| B31 | 5 | 0.25 | 0.4 | 12 | 10 | 0 | 120 | 0 |
| B32 | 5 | 0.25 | 0.4 | 12 | 10 | -5 | 120 | -60 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B33 | 5 | 0.25 | 0.4 | 12 | 10 | 5 | 120 | 60 |
| B34 | 5 | 0.25 | 0.4 | 12 | 12.5 | 2.5 | 150 | 30 |
| B35 | 5 | 0.25 | 0.4 | 12 | 12.5 | -2.5 | 150 | -30 |
| B36 | 5 | 0.25 | 0.4 | 12 | 15 | -5 | 180 | -60 |
| B37 | 5 | 0.25 | 0.4 | 12 | 15 | 0 | 180 | 0 |
| B38 | 5 | 0.25 | 0.4 | 12 | 15 | 5 | 180 | 60 |
| B39 | 5 | 0.25 | 0.4 | 12 | 17.5 | 2.5 | 210 | 30 |
| B40 | 5 | 0.25 | 0.4 | 12 | 17.5 | -2.5 | 210 | -30 |
| B41 | 5.2 | 0.25 | 0.4 | 12.48 | 20.1 | 0 | 250.848 | 0 |
| B42 | 8.17 | 0.25 | 0.4 | 19.608 | 22.7 | -5.2 | 445.1016 | -101.9616 |
| B43 | 8.17 | 0.25 | 0.4 | 19.608 | 22.7 | 5.2 | 445.1016 | 101.9616 |
| Total Weight due to beam = | | | | 547.392 | Sum = | | 0 | 0 |
| | | | | | | | | |

| Column on axis | Depth | Width | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | D(m) | w(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | 0 | -201.6 | 0 |
| 2 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | 5 | -201.6 | 57.6 |
| 3 | 0.4 | 0.4 | 3 | 11.52 | -17.5 | -5 | -201.6 | -57.6 |
| 4 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | 0 | -144 | 0 |
| 5 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | 5 | -144 | 57.6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 0.4 | 0.4 | 3 | 11.52 | -12.5 | -5 | -144 | -57.6 |
| 7 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | 0 | -86.4 | 0 |
| 8 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | 5 | -86.4 | 57.6 |
| 9 | 0.4 | 0.4 | 3 | 11.52 | -7.5 | -5 | -86.4 | -57.6 |
| 10 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | 0 | -28.8 | 0 |
| 11 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | 5 | -28.8 | 57.6 |
| 12 | 0.4 | 0.4 | 3 | 11.52 | -2.5 | -5 | -28.8 | -57.6 |
| 13 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | 0 | 28.8 | 0 |
| 14 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | 5 | 28.8 | 57.6 |
| 15 | 0.4 | 0.4 | 3 | 11.52 | 2.5 | -5 | 28.8 | -57.6 |
| 16 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | 0 | 86.4 | 0 |
| 17 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | 5 | 86.4 | 57.6 |
| 18 | 0.4 | 0.4 | 3 | 11.52 | 7.5 | -5 | 86.4 | -57.6 |
| 19 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | 0 | 144 | 0 |
| 20 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | 5 | 144 | 57.6 |
| 21 | 0.4 | 0.4 | 3 | 11.52 | 12.5 | -5 | 144 | -57.6 |
| 22 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | 0 | 201.6 | 0 |
| 23 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | 5 | 201.6 | 57.6 |
| 24 | 0.4 | 0.4 | 3 | 11.52 | 17.5 | -5 | 201.6 | -57.6 |
| 25 | 0.4 | 0.4 | 3 | 11.52 | -22.5 | 0 | -259.2 | 0 |
| 26 | 0.4 | 0.4 | 3 | 11.52 | 22.5 | 0 | 259.2 | 0 |
| Total Weight due to column = | | | | 299.52 | Sum = | | 0 | 0 |

| Wall identification | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 3 | 7.95 | 0.2 | 1.5 | 33.39 | -21.2 | 3.9 | -707.868 | 130.221 |
| 4 | 7.95 | 0.2 | 1.5 | 33.39 | -21.2 | -3.9 | -707.868 | -130.221 |
| 5 | 5 | 0.2 | 1.5 | 21 | -15 | -5 | -315 | -105 |
| 7 | 1.6 | 0.2 | 1.5 | 6.72 | -17.5 | 0.8 | -117.6 | 5.376 |
| 8 | 15 | 0.2 | 1.5 | 63 | -10 | 6.6 | -630 | 415.8 |
| 9 | 5 | 0.2 | 1.5 | 21 | -10 | 0 | -210 | 0 |
| 10 | 15 | 0.15 | 1.5 | 47.25 | -10 | 1.75 | -472.5 | 82.6875 |
| 11 | 4.9 | 0.15 | 1.5 | 15.435 | -12.5 | 4.15 | -192.9375 | 64.05525 |
| 14 | 5 | 0.2 | 1.5 | 21 | -5 | 0 | -105 | 0 |
| 15 | 4.9 | 0.15 | 1.5 | 15.435 | -2.5 | 4.15 | -38.5875 | 64.05525 |
| 18 | 13.375 | 0.15 | 1.5 | 42.1312 | -9.18 | -3.4 | -386.764875 | -143.24625 |
| 19 | 5 | 0.2 | 1.5 | 21 | 0 | 0 | 0 | 0 |
| 23 | 4.9 | 0.15 | 1.5 | 15.435 | 2.5 | 4.15 | 38.5875 | 64.05525 |
| 24 | 5 | 0.2 | 1.5 | 21 | 5 | 0 | 105 | 0 |
| 25 | 15 | 0.2 | 1.5 | 63 | 10 | 6.6 | 630 | 415.8 |
| 28 | 4.9 | 0.15 | 1.5 | 15.435 | 12.5 | 4.15 | 192.9375 | 64.05525 |
| 29 | 5 | 0.2 | 1.5 | 21 | 10 | 0 | 210 | 0 |
| 30 | 15 | 0.15 | 1.5 | 47.25 | 10 | 1.75 | 472.5 | 82.6875 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 32 | 5 | 0.2 | 1.5 | 21 | 12.5 | -2.5 | 262.5 | -52.5 |
| 31 | 1.6 | 0.2 | 1.5 | 6.72 | 17.5 | 0.8 | 117.6 | 5.376 |
| 34 | 3.4 | 0.15 | 1.5 | 10.71 | 2.5 | -1.7 | 26.775 | -18.207 |
| 35 | 5 | 0.2 | 1.5 | 21 | 15 | -5 | 315 | -105 |
| 40 | 7.95 | 0.2 | 1.5 | 33.39 | 21.2 | 3.9 | 707.868 | 130.221 |
| 41 | 7.95 | 0.2 | 1.5 | 33.39 | 21.2 | -3.9 | 707.868 | -130.221 |
| 43 | 5 | 0.2 | 1.5 | 21 | 10.5 | -6.6 | 220.5 | -138.6 |
| 44 | 1.6 | 0.2 | 1.5 | 6.72 | 12.5 | -5.8 | 84 | -38.976 |
| 45 | 1.6 | 0.2 | 1.5 | 6.72 | 7.5 | -5.8 | 50.4 | -38.976 |
| 46 | 1.6 | 0.2 | 1.5 | 6.72 | -12.5 | -5.8 | -84 | -38.976 |
| 47 | 5 | 0.2 | 1.5 | 21 | -10.5 | -6.6 | -220.5 | -138.6 |
| 48 | 1.6 | 0.2 | 1.5 | 6.72 | -7.5 | -5.8 | -50.4 | -38.976 |
| 50 | 2 | 0.15 | 1.5 | 6.3 | -14.65 | 5.6 | -92.295 | 35.28 |
| 51 | 2.6 | 0.15 | 1.5 | 8.19 | -13.37 | 3 | -109.5003 | 24.57 |
| 52 | 2.1 | 0.15 | 1.5 | 6.615 | -13.55 | 4.3 | -89.63325 | 28.4445 |
| 53 | 4.7 | 0.15 | 1.5 | 14.805 | -9.5 | 4 | -140.6475 | 59.22 |
| 54 | 1.75 | 0.15 | 1.5 | 5.5125 | -4.15 | 2.5 | -22.876875 | 13.78125 |
| 55 | 1.65 | 0.15 | 1.5 | 5.1975 | -3.325 | 3.4 | -17.2816875 | 17.6715 |
| 56 | 1.65 | 0.15 | 1.5 | 5.1975 | 3.325 | 3.4 | 17.2816875 | 17.6715 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 57 | 1.75 | 0.15 | 1.5 | 5.5125 | 4.15 | 2.5 | 22.876875 | 13.78125 |
| 58 | 4.7 | 0.15 | 1.5 | 14.805 | 9.5 | 4 | 140.6475 | 59.22 |
| 59 | 2.6 | 0.15 | 1.5 | 8.19 | 13.37 | 3 | 109.5003 | 24.57 |
| 60 | 2.1 | 0.15 | 1.5 | 6.615 | 13.55 | 4.3 | 89.63325 | 28.4445 |
| 61 | 2 | 0.15 | 1.5 | 6.3 | 14.655 | 5.6 | 92.3265 | 35.28 |
| 62 | 3.4 | 0.15 | 1.5 | 10.71 | -16.4 | -1.7 | -175.644 | -18.207 |
| 63 | 2.1 | 0.15 | 1.5 | 6.615 | -15.87 | -4.2 | -105.01312 | -27.783 |
| 64 | 0.95 | 0.15 | 1.5 | 2.9925 | -17.02 | -3.4 | -50.9473125 | -10.1745 |
| 65 | 1.6 | 0.15 | 1.5 | 5.04 | -15.15 | -5.8 | -76.356 | -29.232 |
| 66 | 1.6 | 0.15 | 1.5 | 5.04 | -10 | -5.8 | -50.4 | -29.232 |
| 67 | 1.6 | 0.15 | 1.5 | 5.04 | -8.45 | -4.2 | -42.588 | -21.168 |
| 68 | 0.95 | 0.15 | 1.5 | 2.9925 | -7.975 | -3.4 | -23.8651875 | -10.1745 |
| 69 | 2.35 | 0.15 | 1.5 | 7.4025 | -8.45 | -1.17 | -62.551125 | -8.6979375 |
| 70 | 4.55 | 0.15 | 1.5 | 14.3325 | -6.75 | -2.2 | -96.744375 | -31.5315 |
| 71 | 2.35 | 0.15 | 1.5 | 7.4025 | -4 | -2.2 | -29.61 | -16.2855 |
| 72 | 0.8 | 0.2 | 1.5 | 3.36 | -7.1 | -6 | -23.856 | -20.16 |
| 73 | 1.35 | 0.2 | 1.5 | 5.67 | -6.25 | -6 | -35.4375 | -34.02 |
| 74 | 11.5 | 0.2 | 1.5 | 48.3 | 0 | -6.6 | 0 | -318.78 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 75 | 1.4 | 0.15 | 1.5 | 4.41 | -2.5 | -5.7 | -11.025 | -25.137 |
| 76 | 1.4 | 0.15 | 1.5 | 4.41 | 2.5 | -5.7 | 11.025 | -25.137 |
| 77 | 2.35 | 0.15 | 1.5 | 7.4025 | 4 | -2.2 | 29.61 | -16.2855 |
| 78 | 4.55 | 0.15 | 1.5 | 14.3325 | 6.75 | 2.2 | 96.744375 | 31.5315 |
| 79 | 2.35 | 0.15 | 1.5 | 7.4025 | 8.45 | -1.17 | 62.551125 | -8.6979375 |
| 80 | 1.5 | 0.15 | 1.5 | 4.725 | 7.3 | -4.05 | 34.4925 | -19.13625 |
| 81 | 0.95 | 0.15 | 1.5 | 2.9925 | 7.975 | -3.4 | 23.8651875 | -10.1745 |
| 82 | 1.6 | 0.15 | 1.5 | 5.04 | 8.45 | -4.2 | 42.588 | -21.168 |
| 83 | 1.6 | 0.15 | 1.5 | 5.04 | 10 | -5.8 | 50.4 | -29.232 |
| 84 | 1.6 | 0.15 | 1.5 | 5.04 | 15.15 | -5.8 | 76.356 | -29.232 |
| 85 | 2.1 | 0.15 | 1.5 | 6.615 | 15.875 | -5.8 | 105.013125 | -38.367 |
| 86 | 0.95 | 0.15 | 1.5 | 2.9925 | 17.025 | -4.2 | 50.9473125 | -12.5685 |
| 87 | 3.4 | 0.15 | 1.5 | 10.71 | 16.4 | -1.7 | 175.644 | -18.207 |
| 88 | 1.4 | 0.15 | 1.5 | 4.41 | 17.5 | -4.1 | 77.175 | -18.081 |
| 89 | 5 | 0.2 | 1.5 | 21 | 17.5 | -5.8 | 367.5 | -121.8 |
| 90 | 5 | 0.2 | 1.5 | 21 | -17.5 | -5.8 | -367.5 | -121.8 |
| 91 | 1.4 | 0.15 | 1.5 | 4.41 | -17.5 | -4.1 | -77.175 | -18.081 |
| 92 | 3.1 | 0.15 | 1.5 | 9.765 | 17.5 | 3.45 | 170.8875 | 33.68925 |
| 93 | 3.1 | 0.15 | 1.5 | 9.765 | -17.5 | 3.45 | -170.8875 | 33.68925 |
| 94 | 1.5 | 0.15 | 1.5 | 4.725 | -7.3 | -4.05 | -34.4925 | -19.13625 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 95 | 1.35 | 0.2 | 1.5 | 5.67 | 6.25 | -6 | 35.4375 | -34.02 |
| 96 | 0.8 | 0.2 | 1.5 | 3.36 | 7.1 | -6 | 23.856 | -20.16 |
| 100 | 5 | 0.15 | 1.5 | 15.75 | 0 | -2.5 | 0 | -39.375 |
| Weight of wall at this floor = | | | | 1118.06 | Sum = | | -97.458375 | -357.50662 |
| Weight of wall from previous floor = | | | | 1210.58 | | | | |
| Total weight due to wall = | | | | 2328.65 | | | | |

| Staircase | | Length L(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| staircase 3 | flight 3 | 1.8 | 10.894 | 19.6092 | 1.85 | 3.14 | 36.27702 | 61.572888 |
| | landing 3 | 1.6 | 8.44 | 13.504 | 1.7 | 4.3 | 22.9568 | 58.0672 |
| Staircase 4 | flight 4 | 1.5 | 10.894 | 16.341 | 0 | 4.35 | 0 | 71.08335 |
| | landing 4 | 2.1 | 8.44 | 17.724 | -1.7 | 4.3 | -30.1308 | 76.2132 |
| stair case 5 | flight 5 | 1.8 | 10.894 | 19.6092 | 0 | 4.35 | 0 | 85.30002 |
| | landing 5 | 1.4 | 8.44 | 11.816 | -1.7 | 4.3 | -20.0872 | 50.8088 |
| Weight of stair at this floor = | | | | 98.6034 | Sum = | | 9.01582 | 403.045458 |
| Total weight of fourth floor = | | | | 6107.704 | | | | |
| | | | | | ∑W*X | -88.446 | Xm = | -0.0144804 |
| | | | | | ∑W*Y | -498.31 | Ym = | -0.0815880 |

**Centre of mass for roof slabs**

| Panel no. | Length L(m) | Width w(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| 1 | 5.2 | 5.2 | 5.29 | 143.0416 | -20.1 | 2.6 | -2875.1361 | 371.90816 |
| 2 | 5.2 | 5.2 | 5.29 | 143.0416 | -20.1 | -2.6 | -2875.1361 | -371.90816 |
| 3 | 5.2 | 5.2 | 5.29 | 143.0416 | 20.1 | 2.6 | 2875.13616 | 371.90816 |
| 4 | 5.2 | 5.2 | 5.29 | 143.0416 | 20.1 | -2.6 | 2875.13616 | -371.90816 |
| 5 | 5 | 1.7 | 5.29 | 44.965 | 0 | 2.5 | 0 | 112.4125 |
| 6 | 5 | 5 | 5.29 | 132.25 | 0 | -2.5 | 0 | -330.625 |
| 7 | 15 | 1.6 | 5.29 | 126.96 | -10 | 5.8 | -1269.6 | 736.368 |
| 8 | 15 | 1.6 | 5.29 | 126.96 | 10 | 5.8 | 1269.6 | 736.368 |
| 9 | 5 | 1.6 | 5.29 | 42.32 | 0 | -5.8 | 0 | -245.456 |
| 10 | 2 | 2 | 5.29 | 21.16 | 0 | 2.75 | 0 | 58.19 |
| Total Weight due to slab = | | | | 1066.781 | Sum = | | 0 | 1067.2575 |

| Beam on axis | Length L(m) | Width w(m) | Depth d(m) | Weight W (KN) | Distance X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| B1 | 5.2 | 0.25 | 0.3 | 9.36 | -20.1 | 0 | -188.136 | 0 |
| B2 | 8.17 | 0.25 | 0.3 | 14.706 | -22.7 | -5.2 | -333.826 | -76.4712 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2 | |
| B3 | 8.17 | 0.25 | 0.3 | 14.706 | -22.7 | 5.2 | -333.8262 | 76.4712 |
| B4 | 5 | 0.25 | 0.3 | 9 | -17.5 | 2.5 | -157.5 | 22.5 |
| B5 | 5 | 0.25 | 0.3 | 9 | -17.5 | -2.5 | -157.5 | -22.5 |
| B6 | 5 | 0.25 | 0.3 | 9 | -15 | 0 | -135 | 0 |
| B7 | 5 | 0.25 | 0.3 | 9 | -15 | 5 | -135 | 45 |
| B8 | 5 | 0.25 | 0.3 | 9 | -15 | -5 | -135 | -45 |
| B9 | 5 | 0.25 | 0.3 | 9 | -12.5 | 2.5 | -112.5 | 22.5 |
| B10 | 5 | 0.25 | 0.3 | 9 | -12.5 | -2.5 | -112.5 | -22.5 |
| B11 | 5 | 0.25 | 0.3 | 9 | -10 | 0 | -90 | 0 |
| B12 | 5 | 0.25 | 0.3 | 9 | -10 | 5 | -90 | 45 |
| B13 | 5 | 0.25 | 0.3 | 9 | -10 | -5 | -90 | -45 |
| B14 | 5 | 0.25 | 0.3 | 9 | -7.5 | 2.5 | -67.5 | 22.5 |
| B15 | 5 | 0.25 | 0.3 | 9 | -7.5 | -2.5 | -67.5 | -22.5 |
| B16 | 5 | 0.25 | 0.3 | 9 | -5 | 0 | -45 | 0 |
| B17 | 5 | 0.25 | 0.3 | 9 | -5 | 5 | -45 | 45 |
| B18 | 5 | 0.25 | 0.3 | 9 | -5 | -5 | -45 | -45 |
| B19 | 5 | 0.25 | 0.3 | 9 | -2.5 | 2.5 | -22.5 | 22.5 |
| B20 | 5 | 0.25 | 0.3 | 9 | -2.5 | -2.5 | -22.5 | -22.5 |
| B21 | 5 | 0.25 | 0.3 | 9 | 0 | 5 | 0 | 45 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B22 | 5 | 0.25 | 0.3 | 9 | 0 | 0 | 0 | 0 |
| B23 | 5 | 0.25 | 0.3 | 9 | 0 | -5 | 0 | -45 |
| B24 | 5 | 0.25 | 0.3 | 9 | 2.5 | 2.5 | 22.5 | 22.5 |
| B25 | 5 | 0.25 | 0.3 | 9 | 2.5 | -2.5 | 22.5 | -22.5 |
| B26 | 5 | 0.25 | 0.3 | 9 | 5 | 0 | 45 | 0 |
| B27 | 5 | 0.25 | 0.3 | 9 | 5 | -5 | 45 | -45 |
| B28 | 5 | 0.25 | 0.3 | 9 | 5 | 5 | 45 | 45 |
| B29 | 5 | 0.25 | 0.3 | 9 | 7.5 | 2.5 | 67.5 | 22.5 |
| B30 | 5 | 0.25 | 0.3 | 9 | 7.5 | -2.5 | 67.5 | -22.5 |
| B31 | 5 | 0.25 | 0.3 | 9 | 10 | 0 | 90 | 0 |
| B32 | 5 | 0.25 | 0.3 | 9 | 10 | -5 | 90 | -45 |
| B33 | 5 | 0.25 | 0.3 | 9 | 10 | 5 | 90 | 45 |
| B34 | 5 | 0.25 | 0.3 | 9 | 12.5 | 2.5 | 112.5 | 22.5 |
| B35 | 5 | 0.25 | 0.3 | 9 | 12.5 | -2.5 | 112.5 | -22.5 |
| B36 | 5 | 0.25 | 0.3 | 9 | 15 | -5 | 135 | -45 |
| B37 | 5 | 0.25 | 0.3 | 9 | 15 | 0 | 135 | 0 |
| B38 | 5 | 0.25 | 0.3 | 9 | 15 | 5 | 135 | 45 |
| B39 | 5 | 0.25 | 0.3 | 9 | 17.5 | 2.5 | 157.5 | 22.5 |
| B40 | 5 | 0.25 | 0.3 | 9 | 17.5 | -2.5 | 157.5 | -22.5 |
| B41 | 5.2 | 0.25 | 0.3 | 9.36 | 20.1 | 0 | 188.136 | 0 |
| B42 | 8.17 | 0.25 | 0.3 | 14.706 | 22.7 | -5.2 | 333.8262 | -76.4712 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B43 | 8.17 | 0.25 | 0.3 | 14.706 | 22.7 | 5.2 | 333.8262 | 76.4712 |
| Total Weight due to beam = | | | | 410.544 | Sum = | | 0 | 0 |
| | | | | | | | | |

| Column on axis | Depth D(m) | Width w(m) | Height h(m) | Weight W (KN) | Distance X(m) | Distance Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.4 | 0.4 | 1.5 | 5.76 | -17.5 | 0 | -100.8 | 0 |
| 2 | 0.4 | 0.4 | 1.5 | 5.76 | -17.5 | 5 | -100.8 | 28.8 |
| 3 | 0.4 | 0.4 | 1.5 | 5.76 | -17.5 | -5 | -100.8 | -28.8 |
| 4 | 0.4 | 0.4 | 1.5 | 5.76 | -12.5 | 0 | -72 | 0 |
| 5 | 0.4 | 0.4 | 1.5 | 5.76 | -12.5 | 5 | -72 | 28.8 |
| 6 | 0.4 | 0.4 | 1.5 | 5.76 | -12.5 | -5 | -72 | -28.8 |
| 7 | 0.4 | 0.4 | 1.5 | 5.76 | -7.5 | 0 | -43.2 | 0 |
| 8 | 0.4 | 0.4 | 1.5 | 5.76 | -7.5 | 5 | -43.2 | 28.8 |
| 9 | 0.4 | 0.4 | 1.5 | 5.76 | -7.5 | -5 | -43.2 | -28.8 |
| 10 | 0.4 | 0.4 | 1.5 | 5.76 | -2.5 | 0 | -14.4 | 0 |
| 11 | 0.4 | 0.4 | 2.725 | 10.464 | -2.5 | 5 | -26.16 | 52.32 |
| 12 | 0.4 | 0.4 | 2.725 | 10.464 | -2.5 | 0 | -26.16 | 0 |
| 13 | 0.4 | 0.4 | 2.725 | 10.464 | 2.5 | 5 | 26.16 | 52.32 |
| 14 | 0.4 | 0.4 | 2.725 | 10.464 | 2.5 | 0 | 26.16 | 0 |
| 15 | 0.4 | 0.4 | 1.5 | 5.76 | 2.5 | -5 | 14.4 | -28.8 |
| 16 | 0.4 | 0.4 | 1.5 | 5.76 | 7.5 | 0 | 43.2 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 17 | 0.4 | 0.4 | 1.5 | 5.76 | 7.5 | 5 | 43.2 | 28.8 |
| 18 | 0.4 | 0.4 | 1.5 | 5.76 | 7.5 | -5 | 43.2 | -28.8 |
| 19 | 0.4 | 0.4 | 1.5 | 5.76 | 12.5 | 0 | 72 | 0 |
| 20 | 0.4 | 0.4 | 1.5 | 5.76 | 12.5 | 5 | 72 | 28.8 |
| 21 | 0.4 | 0.4 | 1.5 | 5.76 | 12.5 | -5 | 72 | -28.8 |
| 22 | 0.4 | 0.4 | 1.5 | 5.76 | 17.5 | 0 | 100.8 | 0 |
| 23 | 0.4 | 0.4 | 1.5 | 5.76 | 17.5 | 5 | 100.8 | 28.8 |
| 24 | 0.4 | 0.4 | 1.5 | 5.76 | 17.5 | -5 | 100.8 | -28.8 |
| 25 | 0.4 | 0.4 | 1.5 | 5.76 | -22.5 | 0 | -129.6 | 0 |
| 26 | 0.4 | 0.4 | 1.5 | 5.76 | 22.5 | 0 | 129.6 | 0 |
| Total Weight due to column = | | | | 168.576 | Sum = | | 0 | 75.84 |

| Wall identification | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 5 | 0.2 | 1.225 | 17.15 | 0 | 5 | 0 | 85.75 |
| 2 | 5 | 0.2 | 1.225 | 17.15 | 0 | 0 | 0 | 0 |
| 3 | 5 | 0.2 | 1.225 | 17.15 | -2.5 | 2.5 | -42.875 | 42.875 |
| 4 | 5 | 0.2 | 1.225 | 17.15 | 2.5 | 2.5 | 42.875 | 42.875 |
| parapet 1 | 15 | 0.2 | 0.95 | 39.9 | -10 | 5.8 | -399 | 231.42 |
| parapet 2 | 15 | 0.2 | 0.95 | 39.9 | -10 | -5.8 | -399 | -231.42 |
| parapet 3 | 15 | 0.2 | 0.95 | 39.9 | 10 | 5.8 | 399 | 231.42 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| parapet 4 | 15 | 0.2 | 0.95 | 39.9 | 10 | -5.8 | 399 | -231.42 |
| parapet 5 | 5 | 0.2 | 0.95 | 13.3 | 0 | -5.8 | 0 | -77.14 |
| parapet 6 | 11.6 | 0.2 | 0.95 | 30.856 | -2.5 | -0.8 | -77.14 | -24.6848 |
| parapet 7 | 11.6 | 0.2 | 0.95 | 30.856 | 2.5 | -0.8 | 77.14 | -24.6848 |
| parapet 8 | 13.2 | 0.2 | 0.95 | 35.112 | 17.5 | 0 | 614.46 | 0 |
| parapet 9 | 13.2 | 0.2 | 0.95 | 35.112 | -17.5 | 0 | -614.46 | 0 |
| Weight of wall at this floor = | | | | 373.436 | Sum = | | 0 | 44.9904 |
| Weight of wall from previous floor = | | | | 1118.066 | | | | |
| Total weight due to wall = | | | | 1491.502 | | | | |

| Staircase | | Length | DL | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | | L(m) | (KN/m2) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| stair case 3 | flight 3 | 1.8 | 10.894 | 19.609 | 1.85 | 3.14 | 61.572888 | 36.27702 |
| | landing 3 | 1.6 | 8.44 | 13.504 | 1.7 | 4.3 | 58.0672 | 22.9568 |
| Weight of stair at this floor = | | | | 33.113 | Sum = | | 119.640088 | 59.23382 |
| Total weight of roof floor = | | | | 3221.527 | | | | |
| | | | | | ∑W*X | 119.64 | Xm = | 0.0371376 |
| | | | | | ∑W*Y | 1217.04 | Ym = | 0.3777843 |

**Centre of mass for head room**

| Panel no. | Length L(m) | Width w(m) | DL (KN/m2) | Weight W (KN) | Distance X(m) | Distance Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| 5 | 5 | 5 | 5.29 | 132.25 | 0 | 2.5 | 0 | 330.625 |

| Beam on axis | Length L(m) | Width w(m) | Depth d(m) | Weight W (KN) | Distance X(m) | Distance Y(m) | W*X(KN.m) | W*Y(KN.m) |
|---|---|---|---|---|---|---|---|---|
| B19 | 5 | 0.25 | 0.3 | 9 | -2.5 | 2.5 | -22.5 | 22.5 |
| B21 | 5 | 0.25 | 0.3 | 9 | 0 | 5 | 0 | 45 |
| B22 | 5 | 0.25 | 0.3 | 9 | 0 | 0 | 0 | 0 |
| B24 | 5 | 0.25 | 0.3 | 9 | 2.5 | 2.5 | 22.5 | 22.5 |
| Total weight of over head beam = | | | | 36 | Sum= | | 0 | 90 |
| | | | | | | | | |
| Column on axis | Depth D(m) | Width w(m) | Height h(m) | Weight W (KN) | Distance X(m) | Distance Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 11 | 0.4 | 0.4 | 1.225 | 4.704 | -2.5 | 5 | -11.76 | 23.52 |
| 12 | 0.4 | 0.4 | 1.225 | 4.704 | -2.5 | 0 | -11.76 | 0 |
| 13 | 0.4 | 0.4 | 1.225 | 4.704 | 2.5 | 5 | 11.76 | 23.52 |
| 14 | 0.4 | 0.4 | 1.225 | 4.704 | 2.5 | 0 | 11.76 | 0 |
| Total weight of over head column = | | | | 18.816 | Sum= | | 0 | 47.04 |

| Wall identification | Length | Thickness | Height | Weight | Distance | | | |
|---|---|---|---|---|---|---|---|---|
| | L(m) | t(m) | h(m) | W (KN) | X(m) | Y(m) | W*X(KN.m) | W*Y(KN.m) |
| 1 | 5 | 0.2 | 1.15 | 16.1 | 0 | 5 | 0 | 80.5 |
| 2 | 5 | 0.2 | 1.15 | 16.1 | 0 | 0 | 0 | 0 |
| 3 | 5 | 0.2 | 1.15 | 16.1 | -2.5 | 2.5 | -40.25 | 40.25 |
| 4 | 5 | 0.2 | 1.15 | 16.1 | 2.5 | 2.5 | 40.25 | 40.25 |
| Total weight of over head Wall = | | | | 64.4 | Sum | | 0 | 161 |
| Total weight of over head floor = | | | | 251.466 | | | | |
| | | | | | ∑W*X | 0 | Xm = | 0 |
| | | | | | ∑W*Y | 628.665 | Ym = | 2.5 |

Table 5. 3: Summary for the center of the mass for each floor

| SUMMARY | | | |
|---|---|---|---|
| FLOOR | W(KN) | Xm | Ym |
| Basement Floor | 3794.862 | 0.006475 | 0.490738 |
| Ground Floor | 4680.118 | 0.201157 | 0.094157 |
| First Floor | 5742.643 | 0.003823 | 0.078027 |
| Second Floor | 5599.355 | -0.10223 | 0.266612 |
| Third Floor | 5277.092 | -0.02864 | 0.206486 |

| | | | |
|---|---|---|---|
| Fourth Floor | 6107.704 | -0.01448 | -0.08159 |
| Roof Floor | 3221.527 | 0.037138 | 0.377784 |
| Head room | 251.46 | 0 | 2.5 |
| ΣW | 34674.77 | | |

### 5.2.2. Determination of center of stiffness

The center of stiffness was determined using D- value method by considering lateral stiffness of the frame elements along X and Y direction.

**Calculation of beam and column stiffness**

$K_b$= beam stiffness

$K_{xc}$ = column stiffness in the x-axis.

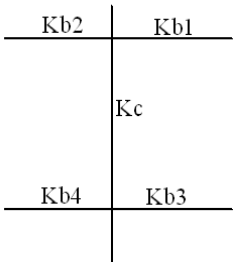
$K_{yc}$ = column stiffness in the y-axis.

For uniform storey height, the D-value of a column is obtained from:

D = a* $K_c$, where a = constant determined by $\overline{K}$

$K_C$ = Stiffness ratio of column

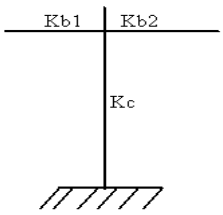
Case-1 General




$a = \frac{\overline{K}}{2+\overline{K}}$

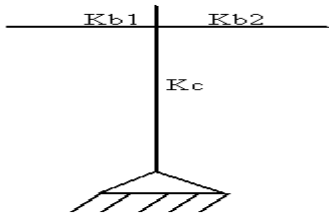
$\overline{K} = \frac{\sum K_b}{2K_c}$

case-2 One end fixed




$\overline{K} = \frac{\sum K_b}{K_c}$

case-3 One end pin supported




$a = \frac{0.5+\overline{K}}{2+\overline{K}}$

$\overline{K} = \frac{\sum K_b}{1+2K_c}$

$a = \frac{0.5\overline{K}}{2+\overline{K}}$

**Stiffness of beams (cm4)**

Table 5. 4: Stiffness of beams (cm4)

| Beam Number | Width w(cm) | Depth d(cm) | Length L(cm) | Kb= $\frac{bh^3}{12L}$ | Membrs |
|---|---|---|---|---|---|
| B1&B41 | 30 | 40 | 520 | 307.6923077 | |
| B2,B3,B42, B43 | 30 | 40 | 795 | 201.2578616 | |
| B4-B40 | 30 | 40 | 500 | 320 | Grade beam |
| B1&B41 | 25 | 40 | 520 | 256.4102564 | |
| B2,B3,B42, B43 | 25 | 40 | 795 | 167.7148847 | |
| B4-B40 | 25 | 40 | 500 | 266.6666667 | Floor beam |
| B1&B41 | 25 | 30 | 520 | 108.1730769 | |
| B2,B3,B42, B43 | 25 | 30 | 795 | 70.75471698 | |
| B4-B40 | 25 | 30 | 500 | 112.5 | |
| B19,B21,B22, B24 | 25 | 30 | 500 | 112.5 | Top beam |

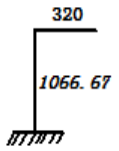
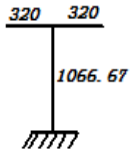
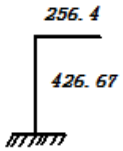
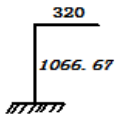
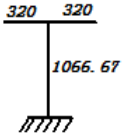
**Stiffness of column (cm4)**

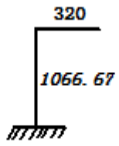
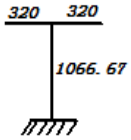
Table 6. 1: Stiffness of column (cm4)

| Floor | Base b(cm) | Depth d(cm) | Length L(cm) | Kxc = $\frac{bh^3}{12L}$ | Kyc = $\frac{bh^3}{12L}$ |
|---|---|---|---|---|---|
| Foundation C1 | 40 | 40 | 500 | 426.6666667 | 426.6666667 |
| Foundation | 40 | 40 | 200 | 1066.666667 | 1066.666667 |
| Ground | 40 | 40 | 330 | 646.4646465 | 646.4646465 |
| Basement, 1st , 2nd, 3rd and 4th,Roof | 40 | 40 | 300 | 711.1111111 | 711.1111111 |
| Head room | 40 | 40 | 245 | 870.7482993 | 870.7482993 |
| Stair 1 | 40 | 40 | 105 | 2031.746032 | 2031.746032 |
| Stair 2 | 40 | 40 | 90 | 2370.37037 | 2370.37037 |
| Stair Ground | 40 | 40 | 110 | 1939.393939 | 1939.393939 |
| Stair Ground X | 40 | 40 | 220 | 969.6969697 | 969.6969697 |
| Stair on x-axis | 40 | 40 | 210 | 1015.873016 | 1015.873016 |

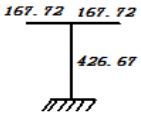
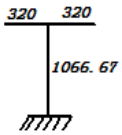
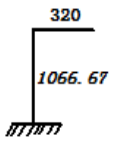
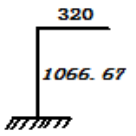
**D-value for basement column about X-axis**

Table 5. 5: D-value for each floor column about x-axis and Yaxis

| Axis | Column | Boundary | K | A | Kxc | Dx = a Kxc | Total Dx |
|---|---|---|---|---|---|---|---|
| 1 | C3 |  | 0.3 | 0.3478 | 1066.66666 | 371.014492 | 742.028985 |
| | C4 |  | 0.6 | 0.4231 | 1066.66666 | 451.282051 | 2707.69230<br>3449.72129 |
| 2 | C1 |  | 0.60<br>096 | 0.4233 | 426.666666 | 180.603820 | 361.207640 |
| | C2 |  | 0.3 | 0.3478 | 1066.66666 | 371.014492 | 742.028985 |
| | C5 |  | 0.6 | 0.4231 | 1066.66666 | 451.282051 | 2707.69230<br>3810.92893 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | C3 |  | 0.3 | 0.3478 | 1066.66666 | 371.014492 | 742.028985 |
| | C4 |  | 0.6 | 0.4231 | 1066.66666 | 451.282051 | 2707.69230 |
| | | | | | | | 3449.72129 |

**D-value for Basement column about Y-axis**

| Axix | column | Boundary | K | a | Kxc | Dy = a Kxc | Total Dy |
|---|---|---|---|---|---|---|---|
| A &J | C1 |  | 0.786164 | 0.46163 | 426.6667 | 196.9601204 | 393.9202408 |
| | C2 |  | 0.6 | 0.42308 | 1066.667 | 451.2820513 | 9546.488294 |
| | C3 |  | 0.3 | 0.34783 | 1066.667 | 371.0144928 | |
| B-J | C3 |  | 0.3 | 0.34783 | 1066.667 | 371.0144928 | |
| | | | sum= | | | 1193.311037 | |

| D-value for ground column about X-axis | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kxc | Dx = a Kxc | Total Dx |
| 1 | C3 | 0.53 | 0.2096 | 711.11 | 149 | 298 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | C4 | 0.825 | 0.292 | 711.11 | 207.67 | 1246.02 |
| | | | | | sum= | 1544.02 |
| 2 | C2 | 0.592 | 0.228 | 711.11 | 162.4 | 324.8 |
| | C5 | 0.825 | 0.292 | 711.11 | 207.67 | 1246.02 |
| | C1 | 0.6 | 0.423 | 426 | 180.48 | 360.96 |
| | | | | | sum= | 1931.78 |
| 3 | C3 | 0.53 | 0.2096 | 711.11 | 149.04 | 298.08 |
| | C4 | 0.825 | 0.292 | 711.11 | 207.67 | 830.68 |
| | C6 | 0.168 | 0.078 | 711.11 | 184.5 | 483.7 |
| | | 0.0131 | 0.06 | 711.11 | 125.14 | |
| | | 0.223 | 0.1 | 711.11 | 203.92 | |
| | | | | | sum= | 1612.46 |

**D-value for Ground column about Y-axis**

| Axis | column | K | a | Kyc | Dy= a Kyc | Total Dy |
|---|---|---|---|---|---|---|
| A-J | c1 | 0.786 | 0.46 | 426.67 | 196.27 | |
| B-D & G-I | c3 | 0.412 | 0.1708 | 711.11 | 121.46 | 242.92 |
| | c2 | 0.825 | 0.292 | 711.11 | 207.67 | |
| | | | | | sum= | 450.59 |
| E | c6 | 0.244 | 0.108 | 1094.02 | 118.9 | 224.78 |
| | | 0.144 | 0.067 | 2031.74 | 136.82 | |
| | c7 | 0.366 | 0.154 | 1094.02 | 169.06 | 322.6 |
| | | 0.223 | 0.1 | 2031.74 | 203.93 | |
| | c3 | 0.412 | 0.1708 | 711.11 | 121..46 | |
| | | | | | sum= | 668.84 |
| F | c6 | 0.113 | 0.053 | 2370.37 | 126.23 | |
| | | 0.29 | 0.0126 | 1015.87 | 128.02 | 220.34 |
| | c7 | 0.169 | 0.0778 | 2370.37 | 184.42 | 319.29 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 0.446 | 0.182 | 1015.87 | 185.33 | |
| | c3 | 0.412 | 0.1708 | 711.11 | 121.46 | |
| | | | | | sum= | 661.09 |

| D-value for first column about X-axis | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kxc | Dx = a Kxc | Total Dx |
| 1 | C3 | 0.678 | 0.253 | 646.46 | 163.55 | 327.1 |
| | C4 | 0.825 | 0.292 | 646.46 | 188.78 | 1132.68 |
| | | | | | sum= | 1459.78 |
| 2 | C2 | 0.809 | 0.288 | 646.46 | 186.18 | 372.36 |
| | C5 | 0.825 | 0.292 | 646.46 | 188.789 | 1132.734 |
| | C1 | 0.396 | 0.1652 | 646.46 | 106.8 | 213.6 |
| | | | | | sum= | 1718.694 |
| 3 | C3 | 0.678 | 0.253 | 646.46 | 163.55 | 327.1 |
| | C4 | 0.825 | 0.292 | 646.46 | 188.78 | 755.12 |
| | C6 | 0.206 | 0.09 | 1939.4 | 181.33 | 472.3 |
| | | 0.137 | 0.064 | 1939.4 | 124.58 | |
| | | 0.206 | 0.09 | 1939.4 | 181.33 | |
| | | | | | sum= | 1554.52 |

| D-value for first column about Y-axis | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kyc | Dy= a Kyc | Total Dy |
| A-J | c1 | 0.5188 | 0.206 | 646.46 | 133.17 | |
| B-D & G-I | c3 | 0.412 | 0.1708 | 646.46 | 110.54 | 221.08 |
| | c2 | 0.825 | 0.292 | 646.46 | 188.789 | |
| | | | | | sum= | 409.869 |
| E | c6 | 0.275 | 0.12 | 969.7 | 117.2 | 213.55 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 0.1375 | 0.0643 | 1939.4 | 124.77 | |
| | c7 | 0.4125 | 0.171 | 969.7 | 165.8 | |
| | | 0.206 | 0.0934 | 1939.4 | 181.3 | 303.63 |
| | c3 | 0.412 | 0.1708 | 646.46 | 110.54 | |
| | | | | | sum= | 627.72 |
| F | c6 | 0.1375 | 0.0643 | 1939.4 | 124.77 | |
| | | 0.275 | 0.12 | 969.7 | 117.2 | 213.55 |
| | c7 | 0.206 | 0.09343 | 1939.4 | 181.3 | |
| | | 0.412 | 0.171 | 969.7 | 165.8 | 303.63 |
| | c3 | 0.412 | 0.1708 | 646.46 | 110.54 | |
| | | | | | sum= | 627.72 |

| D-value for second column about X-axis | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kxc | Dx = a Kxc | Total Dx |
| 1 | C3 | 0.61 | 0.234 | 711.11 | 166.4 | 332.8 |
| | C4 | 0.75 | 0.273 | 711.11 | 194.13 | 776.52 |
| | c6 | 0.56 | 0.22 | 711.11 | 156.1 | 312.2 |
| | | | | | sum= | 1421.52 |
| 2 | C2 | 0.735 | 0.268 | 711.11 | 191.1 | 382.2 |
| | C5 | 0.75 | 0.273 | 711.11 | 108.44 | 650.64 |
| | C1 | 0.36 | 0.152 | 711.11 | 108.44 | 216.88 |
| | | | | | sum= | 1249.72 |
| 3 | C3 | 0.61 | 0.235 | 711.11 | 166.4 | 332.8 |
| | C4 | 0.75 | 0.273 | 711.11 | 108.44 | 433.76 |
| | C6 | 0.168 | 0.078 | 2370.37 | 184.4 | |
| | | 0.1312 | 0.06 | 2031.74 | 125.12 | 934.6 |
| | | 0.197 | 0.08 | 2031.74 | 182.01 | |
| | | | | | sum= | 1701.16 |

| D-value for second column about Y-axis |
|---|

| Axis | column | K | a | Kyc | Dy= a Kyc | Total Dy |
|---|---|---|---|---|---|---|
| A-J | c1 | 0.417 | 0.19 | 711.11 | 135.7 | |
| B-D& G-I | c2 | 0.75 | 0.273 | 711.11 | 194.13 | 224.7 |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | |
| | | | | | sum= | 554.53 |
| E | c6 | 0.2625 | 0.1 | 1015.87 | 117.2 | 205.33 |
| | | 0.1125 | 0.053 | 2370.37 | 126.23 | |
| | | | | | | |
| | c7 | 0.394 | 0.164 | 1015.87 | 167.09 | 292.35 |
| | | 0.169 | 0.078 | 2370.37 | 184.42 | |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | |
| | | | | | sum= | 610.03 |
| F | c6 | 0.1125 | 0.053 | 2370.37 | 126.23 | |
| | | 0.2625 | 0.11 | 1015.87 | 117.87 | 205.33 |
| | c7 | 0.169 | 0.078 | 2370.37 | 184.42 | |
| | | 0.394 | 0.164 | 1015.87 | 167.09 | 292.35 |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | |
| | | | | | sum= | 610.03 |

| **D-value for third column about X-axis** | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kxc | Dx = a Kxc | Total Dx |
| 1 | C3 | 0.61 | 0.234 | 711.11 | 166.4 | 332.8 |
| | C4 | 0.75 | 0.273 | 711.11 | 194.13 | 776.52 |
| | c6 | 0.56 | 0.22 | 711.11 | 156.1 | 312.2 |
| | | | | | sum= | 1421.52 |
| 2 | C2 | 0.735 | 0.268 | 711.11 | 191.1 | 382.2 |
| | C5 | 0.75 | 0.273 | 711.11 | 108.44 | 650.64 |
| | C1 | 0.36 | 0.152 | 711.11 | 108.44 | 216.88 |
| | | | | | sum= | 1249.72 |
| 3 | C3 | 0.61 | 0.235 | 711.11 | 166.4 | 332.8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | C4 | 0.75 | 0.273 | 711.11 | 108.44 | 433.76 |
| | C6 | 0.168 | 0.078 | 2370.37 | 184.4 | 934.6 |
| | | 0.1312 | 0.06 | 2031.74 | 125.12 | |
| | | 0.197 | 0.08 | 2031.74 | 182.01 | |
| | | | | | sum= | 1701.16 |

| D-value for third column about Y-axis | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | | a | Kyc | Dy= a Kyc | Total Dy |
| A-J | c1 | 0.417 | 0.19 | 711.11 | 135.7 | |
| B-D & G-I | c2 | 0.75 | 0.273 | 711.11 | 194.13 | |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | 224.7 |
| | | | | | sum= | 554.53 |
| E | c6 | 0.2625 | 0.1 | 1015.87 | 117.2 | |
| | | 0.1125 | 0.05`3 | 2370.37 | 126.23 | 205.33 |
| | c7 | 0.394 | 0.164 | 1015.87 | 167.09 | |
| | | 0.169 | 0.078 | 2370.37 | 184.42 | 292.35 |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | |
| | | | | | sum= | 610.03 |
| F | c6 | 0.1125 | 0.053 | 2370.37 | 126.23 | |
| | | 0.2625 | 0.11 | 1015.87 | 117.87 | 205.33 |
| | c7 | 0.169 | 0.078 | 2370.37 | 184.42 | |
| | | 0.394 | 0.164 | 1015.87 | 167.09 | 292.35 |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | |
| | | | | | sum= | 610.03 |

| D-value for fourth column about X-axis | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kxc | Dx = a Kxc | Total Dx |
| 1 | C3 | 0.61 | 0.234 | 711.11 | 166.4 | 332.8 |
| | C4 | 0.75 | 0.273 | 711.11 | 194.13 | 776.52 |
| | c6 | 0.75 | 0.273 | 711.11 | 194.13 | 388.26 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | sum= | 1497.58 |
| 2 | C2 | 0.735 | 0.268 | 711.11 | 191.1 | 382.2 |
| | C5 | 0.75 | 0.273 | 711.11 | 108.44 | 650.64 |
| | C1 | 0.36 | 0.152 | 711.11 | 108.44 | 216.88 |
| | | | | | sum= | 1249.72 |
| 3 | C3 | 0.61 | 0.235 | 711.11 | 166.4 | 332.8 |
| | C4 | 0.75 | 0.273 | 711.11 | 108.44 | 433.76 |
| | C6 | 0.168 | 0.078 | 2370.37 | 184.4 | 934.6 |
| | | 0.1312 | 0.06 | 2031.74 | 125.12 | |
| | | 0.197 | 0.08 | 2031.74 | 182.01 | |
| | | | | | sum= | 1701.16 |

| **D-value for fourth column about Y-axis** | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kyc | Dy= a Kyc | Total Dy |
| A-J | c1 | 0.417 | 0.19 | 711.11 | 135.7 | |
| B-D&G-I | c2 | 0.75 | 0.273 | 711.11 | 194.13 | |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | 224.7 |
| | | | | | sum= | 554.53 |
| E | c6 | 0.2625 | 0.1 | 1015.87 | 117.2 | 205.33 |
| | | 0.1125 | 0.053 | 2370.37 | 126.23 | |
| | c7 | 0.394 | 0.164 | 1015.87 | 167.09 | 292.35 |
| | | 0.169 | 0.078 | 2370.37 | 184.42 | |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | |
| | | | | | sum= | 610.03 |
| F | c6 | 0.1125 | 0.053 | 2370.37 | 126.23 | |
| | | 0.2625 | 0.11 | 1015.87 | 117.87 | 205.33 |
| | c7 | 0.169 | 0.078 | 2370.37 | 184.42 | 292.35 |
| | | 0.394 | 0.164 | 1015.87 | 167.09 | |
| | c3 | 0.375 | 0.16 | 711.11 | 112.35 | |
| | | | | | sum= | 610.03 |

| D-value for roof about X-axis | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kxc | Dx = a Kxc | Total Dx |
| 1 | C3 | 0.434 | 0.09 | 711.11 | 63.4 | 126.8 |
| | C4&c6 | 0.5328 | 0.105 | 711.11 | 74.67 | 448.02 |
| | | | | | sum= | 574.82 |
| 2 | c1 | 0.256 | 0.056 | 711.11 | 40.32 | 80.64 |
| | C2 | 0.5226 | 0.04 | 711.11 | 29.2 | 58.4 |
| | C5 | 0.532 | 0.105 | 711.11 | 74.67 | 298.68 |
| | C6 | 0.533 | 0.21 | 711.11 | 149.62 | 299.24 |
| | | | | | sum= | 736.96 |
| 3 | C3 | 0.434 | 0.09 | 711.11 | 63.4 | 126.8 |
| | C4 | 0.533 | 0.105 | 711.11 | 74.67 | 298.68 |
| | C6 | 0.1037 | 0.05 | 2370.37 | 116.86 | 834.58 |
| | | 0.1312 | 0.06 | 2031.74 | 125.12 | |
| | | 0.197 | 0.062 | 2031.74 | 181.1 | |
| | | | | | sum= | 1260.06 |
| **D-value for roof about Y-axis** | | | | | | |
| Axis | column | K | a | Kyc | Dy= a Kyc | Total Dy |
| A-J | c1 | 0.335 | 0.0717 | 711.11 | 51.09 | |
| B-D&G-I | c2 | 0.5328 | 0.105 | 711.11 | 74.8 | |
| | c3 | 0.2264 | 0.06 | 711.11 | 42.67 | 85.34 |
| | | | | | sum= | 211.23 |
| E | c6 | 0.186 | .o85 | 1015.87 | 86.726 | 157.15 |
| | | 0.1125 | 0.053 | 2370.37 | 126.23 | |
| | c7 | 0.242 | 0.11 | 1015.87 | 109.61 | 201.7 |
| | | 0.169 | 0.078 | 2370.37 | 184.42 | |
| | c3 | 0.2264 | 0.06 | 711.11 | 42.67 | |
| | | | | | sum= | 401.52 |

| | | | | | | |
|---|---|---|---|---|---|---|
| F | c6 | 0.08 | 0.04 | 2370.37 | 91.15 | 194.4 |
| | | 0.2625 | 0.11 | 1015.87 | 117.87 | |
| | c7 | 0.1037 | 0.05 | 2370.37 | 116.86 | 270.1 |
| | | 0.394 | 0.164 | 1015.87 | 167.09 | |
| | c3 | 0.2264 | 0.06 | 711.11 | 42.67 | |
| | | | | | sum= | 507.17 |

| D-value for head room about X-axis | | | | | | |
|---|---|---|---|---|---|---|
| Axis | column | K | a | Kxc | Dx = a Kxc | Total Dx |
| 2 | C5 | 0.2 | 0.044 | 870.75 | 38.44 | 76.88 |
| 3 | C6 | 0.2 | 0.044 | 870.75 | 38.44 | 76.88 |

| D-value for head room about Y-axis | | | | | |
|---|---|---|---|---|---|
| Axis | column | | a | Kyc | Dy= a Kyc |
| E | c2 | 0.2 | 0.044 | 870.75 | 38.44 |
| | c3 | 0.129 | 0.03 | 870.75 | 26.4 |
| | | | | sum= | 64.84 |
| F | c2 | 0.2 | 0.044 | 870.75 | 38.44 |
| | c3 | 0.129 | 0.03 | 870.75 | 26.4 |
| | | | | sum= | 64.84 |

### 5.2.3. Determination of base shear and storey shear

**Base shear ($F_b$)**

According to EBCS -8, 2015 the seismic base shear force ($F_b$) for each main direction is determined from:

$F_b = S_d(T_1)*W_1$,

Where: $S_d(T_1)$ → is the ordinate of design spectrum at period $T_1$

$T_1$ - is fundamental period of vibration of the structure for transitional motion in the direction considered.

W - is seismic dead load computed.

- Fundamental period of vibration ($T_1$)
  - ✓ $T_1 = C_1 * H^{\frac{3}{4}}$ ,

    Where $C_1$ depends on nature of the building.

    H is the height of building above the base in meter.

    $C_1$ = 0.075 for reinforced concrete moment resisting frames according to EBCS – 8, 2015

    H = 22.75m

    $T_1 = 0.075 * 22.75^{\frac{3}{4}}$ = **0.78sec**
- Value of α:
  - ✓ α is the ratio of design bed rock acceleration to acceleration of gravity.
  - ✓ $\alpha = \alpha_o * I$, where $\alpha_o$ is the bedrock acceleration ratio for the site & depends on seismic zone.
  - ✓ I - is importance factor.
  - ✓ $\alpha_o$ = 0.1, for Dire Dewa →zone 3,ES EN 2015
  - ✓ I = 1.0, importance category ES EN 2015
  - ✓ $\alpha = 0.1 * 1.0 = 0.1$
- The parameter β is design response for the site given by :
  - ✓ $\beta = \frac{1.2 * S}{T^{\frac{2}{3}}} \leq 2.50$ , where S is the site coefficient for soil characteristics.
  - ✓ S = 1.2 → deposits with predominant soft to medium stiff cohesive soils site coefficient from ES EN 2015
  - ✓ $\beta = \frac{1.2 * 1.2}{0.78^{\frac{2}{3}}} = 1.7 \leq 2.50$ OK!
- Behavior factor depends on type of structural system.
  - ✓ γ = 0.40 → for frame system.
- Design spectrum $S_d(T_1)$
  - ✓ $S_d(T_1) = \alpha * \beta * \gamma = 0.1 * 1.7 * 0.4$ = **0.0679**
  - ✓ $F_b = S_d(T_1) * W$
  - ✓ $W = G + \Psi * Q_K$, where G is the characteristics dead load.

$Q_K$ is the characteristics live load.

Ψ is live load incidence factor.

$Q_K$ is ignored because live load consideration is only applied for storage and ware house according to ES EN 2015.

- $W = G + \Psi * Q_K = G + 0 * Q_K = G$ (total dead load of the building)

  $W =$ **34674.77 KN**

- $F_b = S_d(T_1) * W = 0.0679 * 34674.77 =$ **2354.531 KN.**

### 5.2.4. Distribution of base shear along the floor

Base shear is distributed to each storey using the formula:

- $F_i = \frac{(Fb - Ft) * W_i h_i}{\sum_{j=1}^{n} W_j h_j}$, where $F_i$ = storey shear.

$F_{t=}$ concentrated force at the top.

$F_b$ = base shear

W = weight of building at each floor.

$F_t = 0.077 * T_1 * F_b$

$= 0.07 * 0.78 * 2354.531 =$ **128.7656KN**

$F_b - F_t = 2354.531 - 128.7656 =$ **2225.766KN.**

**Storey shear ($F_i$)**

Table 5. 6: Storey shear for each floor(Fi)

| Floor | hi | Wi | hi*Wi | Fb-Ft | Fi |
|---|---|---|---|---|---|
| Head Room | 22.75 | 251.466 | 5720.8515 | 2225.766 | 28.57419 |
| Roof floor | 21.525 | 3221.527 | 69343.369 | 2225.766 | 346.3524 |
| Forth floor | 18.8 | 6107.704 | 114824.84 | 2225.766 | 573.5207 |
| Third floor | 15.8 | 5277.092 | 83378.05 | 2225.766 | 416.4521 |
| Second floor | 12.8 | 5599.355 | 71671.741 | 2225.766 | 357.982 |
| First floor | 9.8 | 5742.643 | 56277.901 | 2225.766 | 281.0937 |
| Ground floor | 6.65 | 4680.118 | 31122.783 | 2225.766 | 155.4504 |
| Basement floor | 3.5 | 3794.862 | 13282.018 | 2225.766 | 66.34029 |
| | | Sum | 445621.55 | | |

### 5.2.5. Calculation of direct shear ($Q_i$)

When the storey shear acting parallel to x-axis:

- $Q_i = Fi * \frac{D_x}{\sum D_x}$

Where $Q_i$ is direct shear & $F_i$ is storey shear.

**Calculation of direct shear in the x-direction for each floor**

Table 5. 7: Calculation of direct shear in the x-direction for each floor

| Floor | Axis | Dx | Fi | Qi= Fi*Dx/ ∑Dx |
|---|---|---|---|---|
| Basement | Y1 | 3449.72 | 66.34 | 22.1134297 |
| | Y2 | 3449.72 | 66.34 | 22.1134297 |
| | Y3 | 3449.72 | 66.34 | 22.1134297 |
| | ∑Dx | 10349.16 | | |
| Ground | Y1 | 1544.03 | 155.45 | 47.1708698 |
| | Y2 | 1931.78 | 155.45 | 59.0168214 |
| | Y3 | 1612.50 | 155.45 | 49.2626617 |
| | ∑Dx | 5088.31 | | |
| 1st | Y1 | 1459.80 | 281.09 | 86.696875 |
| | Y2 | 1718.69 | 281.09 | 102.072237 |
| | Y3 | 1554.56 | 281.09 | 92.3246294 |
| | ∑Dx | 4733.05 | | |
| 2nd | Y1 | 1421.52 | 357.98 | 116.410904 |
| | Y2 | 1248.72 | 357.98 | 102.259992 |
| | Y3 | 1701.16 | 357.98 | 139.311141 |
| | ∑Dx | 4371.4 | | |
| 3rd | Y1 | 1421.52 | 416.45 | 347.994858 |
| | Y2 | 1248.72 | 416.45 | 305.692596 |
| | Y3 | 1701.16 | 416.45 | 416.452061 |
| | ∑Dx | 4371.4 | | |
| 4th | Y1 | 1497.58 | 573.52 | 193.119937 |
| | Y2 | 1248.72 | 573.52 | 161.028278 |

| | | | | |
|---|---|---|---|---|
| | Y3 | 1701.16 | 573.52 | 219.372529 |
| | ∑Dx | 4447.46 | | |
| Roof | Y1 | 574.8 | 346.35 | 77.6747014 |
| | Y2 | 736.96 | 346.35 | 99.5879401 |
| | Y3 | 1251.28 | 346.35 | 169.089771 |
| | ∑Dx | 2563.04 | | |
| Head Room | Y2 | 76.88 | 28.57 | 14.2870959 |
| | Y3 | 76.88 | 28.57 | 14.2870959 |
| | ∑Dx | 153.76 | | |

**Calculation of direct shear in the Y-direction for each floor**

Table 5. 8: Calculation of direct shear in the Y-direction for each floor

| floor | Axis | Dy | Fi | Qi= Fi*Dy/ ∑Dy |
|---|---|---|---|---|
| Basement | X0 | 0 | 66.34 | 0 |
| | X1 | 1193.32 | 66.34 | 8.2925361 |
| | X2 | 1193.32 | 66.34 | 8.2925361 |
| | X3 | 1193.32 | 66.34 | 8.2925361 |
| | X4 | 1193.32 | 66.34 | 8.2925361 |
| | X5 | 1193.32 | 66.34 | 8.2925361 |
| | X6 | 1193.32 | 66.34 | 8.2925361 |
| | X7 | 1193.32 | 66.34 | 8.2925361 |
| | X8 | 1193.32 | 66.34 | 8.2925361 |
| | X9 | 0 | 66.34 | 0 |
| | ∑Dy | 9546.56 | | |
| Ground | X0 | 196.27 | 155.45 | 6.8932872 |
| | X1 | 450.6 | 155.45 | 15.825726 |
| | X2 | 450.6 | 155.45 | 15.825726 |
| | X3 | 450.6 | 155.45 | 15.825726 |
| | X4 | 668.84 | 155.45 | 23.490631 |

| | | | | |
|---|---|---|---|---|
| | X5 | 661.1 | 155.45 | 23.218791 |
| | X6 | 450.6 | 155.45 | 15.825726 |
| | X7 | 450.6 | 155.45 | 15.825726 |
| | X8 | 450.6 | 155.45 | 15.825726 |
| | X9 | 196.27 | 155.45 | 6.8932872 |
| | ∑Dy | 4426.08 | | |
| 1st | X0 | 133.17 | 281.09 | 9.4025524 |
| | X1 | 409.9 | 281.09 | 28.94125 |
| | X2 | 409.9 | 281.09 | 28.94125 |
| | X3 | 409.9 | 281.09 | 28.94125 |
| | X4 | 627.72 | 281.09 | 44.320569 |
| | X5 | 627.72 | 281.09 | 44.320569 |
| | X6 | 409.9 | 281.09 | 28.94125 |
| | X7 | 409.9 | 281.09 | 28.94125 |
| | X8 | 409.9 | 281.09 | 28.94125 |
| | X9 | 133.17 | 281.09 | 9.4025524 |
| | ∑Dy | 3981.18 | | |
| 2nd | X0 | 135.7 | 357.98 | 12.131075 |
| | X1 | 418.83 | 357.98 | 37.441844 |
| | X2 | 418.83 | 357.98 | 37.441844 |
| | X3 | 418.83 | 357.98 | 37.441844 |
| | X4 | 610.03 | 357.98 | 54.534412 |
| | X5 | 610.03 | 357.98 | 54.534412 |
| | X6 | 418.83 | 357.98 | 37.441844 |
| | X7 | 418.83 | 357.98 | 37.441844 |
| | X8 | 418.83 | 357.98 | 37.441844 |
| | X9 | 135.7 | 357.98 | 12.131075 |
| | ∑Dy | 4004.44 | | |
| 3rd | X0 | 135.7 | 416.45 | 14.112471 |
| | X1 | 418.83 | 416.45 | 43.557306 |

| | | | | |
|---|---|---|---|---|
| | X2 | 418.83 | 416.45 | 43.557306 |
| | X3 | 418.83 | 416.45 | 43.557306 |
| | X4 | 610.03 | 416.45 | 63.441642 |
| | X5 | 610.03 | 416.45 | 63.441642 |
| | X6 | 418.83 | 416.45 | 43.557306 |
| | X7 | 418.83 | 416.45 | 43.557306 |
| | X8 | 418.83 | 416.45 | 43.557306 |
| | X9 | 135.7 | 416.45 | 14.112471 |
| | ∑Dy | 4004.44 | | |
| 4th | X0 | 135.7 | 573.52 | 19.435118 |
| | X1 | 418.83 | 573.52 | 59.98534 |
| | X2 | 418.83 | 573.52 | 59.98534 |
| | X3 | 418.83 | 573.52 | 59.98534 |
| | X4 | 610.03 | 573.52 | 87.369235 |
| | X5 | 610.03 | 573.52 | 87.369235 |
| | X6 | 418.83 | 573.52 | 59.98534 |
| | X7 | 418.83 | 573.52 | 59.98534 |
| | X8 | 418.83 | 573.52 | 59.98534 |
| | X9 | 135.7 | 573.52 | 19.435118 |
| | ∑Dy | 4004.44 | | |
| Roof | X0 | 51.09 | 346.35 | 8.9745169 |
| | X1 | 160.14 | 346.35 | 28.130341 |
| | X2 | 160.14 | 346.35 | 28.130341 |
| | X3 | 160.14 | 346.35 | 28.130341 |
| | X4 | 401.52 | 346.35 | 70.531377 |
| | X5 | 507.17 | 346.35 | 89.089954 |
| | X6 | 160.14 | 346.35 | 28.130341 |
| | X7 | 160.14 | 346.35 | 28.130341 |
| | X8 | 160.14 | 346.35 | 28.130341 |

| | | | | |
|---|---|---|---|---|
| | X9 | 51.09 | 346.35 | 8.9745169 |
| | ∑Dy | 1971.71 | | |
| Head Room | X4 | 64.84 | 28.57 | 14.510891 |
| | X5 | 62.84 | 28.57 | 14.063301 |
| | ∑Dy | 127.68 | | |

**Calculation of center of stiffness**

$$\mathbf{Xs} = \frac{\sum \mathbf{Dy} * \mathbf{X}}{\sum \mathbf{Dy}} \qquad \mathbf{Ys} = \frac{\sum \mathbf{Dx} * \mathbf{Y}}{\sum \mathbf{Dx}}$$

Table 5. 9: Center of stiffness for each floor

| center of stiffness for basement floor | | | |
|---|---|---|---|
| Axis | Dx | Y | Dx*Y |
| 1 | 3449.72 | -5 | -17248.6 |
| 2 | 3449.72 | 0 | 0 |
| 3 | 3449.72 | 5 | 17248.6 |
| ∑Dx | 10349.16 | | 0 |

| Axis | Dy | X | DY*X |
|---|---|---|---|
| A | 0 | -22.7 | 0 |
| B | 1193.32 | -17.5 | -20883.1 |
| C | 1193.32 | -12.5 | -14916.5 |
| D | 1193.32 | -7.5 | -8949.9 |
| E | 1193.32 | -2.5 | -2983.3 |
| F | 1193.32 | 2.5 | 2983.3 |
| G | 1193.32 | 7.5 | 8949.9 |
| H | 1193.32 | 12.5 | 14916.5 |
| I | 1193.32 | 17.5 | 20883.1 |
| J | 0 | 22.7 | 0 |
| ∑Dy | 9546.56 | | 0 |
| Xs= | 0 | Ys= | 0 |

| center of stiffness for Ground floor | | | |
|---|---|---|---|
| Axis | Dx | Y | Dx*Y |
| 1 | 1544.03 | -5 | -7720.15 |
| 2 | 1931.78 | 0 | 0 |
| 3 | 1612.50 | 5 | 8062.5 |
| ∑Dx | 5088.31 | | 342.35 |

| Axis | Dy | X | DY*X |
|---|---|---|---|
| A | 196.27 | -22.7 | -4455.329 |
| B | 450.6 | -17.5 | -7885.5 |
| C | 450.6 | -12.5 | -5632.5 |
| D | 450.6 | -7.5 | -3379.5 |
| E | 668.84 | -2.5 | -1672.1 |
| F | 661.1 | 2.5 | 1652.75 |
| G | 450.6 | 7.5 | 3379.5 |
| H | 450.6 | 12.5 | 5632.5 |
| I | 450.6 | 17.5 | 7885.5 |
| J | 196.27 | 22.7 | 4455.329 |
| ∑Dy | 4426.08 | | -19.35 |
| Xs= | -0.00437 | Ys= | 0.0672817 |

| center of stiffness for first floor | | | |
|---|---|---|---|
| Axis | Dx | Y | Dx*Y |
| 1 | 1459.80 | -5 | -7299 |
| 2 | 1718.69 | 0 | 0 |
| 3 | 1554.56 | 5 | 7772.8 |
| ∑Dx | 4733.05 | | 473.8 |

| Axis | Dy | X | DY*X |
|---|---|---|---|
| A | 133.17 | -22.7 | -3022.959 |
| B | 409.9 | -17.5 | -7173.25 |
| C | 409.9 | -12.5 | -5123.75 |
| D | 409.9 | -7.5 | -3074.25 |
| E | 627.72 | -2.5 | -1569.3 |
| F | 627.72 | 2.5 | 1569.3 |
| G | 409.9 | 7.5 | 3074.25 |
| H | 409.9 | 12.5 | 5123.75 |
| I | 409.9 | 17.5 | 7173.25 |
| J | 133.17 | 22.7 | 3022.959 |
| ∑Dy | 3981.18 | | 0 |
| Xs= | 0 | Ys= | 0.1001046 |

| center of stiffness for second floor | | | |
|---|---|---|---|
| Axis | Dx | Y | Dx*Y |
| 1 | 1421.52 | -5 | -7107.6 |
| 2 | 1248.72 | 0 | 0 |
| 3 | 1701.16 | 5 | 8505.8 |
| ∑Dx | 4371.4 | | 1398.2 |

| Axis | Dy | X | DY*X |
|---|---|---|---|
| A | 135.7 | -22.7 | -3080.39 |
| B | 418.83 | -17.5 | -7329.525 |
| C | 418.83 | -12.5 | -5235.375 |
| D | 418.83 | -7.5 | -3141.225 |
| E | 610.03 | -2.5 | -1525.075 |
| F | 610.03 | 2.5 | 1525.075 |
| G | 418.83 | 7.5 | 3141.225 |
| H | 418.83 | 12.5 | 5235.375 |

| | | | |
|---|---|---|---|
| I | 418.83 | 17.5 | 7329.525 |
| J | 135.7 | 22.7 | 3080.39 |
| ∑Dy | 4004.44 | | 0 |
| Xs= | 0 | Ys= | 0.3198518 |

| center of stiffness for third floor | | | |
|---|---|---|---|
| Axis | Dx | Y | Dx*Y |
| 1 | 1421.52 | -5 | -7107.6 |
| 2 | 1248.72 | 0 | 0 |
| 3 | 1701.16 | 5 | 8505.8 |
| ∑Dx | 4371.4 | | 1398.2 |

| Axis | Dy | X | DY*X |
|---|---|---|---|
| A | 135.7 | -22.7 | -3080.39 |
| B | 418.83 | -17.5 | -7329.525 |
| C | 418.83 | -12.5 | -5235.375 |
| D | 418.83 | -7.5 | -3141.225 |
| E | 610.03 | -2.5 | -1525.075 |
| F | 610.03 | 2.5 | 1525.075 |
| G | 418.83 | 7.5 | 3141.225 |
| H | 418.83 | 12.5 | 5235.375 |
| I | 418.83 | 17.5 | 7329.525 |
| J | 135.7 | 22.7 | 3080.39 |
| ∑Dy | 4004.44 | | 0 |
| Xs= | 0 | Ys= | 0.3198518 |

| center of stiffness for 4th floor | | | |
|---|---|---|---|
| Axis | Dx | Y | Dx*Y |
| 1 | 1497.58 | -5 | -7487.9 |
| 2 | 1248.72 | 0 | 0 |
| 3 | 1701.16 | 5 | 8505.8 |

| | | | |
|---|---|---|---|
| ∑Dx | 4447.46 | | 1017.9 |

| Axis | Dy | X | DY*X |
|---|---|---|---|
| A | 135.7 | -22.7 | -3080.39 |
| B | 418.83 | -17.5 | -7329.525 |
| C | 418.83 | -12.5 | -5235.375 |
| D | 418.83 | -7.5 | -3141.225 |
| E | 610.03 | -2.5 | -1525.075 |
| F | 610.03 | 2.5 | 1525.075 |
| G | 418.83 | 7.5 | 3141.225 |
| H | 418.83 | 12.5 | 5235.375 |
| I | 418.83 | 17.5 | 7329.525 |
| J | 135.7 | 22.7 | 3080.39 |
| ∑Dy | 4004.44 | | 0 |
| Xs= | 0 | Ys= | 0.2288722 |

| center of stiffness for roof floor | | | |
|---|---|---|---|
| Axis | Dx | Y | Dx*Y |
| 1 | 574.8 | -5 | -2874 |
| 2 | 736.96 | 0 | 0 |
| 3 | 1251.28 | 5 | 6256.4 |
| ∑Dx | 2563.04 | | 3382.4 |

| Axis | Dy | X | DY*X |
|---|---|---|---|
| A | 51.09 | -22.7 | -1159.743 |
| B | 160.14 | -17.5 | -2802.45 |
| C | 160.14 | -12.5 | -2001.75 |
| D | 160.14 | -7.5 | -1201.05 |
| E | 401.52 | -2.5 | -1003.8 |
| F | 507.17 | 2.5 | 1267.925 |

| | | | |
|---|---|---|---|
| G | 160.14 | 7.5 | 1201.05 |
| H | 160.14 | 12.5 | 2001.75 |
| I | 160.14 | 17.5 | 2802.45 |
| J | 51.09 | 22.7 | 1159.743 |
| ∑Dy | 1971.71 | | 264.125 |
| Xs= | 0.133957 | Ys= | 1.3196829 |

| center of stiffness for head room | | | |
|---|---|---|---|
| Axis | Dy | X | DY*X |
| E | 64.84 | -2.5 | -162.1 |
| F | 62.84 | 2.5 | 157.1 |
| ∑Dy | 127.68 | | -5 |
| Xs | -0.03916 | Ys | 2.5 |

| Axis | Dx | Y | Dx*Y |
|---|---|---|---|
| 2 | 76.88 | 0 | 0 |
| 3 | 76.88 | 5 | 384.4 |
| ∑Dx | 153.76 | | 384.4 |

### 5.2.6. Correction for center of mass

After computation of all the center of mass at each floor level, it is adjusted using the following formula.

- $Xmass = \frac{(Xm*\sum DL)_{i-1} + (Xm*\sum DL)_i}{\{(\sum DL)_{i-1} + (\sum DL)i\}}$
- $Ymass = \frac{(Ym*\sum DL)_{i-1} + (Ym*\sum DL)_i}{\{(\sum DL)_{i-1} + (\sum DL)i\}}$

Where: - i is the level of floor and it is zero at roof level.

Table 5. 10:Correction of center of mass for each floor

| **Correction for center of mass** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Floor level | Original mass center | | Wi | Wi*Xm | Wi*Ym | Modified mass center | |
| | Xm | Ym | | | | Xm | Ym |
| Head | 0 | 2.5 | 251.466 | 0 | 628.665 | 0 | 2.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Roof | 0.037137 | 0.377784358 | 3221.527 | 119.640 | 1217.04 | 0.0344487 | 0.53144579 |
| 4th | -0.01448 | -0.08158801 | 6107.704 | -88.442 | -498.315 | 0.00334406 | 0.07704032 |
| 3rd | -0.02864 | 0.206486317 | 5277.091 | -151.13 | 1089.64 | -0.0210438 | 0.05194047 |
| 2nd | -0.10223 | 0.266612244 | 5599.354 | -572.44 | 1492.85 | -0.0665274 | 0.23744002 |
| 1st | 0.003822 | 0.078026842 | 5742.643 | 21.9518 | 448.080 | -0.0485357 | 0.17112830 |
| Ground | 0.201157 | 0.094156585 | 4680.1178 | 941.44 | 440.6639 | 0.09243154 | 0.085269558 |
| Basement | 0.006475 | 0.490737918 | 3794.862 | 24.5716 | 1862.283 | 0.11398395 | 0.271734769 |
| | | sum= | 34674.767 | | | | |

### 5.2.7. Calculation of eccentricity

In addition to actual eccentricity, in order to cover uncertainties in the location of mass in the spatial variation of seismic motion additional eccentricity is considered as per ES EN 2015.

Additional eccentricity ($e_a$) = $\pm 0.05L_i$, where $L_i$ is floor dimension perpendicular to the direction of the seismic action.

Formula and key to the table

- $e_x = x_m - x_s$, where $x_s$ = stiffness center in the x-axis
- $e_y = y_m - y_s$ $y_s$ = stiffness center in the y-axis
- $e_{ax} = \pm 0.05Lx$ $x_m$ = mass center of x- axis Lx = length in the x-direction
- $e_{ay} = \pm 0.05Lx$ $y_m$ = mass center of y- axis Ly = length in the y-direction
- $e_{dx} = e_x + e_{ax}$ $e_a$ = additional eccentricity
- $e_{dy} = e_y + e_{ay}$ $e_d$ = design eccentricity
- $e_{dx1} = e_x + e_{ax}$, $e_{dx2} = e_x - e_{ax}$, Lx = 54.74m
- $e_{dy1} = e_y + e_{ay}$, $e_{dy2} = e_y - e_{ay}$, Ly = 20.58m

Table 5. 11: Eccentricity for each floor

| Floor | Stiffness | | Center of Mass | | Eccentricity | |
|---|---|---|---|---|---|---|
| | Xs | Ys | Xm | Ym | ex | ey |
| Basement | 0 | 0 | 0.01 | 0.49 | 0.01 | 0.49 |
| Ground | -0.004372 | 0.067281671 | 0.20 | 0.09 | 0.21 | 0.03 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st | 0 | 0.100104584 | 0.00 | 0.08 | 0.00 | -0.02 |
| 2nd | 0 | 0.319851764 | -0.10 | 0.27 | -0.10 | -0.05 |
| 3rd | 0 | 0.319851764 | -0.03 | 0.21 | -0.03 | -0.11 |
| 4th | 0 | 0.22887221 | -0.01 | -0.08 | -0.01 | -0.31 |
| Roof | 0.1339573 | 1.319682877 | 0.04 | 0.38 | -0.10 | -0.94 |
| Head | -0.03916 | 2.5 | 0 | 2.5 | 0.03916 | 0 |

| Floor | Additional eccentricity | | Lx= | 45.4 | Ly= | 13.2 |
|---|---|---|---|---|---|---|
| | | | Design eccentricity | | | |
| | eax | eay | edx1 | edx2 | edy1 | edy2 |
| Basement | 2.27 | 0.66 | 2.28 | -2.26 | 1.15 | -0.17 |
| Ground | 2.27 | 0.66 | 2.48 | -2.06 | 0.69 | -0.63 |
| 1st | 2.27 | 0.66 | 2.27 | -2.27 | 0.64 | -0.68 |
| 2nd | 2.27 | 0.66 | 2.17 | -2.37 | 0.61 | -0.71 |
| 3rd | 2.27 | 0.66 | 2.24 | -2.30 | 0.55 | -0.77 |
| 4th | 2.27 | 0.66 | 2.26 | -2.28 | 0.35 | -0.97 |
| Roof | 2.27 | 0.66 | 2.17 | -2.37 | -0.28 | -1.60 |
| Head | 2.27 | 0.66 | 2.31 | -2.23 | 0.66 | -0.66 |

Table 5. 12: Shear correction factor for torsion for each floor

**Shear Correction Factor for Torsion**

| Basement floor | | | |
|---|---|---|---|
| X Direction | | | |
| Axis | Yi | Dix | Dix*Yi2 |
| 1 | -5 | 3449.72 | 86243 |
| 2 | 0 | 3449.72 | 0 |
| 3 | 5 | 3449.72 | 86243 |
| | | ∑Dix*Yi2 | 172486 |

| Y Direction | | | |
|---|---|---|---|
| Axis | Xi | Diy | Diy*Xi2 |
| A | -22.7 | 0 | 0.00 |
| B | -17.5 | 1193.32 | 365454.25 |
| C | -12.5 | 1193.32 | 186456.25 |
| D | -7.5 | 1193.32 | 67124.25 |

| | | | |
|---|---|---|---|
| E | -2.5 | 1193.32 | 7458.25 |
| F | 2.5 | 1193.32 | 7458.25 |
| G | 7.5 | 1193.32 | 67124.25 |
| H | 12.5 | 1193.32 | 186456.25 |
| I | 17.5 | 1193.32 | 365454.25 |
| J | 0 | 0 | 0.00 |
| | | ∑Diy*Xi2 | 1252986.00 |

| | |
|---|---|
| Jr | 14254 72.00 |

| Ground floor | | | |
|---|---|---|---|
| X Direction | | | |
| Axis | Yi | Dix | Dix*Yi2 |
| 1 | -5.067282 | 1544.03 | 39646.5 887 |
| 2 | -0.067282 | 1931.78 | 8.74482 666 |
| 3 | 4.9327183 | 1612.50 | 39234.8 826 |
| | | ∑Dix*Yi 2 | 78890.2 161 |

| Y Direction | | | |
|---|---|---|---|
| Axis | Xi | Diy | Diy*Xi2 |
| A | -22.6956282 | 196.27 | 101097.02 |
| B | -17.4956282 | 450.6 | 137927.31 |
| C | -12.4956282 | 450.6 | 70357.01 |
| D | -7.49562819 | 450.6 | 25316.71 |
| E | -2.5 | 668.84 | 4180.25 |
| F | 2.504371814 | 661.1 | 4146.34 |
| G | 7.504371814 | 450.6 | 25375.81 |
| H | 12.50437181 | 450.6 | 70455.51 |
| I | 17.50437181 | 450.6 | 138065.21 |
| J | 22.70437181 | 196.27 | 101174.93 |
| | | ∑Diy*Xi 2 | 678096.08 |

| | |
|---|---|
| Jr | 756986. 30 |

| First floor | | | |
|---|---|---|---|
| X Direction | | | |
| Axis | Yi | Dix | Dix*Yi2 |
| 1 | -5.100105 | 1459.80 | 37970.9553 |
| 2 | -0.100105 | 1718.69 | 17.2228682 |
| 3 | 4.8998954 | 1554.56 | 37323.3923 |
| | | ∑Dix*Yi2 | 75311.5704 |

| | |
|---|---|
| Jr | 64567 1.66 |

| Y Direction | | | |
|---|---|---|---|
| Axis | Xi | Diy | Diy*Xi2 |
| A | -22.7 | 133.17 | 68621.17 |
| B | -17.5 | 409.9 | 125531.88 |
| C | -12.5 | 409.9 | 64046.88 |
| D | -7.5 | 409.9 | 23056.88 |
| E | -2.5 | 627.72 | 3923.25 |
| F | 2.5 | 627.72 | 3923.25 |
| G | 7.5 | 409.9 | 23056.88 |
| H | 12.5 | 409.9 | 64046.88 |
| I | 17.5 | 409.9 | 125531.88 |
| J | 22.7 | 133.17 | 68621.17 |
| | | ∑Diy*Xi2 | 570360.09 |

| Second floor | | | |
|---|---|---|---|
| X Direction | | | |
| Axis | Yi | Dix | Dix*Yi2 |
| 1 | -5.319852 | 1421.52 | 40230.1856 |
| 2 | -0.319852 | 1248.72 | 127.750488 |

| Y Direction | | | |
|---|---|---|---|
| Axis | Xi | Diy | Diy*Xi2 |
| A | -22.7 | 135.7 | 69924.85 |
| B | -17.5 | 418.83 | 128266.69 |

| | | | |
|---|---|---|---|
| 3 | 4.6801482 | 1701.16 | 37261.8472 |
| | | ∑Dix*Yi2 | 77619.7833 |

| | |
|---|---|
| Jr | 659630.99 |

| | | | |
|---|---|---|---|
| C | -12.5 | 418.83 | 65442.19 |
| D | -7.5 | 418.83 | 23559.19 |
| E | -2.5 | 610.03 | 3812.69 |
| F | 2.5 | 610.03 | 3812.69 |
| G | 7.5 | 418.83 | 23559.19 |
| H | 12.5 | 418.83 | 65442.19 |
| I | 17.5 | 418.83 | 128266.69 |
| J | 22.7 | 135.7 | 69924.85 |
| | | ∑Diy*Xi2 | 582011.21 |

| Third floor | | | |
|---|---|---|---|
| X Direction | | | |
| Axis | Yi | Dix | Dix*Yi2 |
| 1 | -5.319852 | 1421.52 | 40230.1856 |
| 2 | -0.319852 | 1248.72 | 127.750488 |
| 3 | 4.6801482 | 1701.16 | 37261.8472 |
| | | ∑Dix*Yi2 | 77619.7833 |

| | |
|---|---|
| Jr | 65963 0.99 |

| Y Direction | | | |
|---|---|---|---|
| Axis | Xi | Diy | Diy*Xi2 |
| A | -22.7 | 135.7 | 69924.85 |
| B | -17.5 | 418.83 | 128266.69 |
| C | -12.5 | 418.83 | 65442.19 |
| D | -7.5 | 418.83 | 23559.19 |
| E | -2.5 | 610.03 | 3812.69 |
| F | 2.5 | 610.03 | 3812.69 |
| G | 7.5 | 418.83 | 23559.19 |
| H | 12.5 | 418.83 | 65442.19 |

| | | | |
|---|---|---|---|
| I | 17.5 | 418.83 | 128266.69 |
| J | 22.7 | 135.7 | 69924.85 |
| | | ∑Diy*Xi2 | 582011.21 |

| Fourth floor | | | |
|---|---|---|---|
| X Direction | | | |
| Axis | Yi | Dix | Dix*Yi2 |
| 1 | -5.228872 | 1497.58 | 40945.4914 |
| 2 | -0.228872 | 1248.72 | 65.4110612 |
| 3 | 4.7711278 | 1701.16 | 38724.6285 |
| | | ∑Dix*Yi2 | 79735.531 |

| | |
|---|---|
| Jr | 66174.74 |

| Y Direction | | | |
|---|---|---|---|
| Axis | Xi | Diy | Diy*Xi2 |
| A | -22.7 | 135.7 | 69924.85 |
| B | -17.5 | 418.83 | 128266.69 |
| C | -12.5 | 418.83 | 65442.19 |
| D | -7.5 | 418.83 | 23559.19 |
| E | -2.5 | 610.03 | 3812.69 |
| F | 2.5 | 610.03 | 3812.69 |
| G | 7.5 | 418.83 | 23559.19 |
| H | 12.5 | 418.83 | 65442.19 |
| I | 17.5 | 418.83 | 128266.69 |
| J | 22.7 | 135.7 | 69924.85 |
| | | ∑Diy*Xi2 | 582011.21 |

| Roof floor | | | |
|---|---|---|---|
| X Direction | | | |
| Axis | Yi | Dix | Dix*Yi2 |
| 1 | - | 574.8 | 22956. |

| Y Direction | | | |
|---|---|---|---|
| Axis | Xi | Diy | Diy*Xi2 |
| A | - | 51.09 | 26637.80 |

| | | | |
|---|---|---|---|
| | 6.319683 | | 5875 |
| 2 | -1.319683 | 736.96 | 1283.46219 |
| 3 | 3.6803171 | 1251.28 | 16948.2549 |
| | | ∑Dix*Yi2 | 41188.3046 |

| | |
|---|---|
| Jr | 26562.82 |

| | | | |
|---|---|---|---|
| | 22.8339573 | | |
| B | -17.6339573 | 160.14 | 49796.57 |
| C | -12.6339573 | 160.14 | 25561.05 |
| D | -7.63395733 | 160.14 | 9332.53 |
| E | -2.63395733 | 401.52 | 2785.64 |
| F | 2.366042674 | 507.17 | 2839.22 |
| G | 7.366042674 | 160.14 | 8688.97 |
| H | 12.366042667 | 160.14 | 24488.45 |
| I | 17.366042667 | 160.14 | 48294.93 |
| J | 22.566042667 | 51.09 | 26016.37 |
| | | ∑Diy*Xi2 | 224441.51 |

| Head Room | | | |
|---|---|---|---|
| X Direction | | | |
| Axis | Yi | Dix | Dix*Yi2 |
| 2 | -2.5 | 76.88 | 480.5 |
| 3 | 2.5 | 76.88 | 480.5 |

| Y Direction | | | |
|---|---|---|---|
| Axis | Xi | Diy | Diy*Xi2 |
| E | -2.4608396 | 64.84 | 392.65 |
| F | 2.53916 | 62.84 | 405.15 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | 0401 | | |
| | | ∑Dix*Yi 2 | 961 | | | ∑Diy*Xi 2 | 797.80 |

| | |
|---|---|
| Jr | 1758.80 |

### 5.2.8. Computation of Forces

- α1y1=1+ (Diy*Xi)*edx1/Jr
- α1y2=1+ (Diy*Xi)*edx2/Jr
- α1x1=1+ (Dix*Yi)*edy1/Jr
- α1X2=1+ (Dix*Yi)*edy2/Jr

Table 5. 13: Computation of force for each floor plan

**Basement Floor about Y Direction**

| | |
|---|---|
| Jr | 1425472.00 |
| edx1 | 2.28 |
| edx2 | -2.26 |
| Diy | 9546.56 |

| Axis | Xi | α1y1 | α1y2 | α1y | Q | Fi=αiyi*Qi |
|---|---|---|---|---|---|---|
| A | -22.7 | 0.654 | 1.344 | 1.344 | 0.000 | 0.000 |
| B | -17.5 | 0.733 | 1.265 | 1.265 | 8.293 | 10.492 |
| C | -12.5 | 0.809 | 1.189 | 1.189 | 8.293 | 9.864 |
| D | -7.5 | 0.886 | 1.114 | 1.114 | 8.293 | 9.235 |
| E | -2.5 | 0.962 | 1.038 | 1.038 | 8.293 | 8.607 |
| F | 2.5 | 1.038 | 0.962 | 1.038 | 8.293 | 8.609 |
| G | 7.5 | 1.114 | 0.886 | 1.114 | 8.293 | 9.241 |
| H | 12.5 | 1.191 | 0.811 | 1.191 | 8.293 | 9.873 |
| I | 17.5 | 1.267 | 0.735 | 1.267 | 8.293 | 10.505 |
| J | 0 | 1.000 | 1.000 | 1.000 | 0.000 | 0.000 |

**Basement Floor about X Direction**

| | |
|---|---|
| Jr | 1425472.00 |

| | |
|---|---|
| edy1 | 1.15 |
| edy2 | -0.17 |
| Dix | 10349.16 |

| Axis | Yi | α1x1 | α1x2 | α1x | Q | Fi=αixi*Qi |
|---|---|---|---|---|---|---|
| 1 | -5 | 0.958 | 0.006 | 0.958 | 22.113 | 21.190 |
| 2 | 0 | 1.000 | 0.000 | 1.000 | 22.113 | 22.113 |
| 3 | 5 | 1.042 | -0.006 | 1.042 | 22.113 | 23.037 |

**Ground Floor Y Direction**

| | |
|---|---|
| Jr | 756986.30 |
| edx1 | 2.48 |
| edx2 | -2.06 |
| Diy | 4426.08 |

| Axis | Xi | α1y1 | α1y2 | α1y | Q | Fi=αiyi*Qi |
|---|---|---|---|---|---|---|
| A | -22.6956 | 0.671 | 1.274 | 1.274 | 6.893 | 8.782 |
| B | -17.4956 | 0.747 | 1.211 | 1.211 | 15.826 | 19.168 |
| C | -12.4956 | 0.819 | 1.151 | 1.151 | 15.826 | 18.213 |
| D | -7.49563 | 0.892 | 1.090 | 1.090 | 15.826 | 17.258 |
| E | -2.5 | 0.964 | 1.030 | 1.030 | 23.491 | 24.200 |
| F | 2.504372 | 1.036 | 0.970 | 1.036 | 23.219 | 24.060 |
| G | 7.504372 | 1.109 | 0.909 | 1.109 | 15.826 | 17.545 |
| H | 12.50437 | 1.181 | 0.849 | 1.181 | 15.826 | 18.690 |
| I | 17.50437 | 1.253 | 0.789 | 1.253 | 15.826 | 19.835 |
| J | 22.70437 | 1.329 | 0.726 | 1.329 | 6.893 | 9.159 |

**Ground Floor X Direction**

| | |
|---|---|
| Jr | 756986.30 |
| edy1 | 0.69 |
| edy2 | -0.63 |

| | | Dix | 5088.31 | | | |
|---|---|---|---|---|---|---|
| Axis | Yi | α1x1 | α1x2 | α1x | Q | Fi=αixi*Qi |
| 1 | -5.06728 | 0.977 | 0.022 | 0.977 | 47.171 | 46.067 |
| 2 | -0.06728 | 1.000 | 0.000 | 1.000 | 59.017 | 58.998 |
| 3 | 4.932718 | 1.023 | -0.021 | 1.023 | 49.263 | 50.385 |

**First Floor Y Direction**

| | |
|---|---|
| Jr | 645671.66 |
| edx1 | 2.27 |
| edx2 | -2.27 |
| Diy | 3981.18 |

| Axis | Xi | α1y1 | α1y2 | α1y | Q | Fi=αiyi*Qi |
|---|---|---|---|---|---|---|
| A | -22.7 | 0.682 | 1.317 | 1.317 | 9.403 | 12.385 |
| B | -17.5 | 0.755 | 1.245 | 1.245 | 28.941 | 36.018 |
| C | -12.5 | 0.825 | 1.175 | 1.175 | 28.941 | 33.996 |
| D | -7.5 | 0.895 | 1.105 | 1.105 | 28.941 | 31.974 |
| E | -2.5 | 0.965 | 1.035 | 1.035 | 44.321 | 45.869 |
| F | 2.5 | 1.035 | 0.965 | 1.035 | 44.321 | 45.874 |
| G | 7.5 | 1.105 | 0.895 | 1.105 | 28.941 | 31.984 |
| H | 12.5 | 1.175 | 0.825 | 1.175 | 28.941 | 34.013 |
| I | 17.5 | 1.245 | 0.755 | 1.245 | 28.941 | 36.042 |
| J | 22.7 | 1.318 | 0.683 | 1.318 | 9.403 | 12.395 |

**First Floor X Direction**

| | |
|---|---|
| Jr | 645671.66 |
| edy1 | 0.64 |
| edy2 | -0.68 |
| Dix | 4733.05 |

| Axis | Yi | α1x1 | α1x2 | α1x | Q | Fi=αixi*Qi |
|---|---|---|---|---|---|---|
| 1 | -5.1001 | 0.976 | 0.026 | 0.976 | 86.697 | 84.629 |
| 2 | -0.1001 | 1.000 | 0.001 | 1.000 | 102.072 | 102.024 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 4.899895 | 1.023 | -0.024 | 1.023 | 92.325 | 94.440 |

**Second Floor Y Direction**

| | |
|---|---|
| Jr | 659630.99 |
| edx1 | 2.17 |
| edx2 | -2.37 |
| Diy | 4004.44 |

| Axis | Xi | α1y1 | α1y2 | α1y | Q | Fi=αiyi*Qi |
|---|---|---|---|---|---|---|
| A | -22.7 | 0.701 | 1.327 | 1.327 | 12.131 | 16.097 |
| B | -17.5 | 0.770 | 1.252 | 1.252 | 37.442 | 46.878 |
| C | -12.5 | 0.836 | 1.180 | 1.180 | 37.442 | 44.182 |
| D | -7.5 | 0.901 | 1.108 | 1.108 | 37.442 | 41.486 |
| E | -2.5 | 0.967 | 1.036 | 1.036 | 54.534 | 56.498 |
| F | 2.5 | 1.033 | 0.964 | 1.033 | 54.534 | 56.329 |
| G | 7.5 | 1.099 | 0.892 | 1.099 | 37.442 | 41.137 |
| H | 12.5 | 1.164 | 0.820 | 1.164 | 37.442 | 43.601 |
| I | 17.5 | 1.230 | 0.748 | 1.230 | 37.442 | 46.065 |
| J | 22.7 | 1.299 | 0.673 | 1.299 | 12.131 | 15.755 |

**Second Floor X Direction**

| | |
|---|---|
| Jr | 659630.99 |
| edy1 | 0.61 |
| edy2 | -0.71 |
| Dix | 4371.40 |

| Axis | Yi | α1x1 | α1x2 | α1x | Q | Fi=αixi*Qi |
|---|---|---|---|---|---|---|
| 1 | -5.31985 | 0.979 | 0.025 | 0.979 | 116.411 | 113.921 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | -0.31985 | 0.999 | 0.002 | 0.999 | 102.260 | 102.128 |
| 3 | 4.680148 | 1.019 | -0.022 | 1.019 | 139.311 | 141.933 |

**Third Floor Y Direction**

| | |
|---|---|
| Jr | 659630.99 |
| edx1 | 2.24 |
| edx2 | 0.30 |
| Diy | 4004.44 |

| Axis | Xi | α1y1 | α1y2 | α1y | Q | Fi=αiyi*Qi |
|---|---|---|---|---|---|---|
| A | -22.7 | 0.691 | 0.959 | 0.959 | 14.112 | 13.529 |
| B | -17.5 | 0.762 | 0.968 | 0.968 | 43.557 | 42.169 |
| C | -12.5 | 0.830 | 0.977 | 0.977 | 43.557 | 42.566 |
| D | -7.5 | 0.898 | 0.986 | 0.986 | 43.557 | 42.962 |
| E | -2.5 | 0.966 | 0.995 | 0.995 | 63.442 | 63.153 |
| F | 2.5 | 1.034 | 1.005 | 1.034 | 63.442 | 65.600 |
| G | 7.5 | 1.102 | 1.014 | 1.102 | 43.557 | 48.002 |
| H | 12.5 | 1.170 | 1.023 | 1.170 | 43.557 | 50.966 |
| I | 17.5 | 1.238 | 1.032 | 1.238 | 43.557 | 53.929 |
| J | 22.7 | 1.309 | 1.041 | 1.309 | 14.112 | 18.471 |

**Third Floor X Direction**

| | |
|---|---|
| Jr | 659630.99 |
| edy1 | 0.55 |
| edy2 | -0.77 |
| Dix | 4371.40 |

| Axis | Yi | α1x1 | α1x2 | α1x | Q | Fi=αixi*Qi |
|---|---|---|---|---|---|---|
| 1 | -5.31985 | 0.981 | 0.027 | 0.981 | 347.995 | 341.288 |
| 2 | -0.31985 | 0.999 | 0.002 | 0.999 | 305.693 | 305.338 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 4.680148 | 1.017 | -0.024 | 1.017 | 416.452 | 423.513 |

**Forth Floor Y Direction**

| | |
|---|---|
| Jr | 661746.74 |
| edx1 | 2.26 |
| edx2 | -2.28 |
| Diy | 4004.44 |

| Axis | Xi | α1y1 | α1y2 | α1y | Q | Fi=αiyi*Qi |
|---|---|---|---|---|---|---|
| A | -22.7 | 0.690 | 1.314 | 1.314 | 19.435 | 25.534 |
| B | -17.5 | 0.761 | 1.242 | 1.242 | 59.985 | 74.497 |
| C | -12.5 | 0.829 | 1.173 | 1.173 | 59.985 | 70.351 |
| D | -7.5 | 0.898 | 1.104 | 1.104 | 59.985 | 66.205 |
| E | -2.5 | 0.966 | 1.035 | 1.035 | 87.369 | 90.389 |
| F | 2.5 | 1.034 | 0.986 | 1.034 | 87.369 | 90.350 |
| G | 7.5 | 1.102 | 0.896 | 1.102 | 59.985 | 66.126 |
| H | 12.5 | 1.171 | 0.827 | 1.171 | 59.985 | 70.219 |
| I | 17.5 | 1.239 | 0.758 | 1.239 | 59.985 | 74.313 |
| J | 22.7 | 1.310 | 0.686 | 1.310 | 19.435 | 25.457 |

**Fourth Floor X Direction**

| | |
|---|---|
| Jr | 661746.74 |
| edy1 | 0.35 |
| edy2 | -0.97 |
| Dix | 4447.46 |

| Axis | Yi | α1x1 | α1x2 | α1x | Q | Fi=αixi*Qi |
|---|---|---|---|---|---|---|
| 1 | -5.22887 | 0.988 | 0.034 | 0.988 | 193.120 | 190.748 |
| 2 | -0.22887 | 0.999 | 0.001 | 0.999 | 161.028 | 160.942 |
| 3 | 4.771128 | 1.011 | -0.031 | 1.011 | 219.373 | 221.831 |

**Roof Floor Y Direction**

| | |
|---|---|
| Jr | 265629.82 |

| | |
|---|---|
| edx1 | 2.17 |
| edx2 | -2.37 |
| Diy | 1971.71 |

| Axis | Xi | α1y1 | α1y2 | α1y | Q | Fi=αiyi*Qi |
|---|---|---|---|---|---|---|
| A | -22.834 | 0.632 | 1.401 | 1.401 | 8.975 | 12.575 |
| B | -17.634 | 0.716 | 1.310 | 1.310 | 28.130 | 36.845 |
| C | -12.634 | 0.796 | 1.222 | 1.222 | 28.130 | 34.374 |
| D | -7.63396 | 0.877 | 1.134 | 1.134 | 28.130 | 31.903 |
| E | -2.63396 | 0.958 | 1.046 | 1.046 | 70.531 | 73.795 |
| F | 2.366043 | 1.038 | 0.958 | 1.038 | 89.090 | 92.490 |
| G | 7.366043 | 1.119 | 0.871 | 1.119 | 28.130 | 31.473 |
| H | 12.36604 | 1.199 | 0.783 | 1.199 | 28.130 | 33.742 |
| I | 17.36604 | 1.280 | 0.695 | 1.280 | 28.130 | 36.011 |
| J | 22.56604 | 1.364 | 0.604 | 1.364 | 8.975 | 12.241 |

**Roof Floor X Direction**

| | |
|---|---|
| Jr | 265629.82 |
| edy1 | -0.28 |
| edy2 | -1.60 |
| Dix | 2563.04 |

| Axis | Yi | α1x1 | α1x2 | α1x | Q | Fi=αixi*Qi |
|---|---|---|---|---|---|---|
| 1 | -6.31968 | 1.017 | 0.098 | 1.017 | 77.675 | 79.010 |
| 2 | -1.31968 | 1.004 | 0.020 | 1.004 | 99.588 | 99.945 |
| 3 | 3.680317 | 0.990 | -0.057 | 0.990 | 169.090 | 167.397 |

**Head Room Y Direction**

| | |
|---|---|
| Jr | 1758.80 |
| edx1 | 2.31 |
| edx2 | -2.23 |
| Diy | 127.68 |

| Axis | Xi | α1y1 | α1y2 | α1y | Q | Fi=αiyi*Qi |
|---|---|---|---|---|---|---|
| E | -2.4608396 | 0.587 | 1.399 | 1.399 | 14.511 | 20.294 |
| F | 2.5391604 | 1.426 | 0.589 | 1.426 | 14.063 | 20.049 |

**Head Room X Direction**

| | |
|---|---|
| Jr | 1758.80 |
| edy1 | 0.66 |
| edy2 | -0.66 |
| Dix | 153.76 |

| Axis | Yi | α1x1 | α1x2 | α1x | Q | Fi=αixi*Qi |
|---|---|---|---|---|---|---|
| Y2 | -2.5 | 0.856 | 0.144 | 0.856 | 14.287 | 12.226 |
| Y3 | 2.5 | 1.144 | -0.144 | 1.144 | 14.287 | 16.348 |

### 5.2.9. Summary of shear (Fi)

Table 5. 14:Summary for shear for each floor(Fi)

| shear (Fi) in x-direction | | |
|---|---|---|
| Floor | Axis | Fi (X-di) |
| Basement | 1 | 21.18969 |
| | 2 | 22.11343 |
| | 3 | 23.03717 |
| Ground | 1 | 46.06727 |
| | 2 | 58.99849 |
| | 3 | 50.3846 |
| First | 1 | 84.62921 |
| | 2 | 102.0245 |
| | 3 | 94.44007 |
| Second | 1 | 113.9207 |
| | 2 | 102.1285 |
| | 3 | 141.9328 |
| Third | 1 | 341.2885 |

| Shear (Fi) in y-direction | | |
|---|---|---|
| Floor | Axis | Fi (Y-di) |
| Basement | A | 0 |
| | B | 10.49242 |
| | C | 9.863879 |
| | D | 9.235342 |
| | E | 8.606805 |
| | F | 8.608603 |
| | G | 9.240736 |
| | H | 9.872869 |
| | I | 10.505 |
| | J | 0 |
| Ground | A | 8.781751 |
| | B | 19.16793 |
| | C | 18.21278 |

| | | |
|---|---|---|
| Floor | Axis | Fi (Y-di) |
| Third | A | 13.52904 |
| | B | 42.16908 |
| | C | 42.56571 |
| | D | 42.96235 |
| | E | 63.15279 |
| | F | 65.59972 |
| | G | 48.00233 |
| | H | 50.96569 |
| | I | 53.92904 |
| | J | 18.47141 |
| Fourth | A | 25.534 |
| | B | 74.49712 |
| | C | 70.35089 |

| | | |
|---|---|---|
| | 2 | 305.3384 |
| | 3 | 423.5127 |
| Fourth | 1 | 190.7477 |
| | 2 | 160.9417 |
| | 3 | 221.8313 |
| Roof | 1 | 79.0099 |
| | 2 | 99.94542 |
| | 3 | 167.3971 |
| Head | 2 | 12.22621 |
| | 3 | 16.34798 |

| | | |
|---|---|---|
| | D | 17.25762 |
| | E | 24.19951 |
| | F | 24.06045 |
| | G | 17.54473 |
| | H | 18.69007 |
| | I | 19.8354 |
| | J | 9.158636 |
| First | A | 12.38495 |
| | B | 36.01825 |
| | C | 33.99625 |
| | D | 31.97425 |
| | E | 45.86881 |
| | F | 45.87404 |
| | G | 31.98448 |
| | H | 34.0133 |
| | I | 36.04213 |
| | J | 12.39501 |
| Second | A | 16.09681 |
| | B | 46.87797 |
| | C | 44.18193 |
| | D | 41.4859 |
| | E | 56.49781 |
| | F | 56.32858 |
| | A | 41.13733 |

| | | |
|---|---|---|
| | D | 66.20467 |
| | E | 90.38874 |
| | F | 90.35046 |
| | G | 66.12583 |
| | H | 70.21949 |
| | I | 74.31315 |
| | J | 25.45669 |
| Roof | A | 12.57469 |
| | B | 36.84512 |
| | C | 34.3741 |
| | D | 31.90307 |
| | E | 73.79517 |
| | F | 92.49022 |
| | G | 31.47284 |
| | H | 33.7417 |
| | I | 36.01055 |
| | J | 12.24136 |
| Head | E | 20.29386 |
| | F | 20.0493 |

| | | | |
|---|---|---|---|
| X7 | 43.60099 | | |
| X8 | 46.06465 | | |
| X9 | 15.75499 | | |

# CHAPTER-SIX
# STRUCTURAL FRAME ANALAYSIS

## 6.1. Modeling for 3d frame analysis using etabs v.2016

Our frame was analyzed using ETABS 2016 v2.0. The procedure for modelling the frame will be as follows:

### 6.1.1. Material specification to input Etabs

**Step 1**: Plot Grid Coordinates - Plot Grid Coordinates that represent the given structural design.

**Step 2**: Define Material - We define two types of material those are C-25, C-30 Concrete and S-500 Rebar with their material Properties.

Therefore, we used ETABS software V.2016.

C-25: -Material type: concrete:

Symmetry type: Isotropic

Modulus of Elasticity: 29E3 Mpa

Poisson's ratio: 0.2

Modulus (G): 12916.67MPa

Coeff. Thermal Expansion: 9.9E-06

Unit Weight:25 KN/$m^3$

S-500: - Material type: Rebar:

Unit Weight: 78.49 KN/$m^3$.

Modulus of Elasticity: 210E+09

Poisson's ratio: 0.3

Shear Modulus (G):76903069

Coeff. Thermal Expansion: 1.17E-05

Minimum Yield Stress, Fy: 435 Mpa

Minimum Tensile Stress, Fu: 500.000 Mpa

Directional Symmetry type: uniaxial

**Step 3**: Then, we have used the default load combinations in the ETABS itself.

- Beam

  Cross section: 400x250 cm for intermediate beam

- Column Cross section: 400x400 cm

Those materials are defined in which their composition is C-25 and S-500 defined previously..

**Step 4**: Draw the different Structural Members

Using the grid System Draw the structural Members with their Defined Frame Section Properties.

It includes assignment of Restraints (fixed Joint)

**Step 5**: Assign Loads

**Define Load and Frame Section**

Define the following loads in the load pattern.

- Dead load
- Live load
- Wind load (X+)
- Wind load (X-)
- Wind load (Y+)
- Wind load (Y-)
- Seismic (X+)
- Seismic (X-)
- Seismic (Y+)
- Seismic (Y-)

First, Introduce Live Load on Definition of load Pattern then: -

We use Load Combination: Serviceability = D. L+L.L

| load combination | | | | | |
|---|---|---|---|---|---|
| comb 1 | 1.35DL | 1.5LL | linear add | | linear add |
| comb 2 | DL | LL | | | linear add |
| comb 3 | DL | 0.6LL | EQXL | 0.3EQYL | linear add |
| comb 4 | DL | 0.6LL | EQXR | 0.3EQYL | linear add |
| comb 5 | DL | 0.6LL | -EQXL | 0.3EQYL | linear add |
| comb 6 | DL | 0.6LL | -EQXR | 0.3EQYL | linear add |
| comb 7 | DL | 0.6LL | EQXL | 0.3EQYR | linear add |
| comb 8 | DL | 0.6LL | EQXR | 0.3EQYR | linear add |
| comb 9 | DL | 0.6LL | -EQXL | 0.3EQYR | linear |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | add |
| | | | | | linear |
| comb 10 | DL | 0.6LL | -EQXR | 0.3EQYR | add |
| | | | | - | linear |
| comb 11 | DL | 0.6LL | EQXL | 0.3EQYL | add |
| | | | | - | linear |
| comb 12 | DL | 0.6LL | EQXR | 0.3EQYL | add |
| | | | | - | linear |
| comb 13 | DL | 0.6LL | -EQXL | 0.3EQYL | add |
| | | | | - | linear |
| comb 14 | DL | 0.6LL | -EQXR | 0.3EQYL | add |
| | | | | - | linear |
| comb 15 | DL | 0.6LL | EQXL | 0.3EQYR | add |
| | | | | - | linear |
| comb 16 | DL | 0.6LL | EQXR | 0.3EQYR | add |
| | | | | - | linear |
| comb 17 | DL | 0.6LL | -EQXL | 0.3EQYR | add |
| | | | | - | linear |
| comb 18 | DL | 0.6LL | -EQXR | 0.3EQYR | add |
| | | | | | linear |
| comb 19 | DL | 0.6LL | EQYL | 0.3EQXL | add |
| | | | | | linear |
| comb 20 | DL | 0.6LL | EQYR | 0.3EQXL | add |
| | | | | | linear |
| comb 21 | DL | 0.6LL | -EQYL | 0.3EQXL | add |
| | | | | | linear |
| comb 22 | DL | 0.6LL | -EQYR | 0.3EQXL | add |
| | | | | | linear |
| comb 23 | DL | 0.6LL | EQYL | 0.3EQXR | add |
| | | | | | linear |
| comb 24 | DL | 0.6LL | EQYR | 0.3EQXR | add |
| | | | | | linear |
| comb 25 | DL | 0.6LL | -EQYL | 0.3EQXR | add |
| | | | | | linear |
| comb 26 | DL | 0.6LL | -EQYR | 0.3EQXR | add |
| | | | | - | linear |
| comb 27 | DL | 0.6LL | EQYL | 0.3EQXL | add |
| | | | | - | linear |
| comb 28 | DL | 0.6LL | EQYR | 0.3EQXL | add |
| | | | | - | linear |
| comb 29 | DL | 0.6LL | -EQYL | 0.3EQXL | add |
| | | | | - | linear |
| comb 30 | DL | 0.6LL | -EQYR | 0.3EQXL | add |
| | | | | - | linear |
| comb 31 | DL | 0.6LL | EQYL | 0.3EQXR | add |
| | | | | - | linear |
| comb 32 | DL | 0.6LL | EQYR | 0.3EQXR | add |

| | | | | | |
|---|---|---|---|---|---|
| | | | | - | linear |
| comb 33 | DL | 0.6LL | -EQYL | 0.3EQXR | add |
| | | | | - | linear |
| comb 34 | DL | 0.6LL | -EQYR | 0.3EQXR | add |
| | | | | | linear |
| comb 35 | 1.35DL | 1.5LL | 0.9WL | | add |
| | | | | | linear |
| comb 36 | 1.35DL | 1.5LL | -0.9WL | | add |
| | | | | | linear |
| comb 37 | 1.35DL | 1.5WL | | | add |
| comb 38 | comb 3-18 | | | | envelope |
| comb 39 | comb 19-34 | | | | envelope |
| comb 40 | comb 1-39 | | | | envelope |

Where: -

DL and LL is dead load and live load of the building.

EQX is earth quick along X- axis

EQY is earth quick along Y- axis

Next we assigned Fi (Story shear) as a joint load on each frame Joint. Note that We analyzed the 3D frame separately for each earthquake coming from X and Y Direction. Finally, we imposed the un-factored distributed load transferred from slab and wall on the

beam members.

**Step 6**: Analysis

After checking for errors we run the analysis.

Finally, as shown below we determined the moments for major and minor Axis and shear Force

## 6.2. ETABS Software Output

### 6.2.1. Axil force output

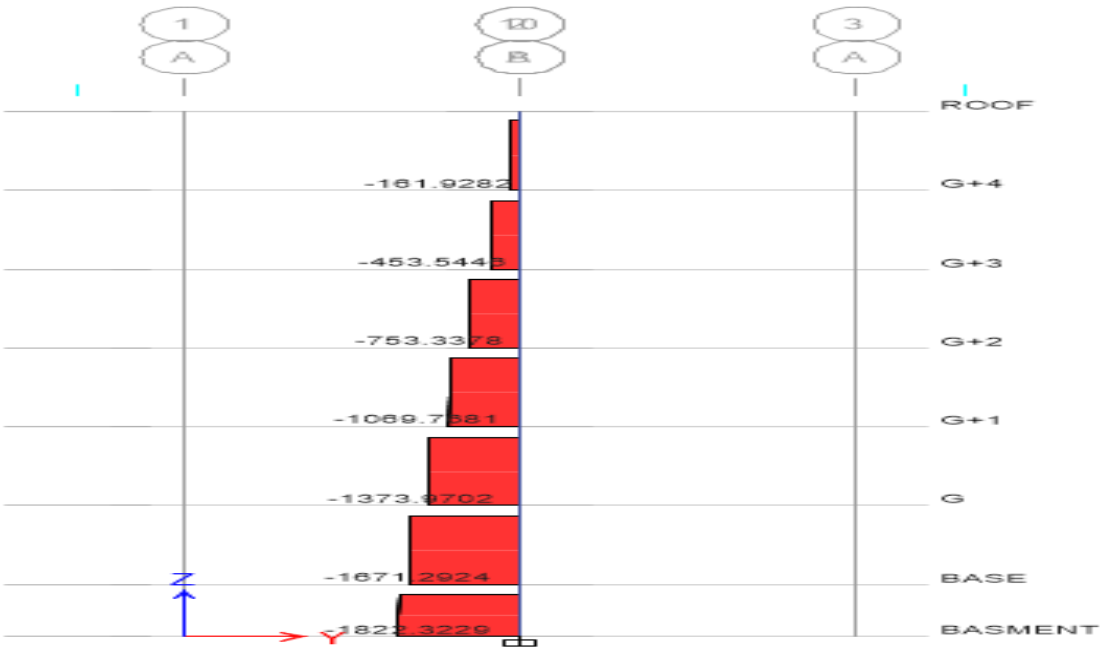



Figure 6. 1: Axil force for Axis A

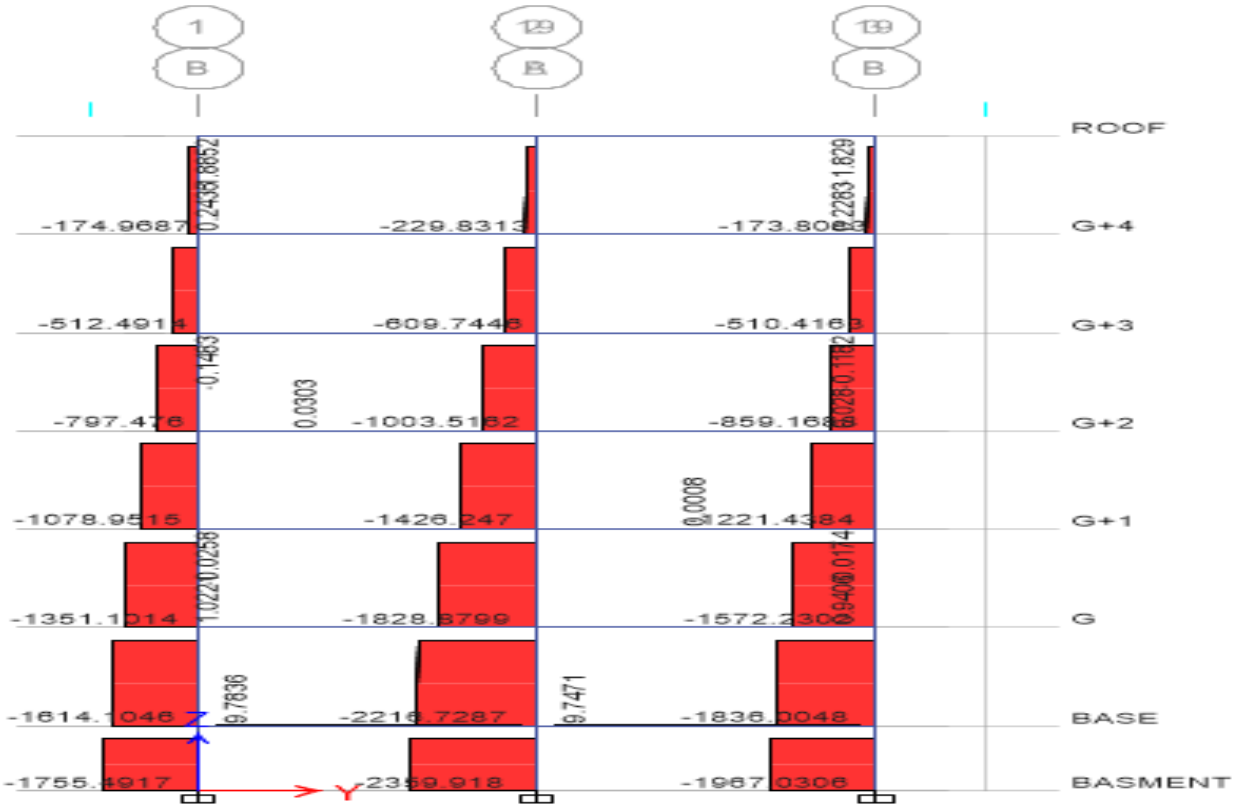



Figure 6. 2: Axil force for Axis B

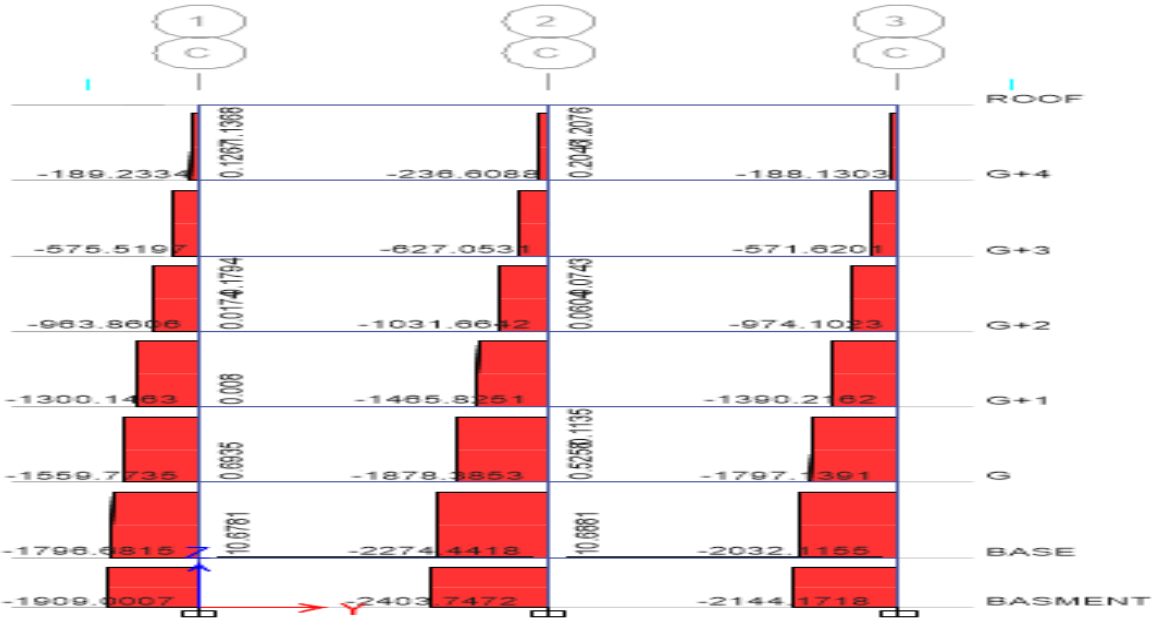



Figure 6. 3: Axil force for Axis C

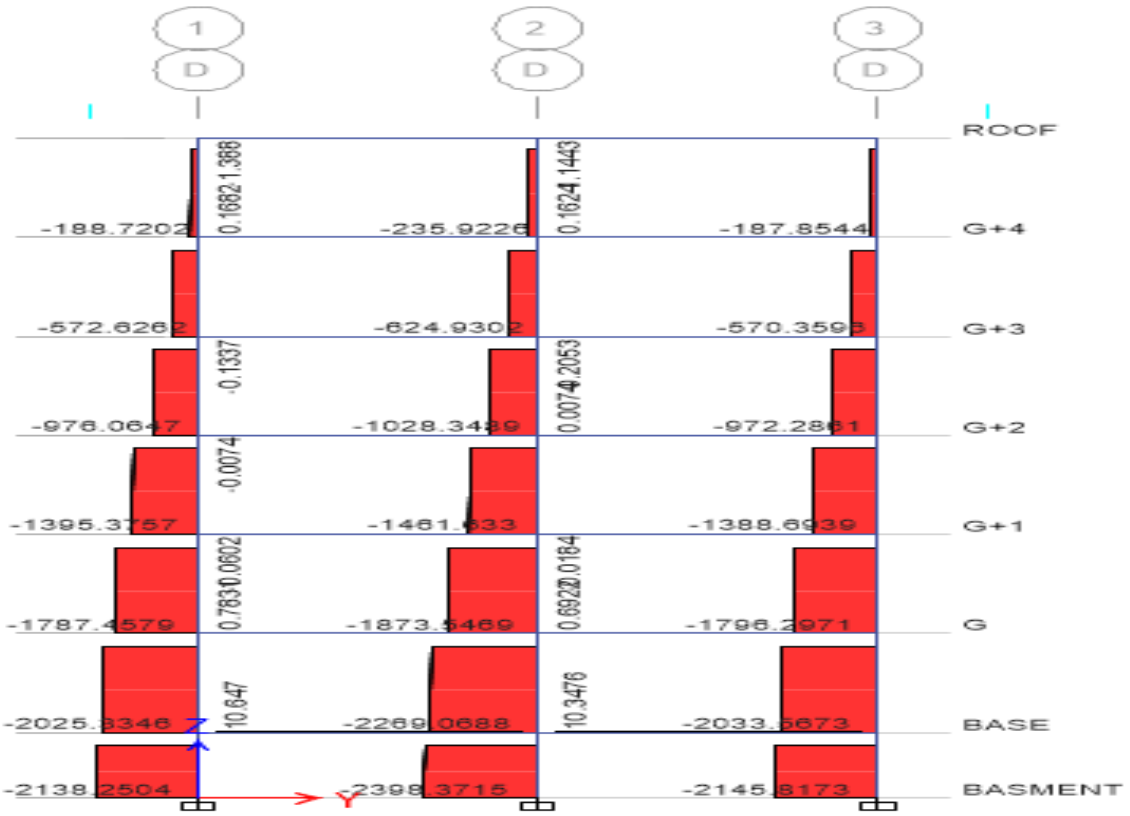



Figure 6. 4: Axil force for Axis D

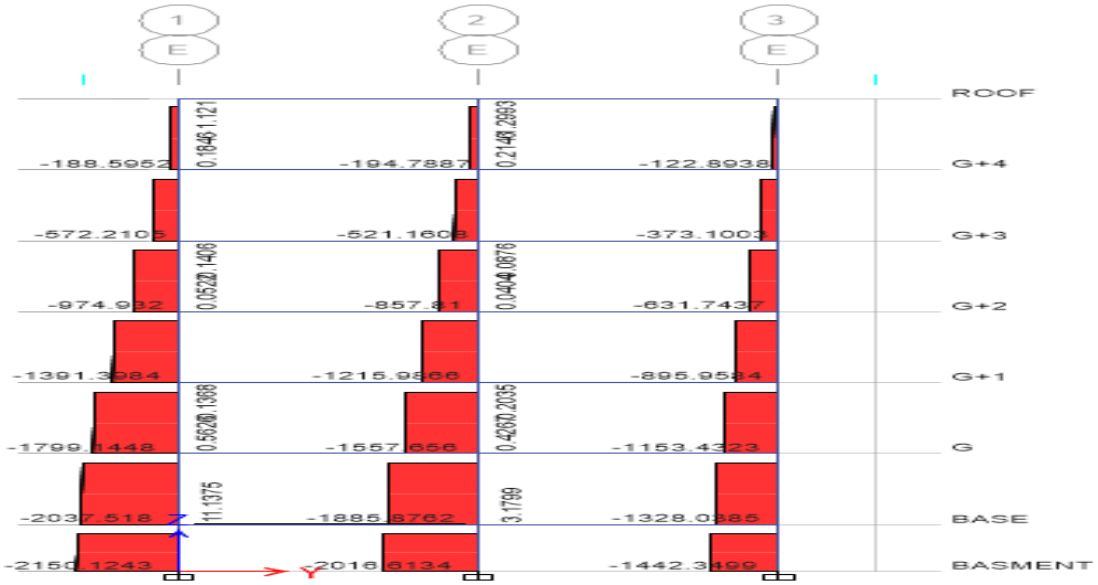



Figure 6. 5: Axil force for Axis E

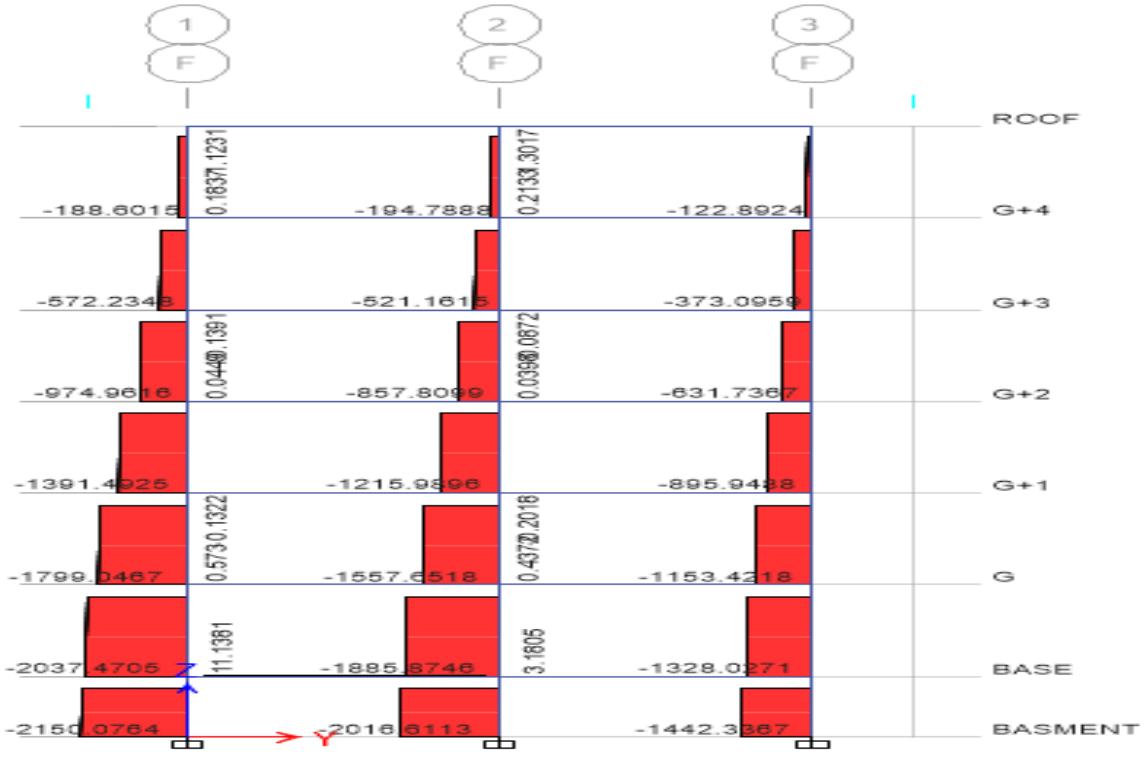



Figure 6. 6: Axil force for Axis F

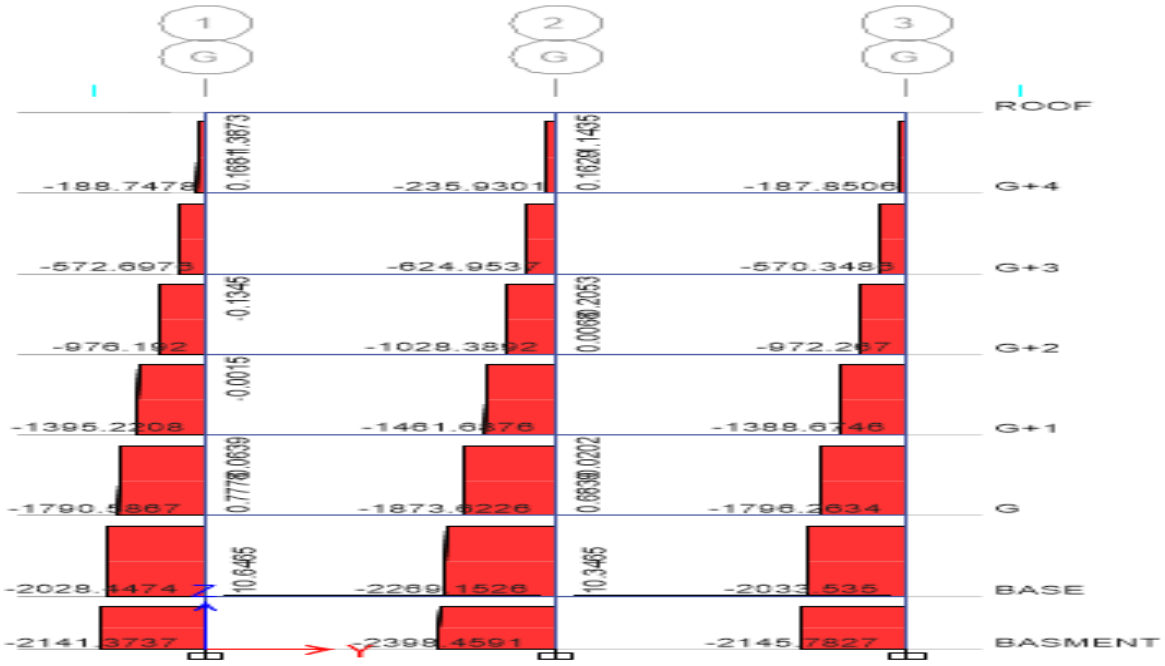



Figure 6. 7: Axil force for Axis G

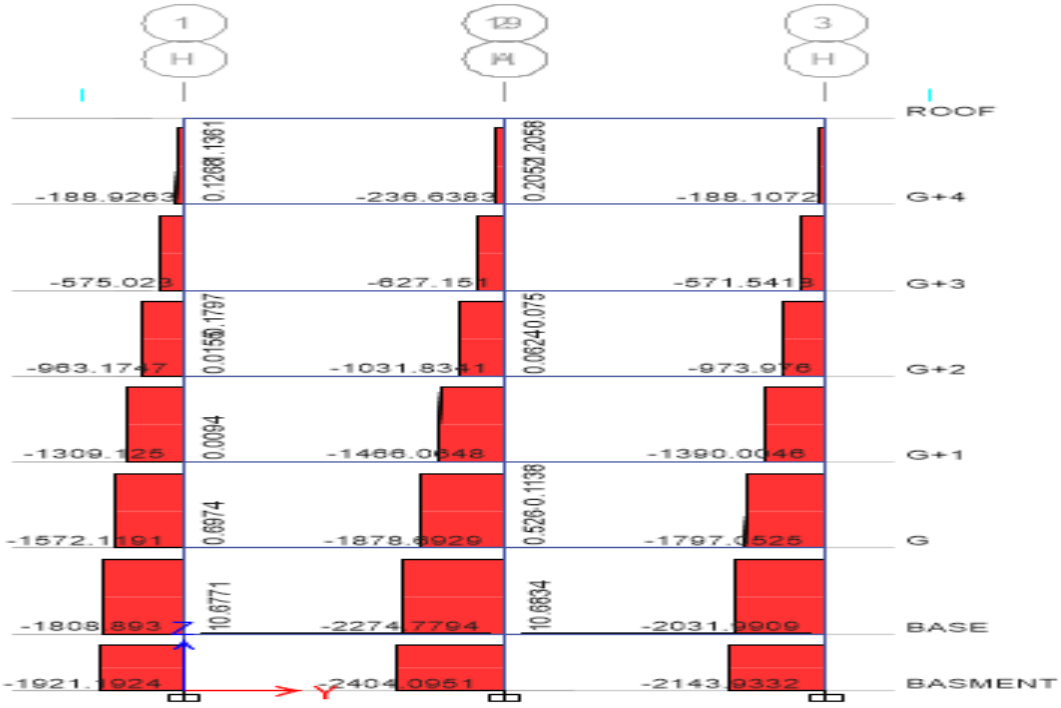



Figure 6. 8: Axil force for Axis H

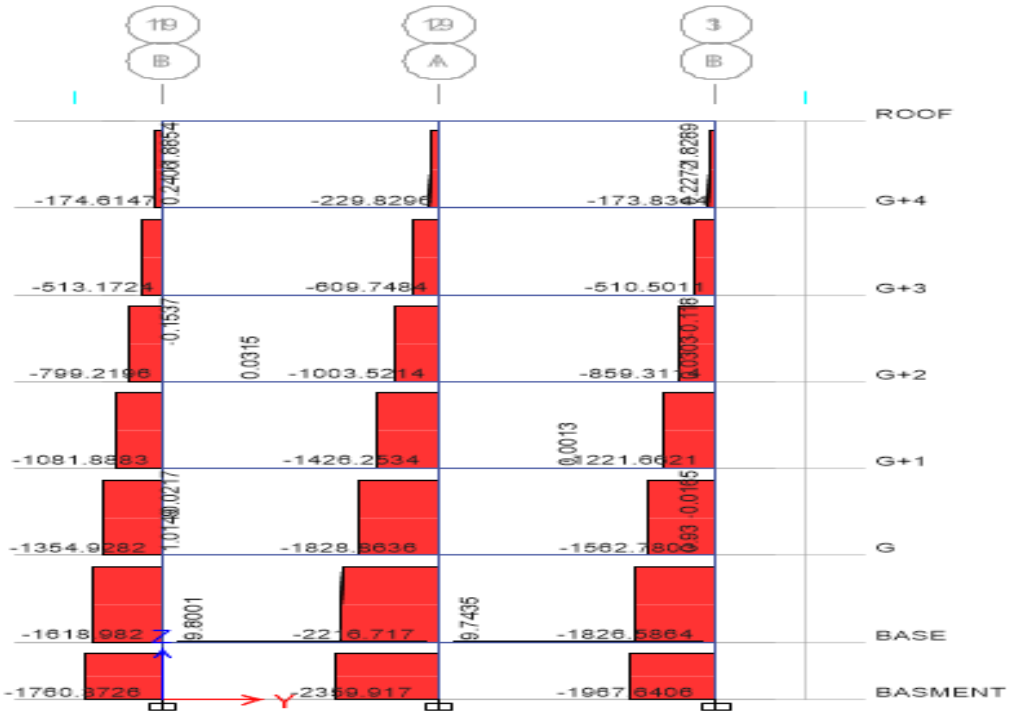



Figure 6. 9: Axil force for Axis I

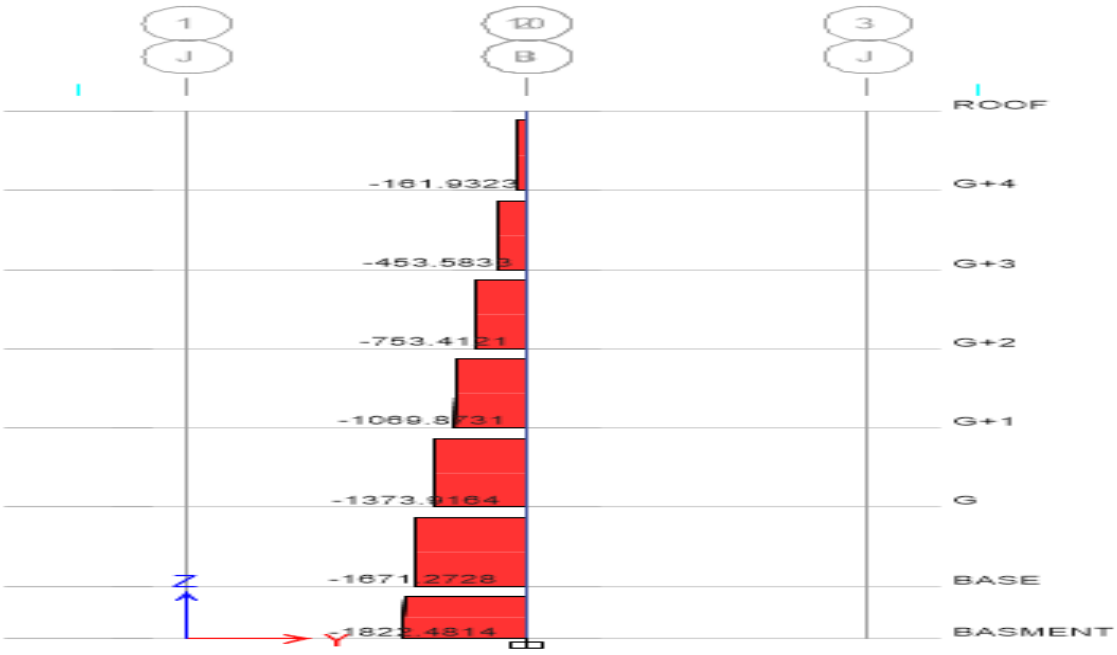



Figure 6. 10: Axil force for Axis J

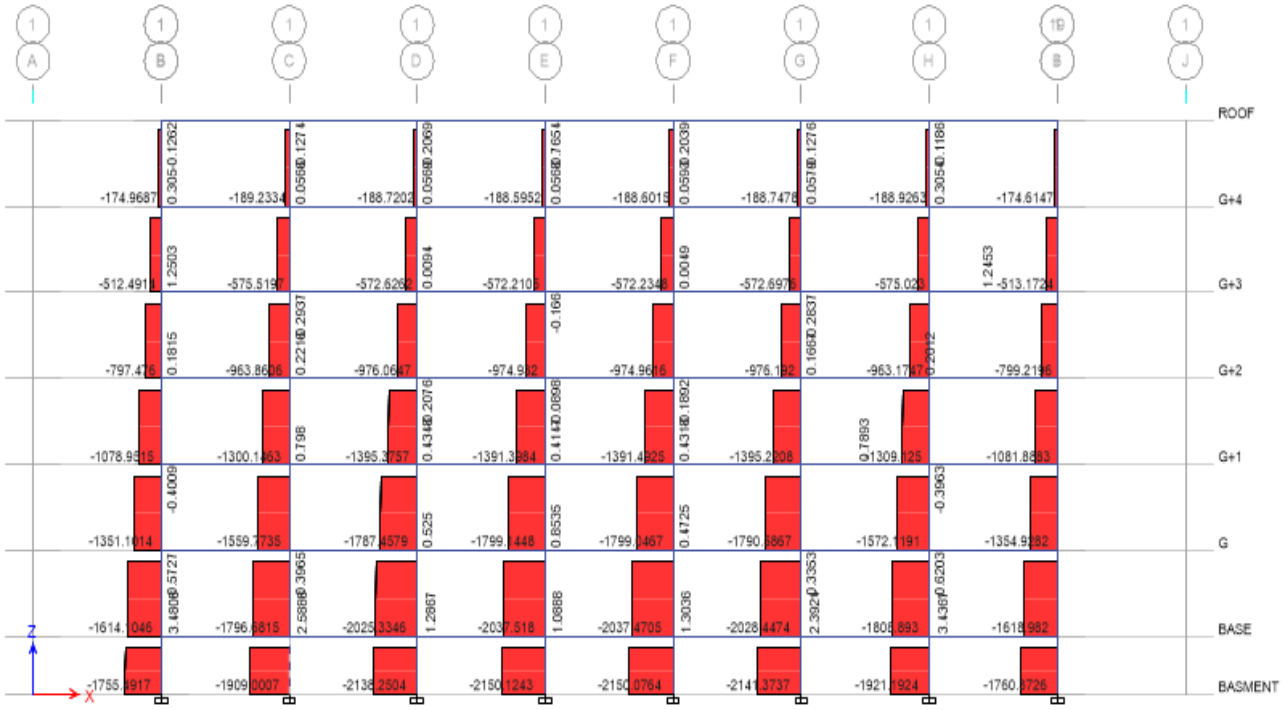



Figure 6. 11: Axil force for Axis 1

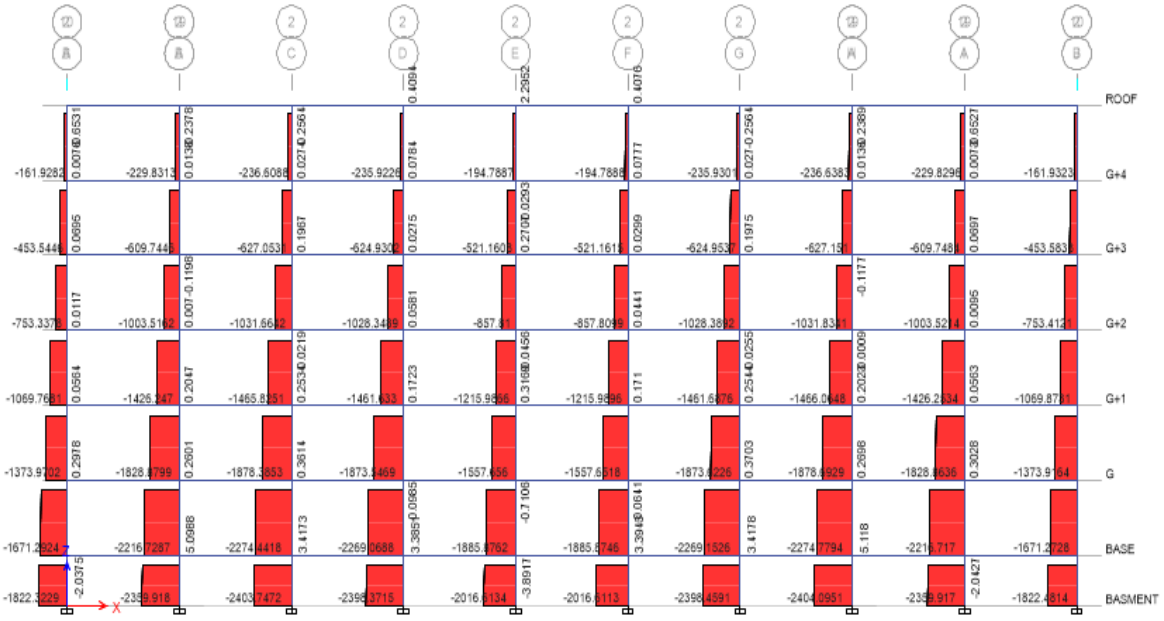


Figure 6. 12: Axil force for Axis 2

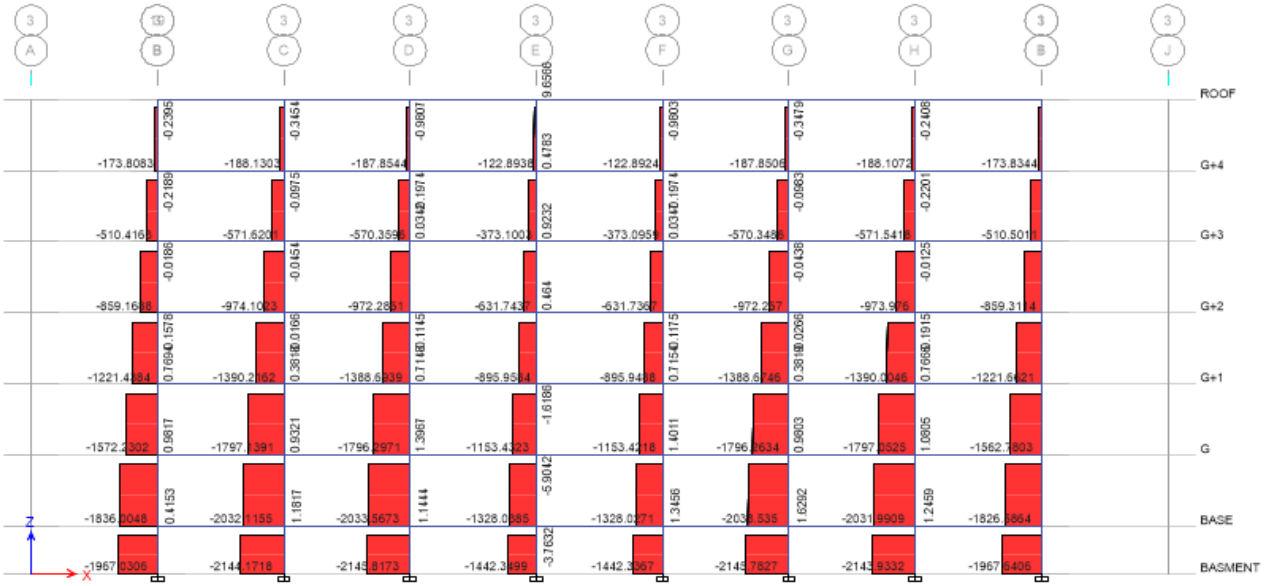



Figure 6. 13: Axil force for Axis 3

### 6.2.2. Shear force diagram

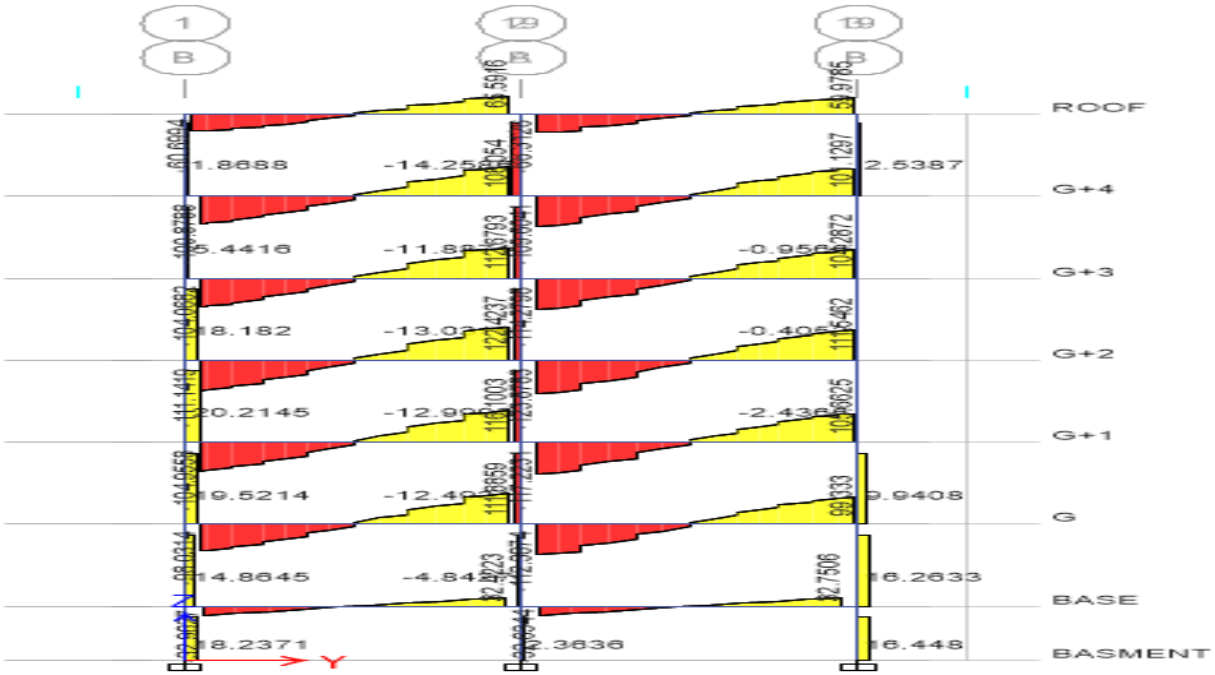



Figure 6. 14: Shear force diagram for axis B

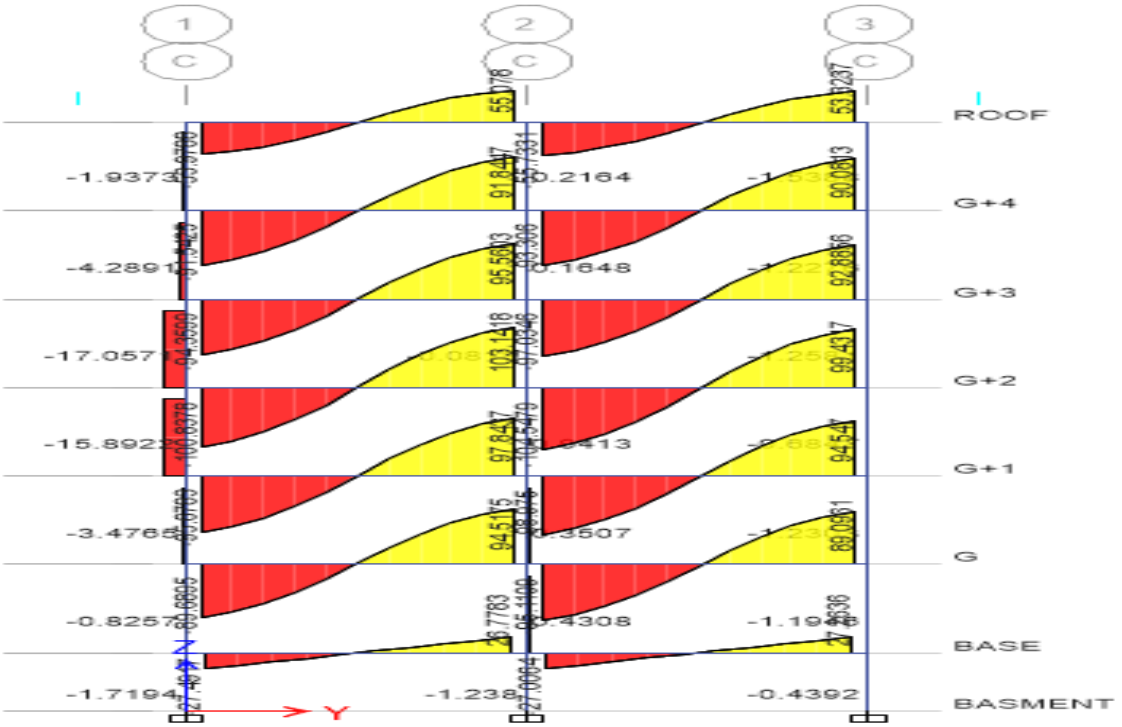



Figure 6. 15: Shear force diagram for axis C

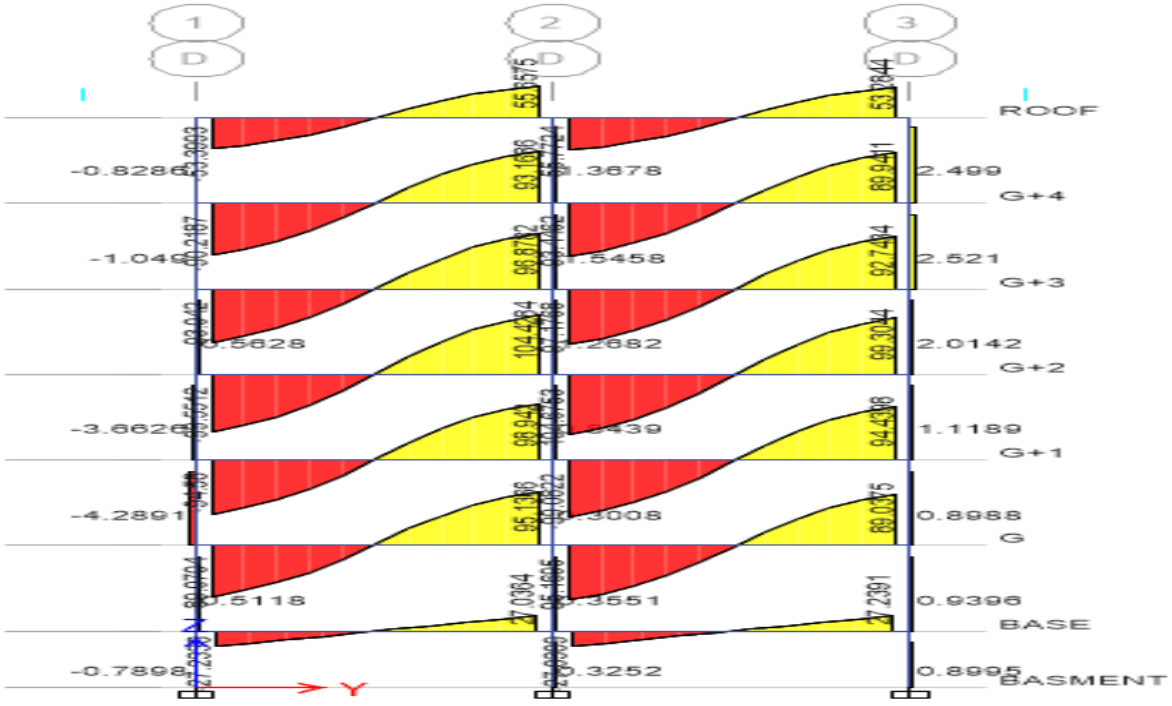



Figure 6. 16: Shear force diagram for axis D

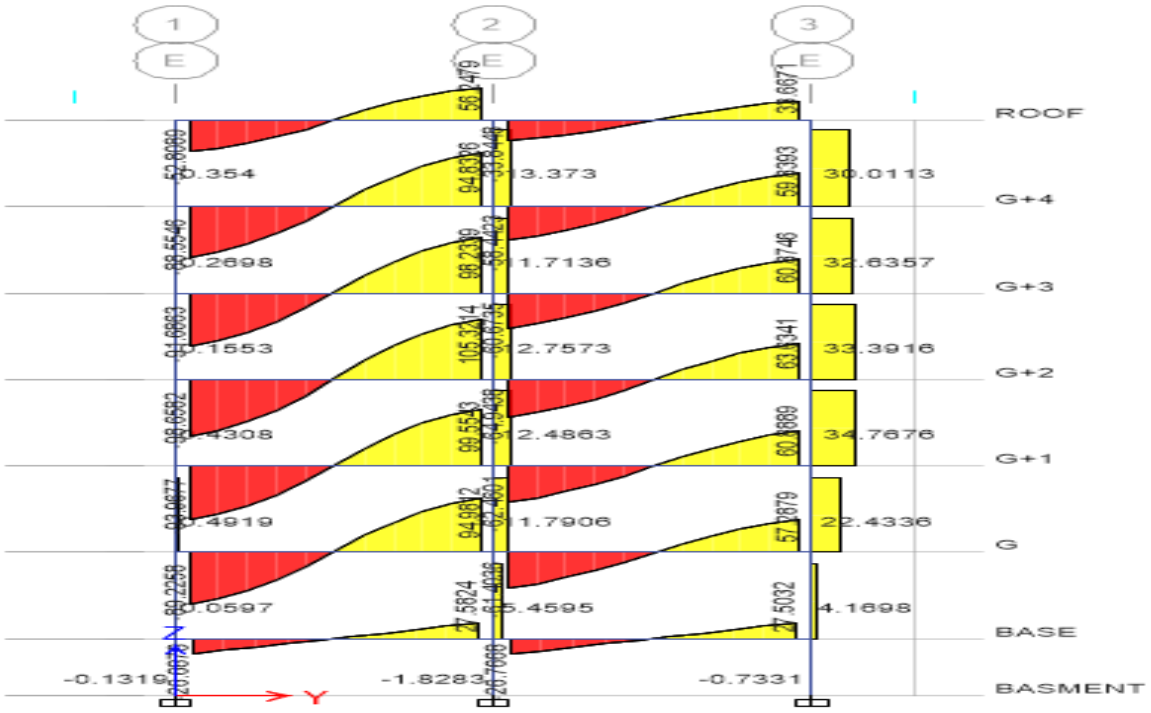



Figure 6. 17: Shear force diagram for axis E

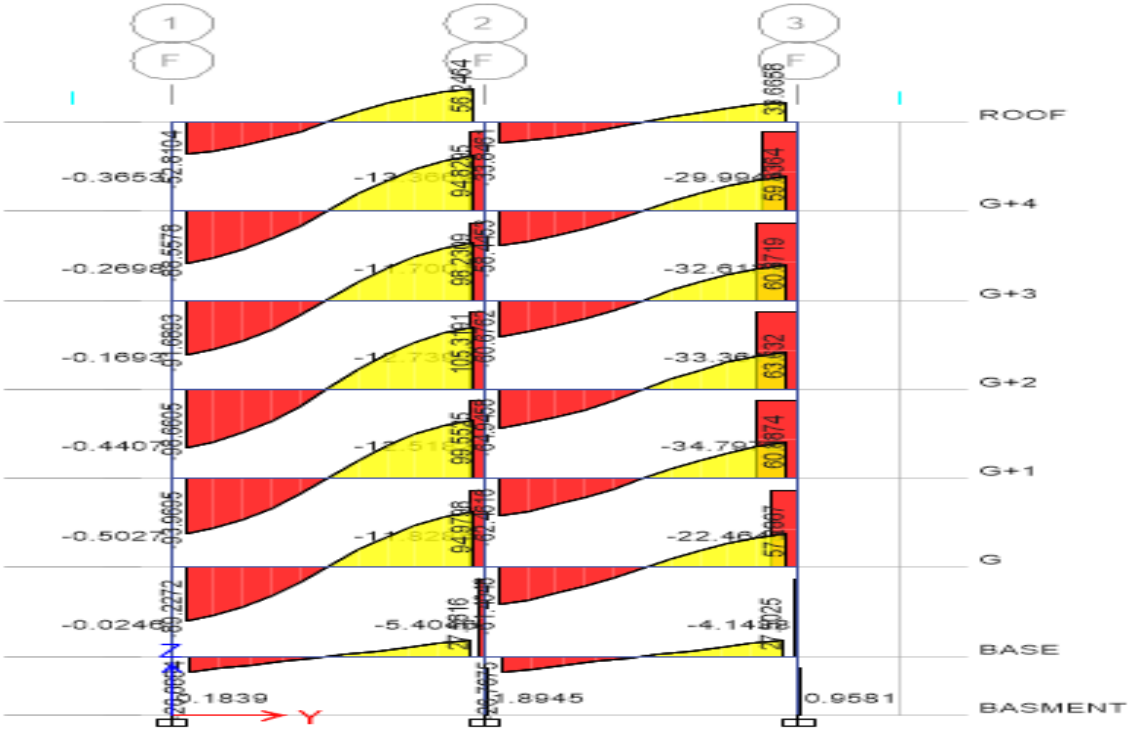


Figure 6. 18: Shear force diagram for axis F

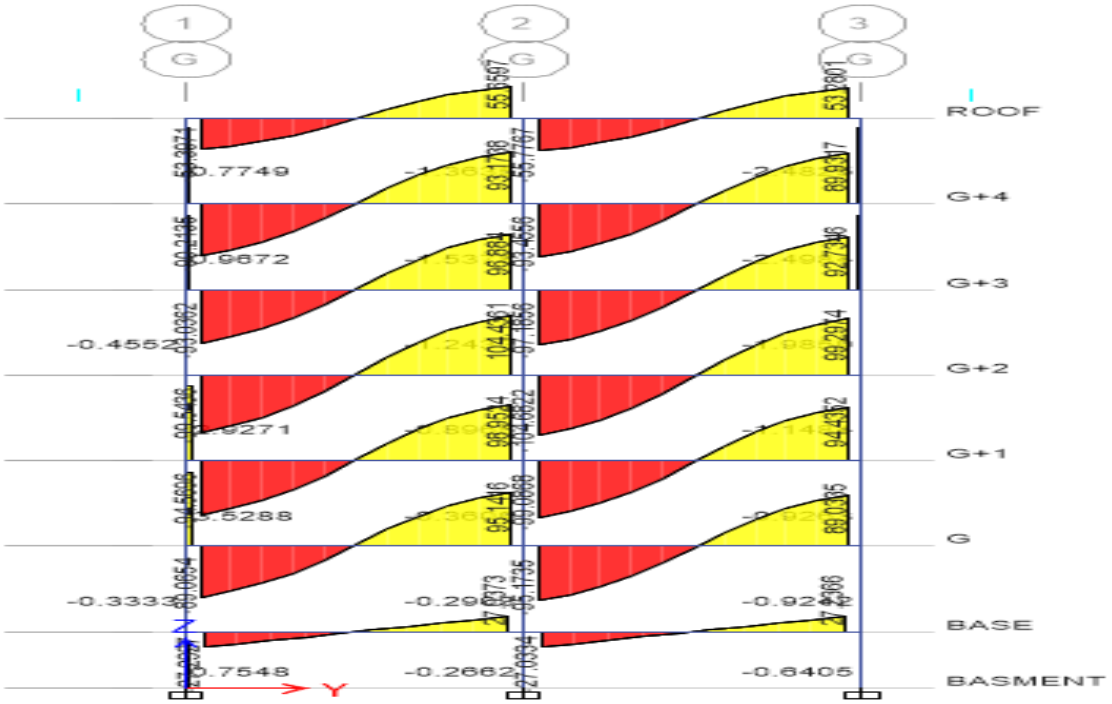



Figure 6. 19: Shear force diagram for axis G

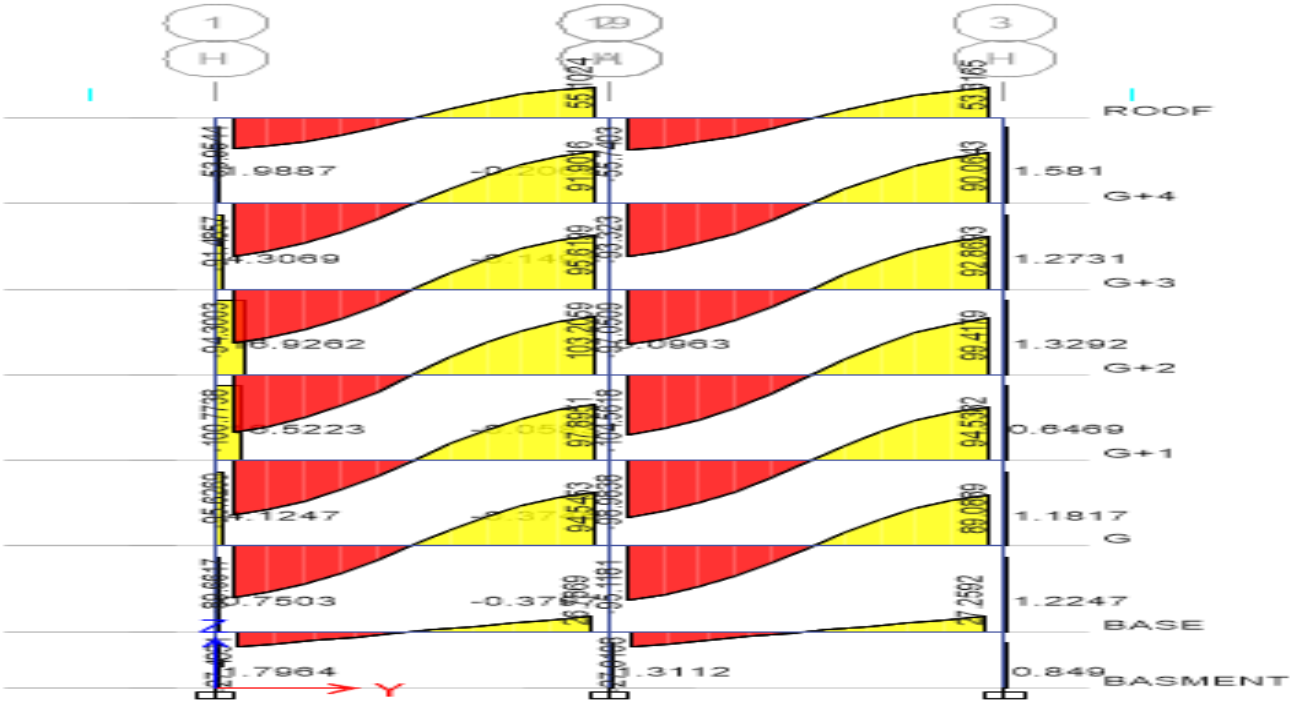



Figure 6. 20: Shear force diagram for axis H

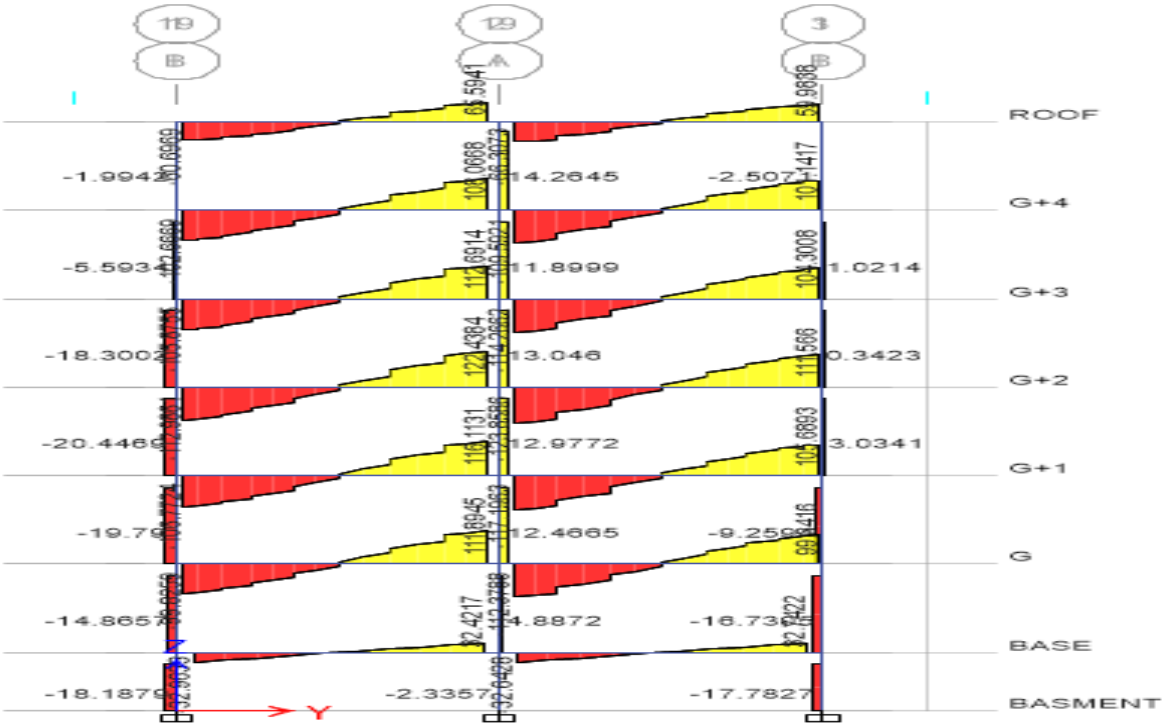



Figure 6. 21: Shear force diagram for axis I

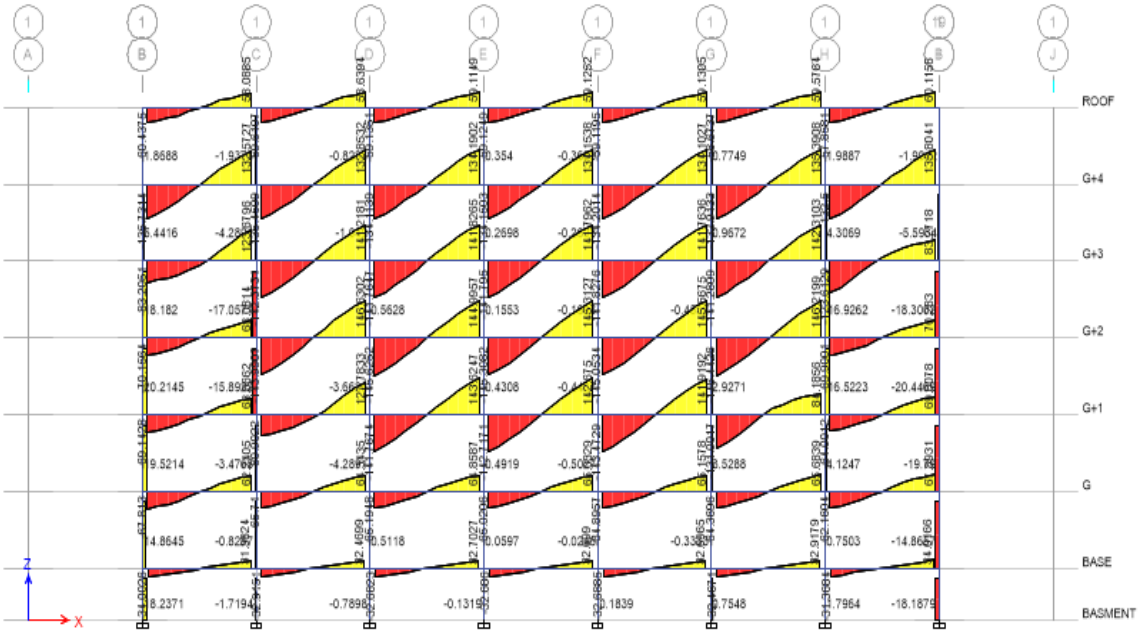


Figure 6. 22: Shear force diagram for axis 1

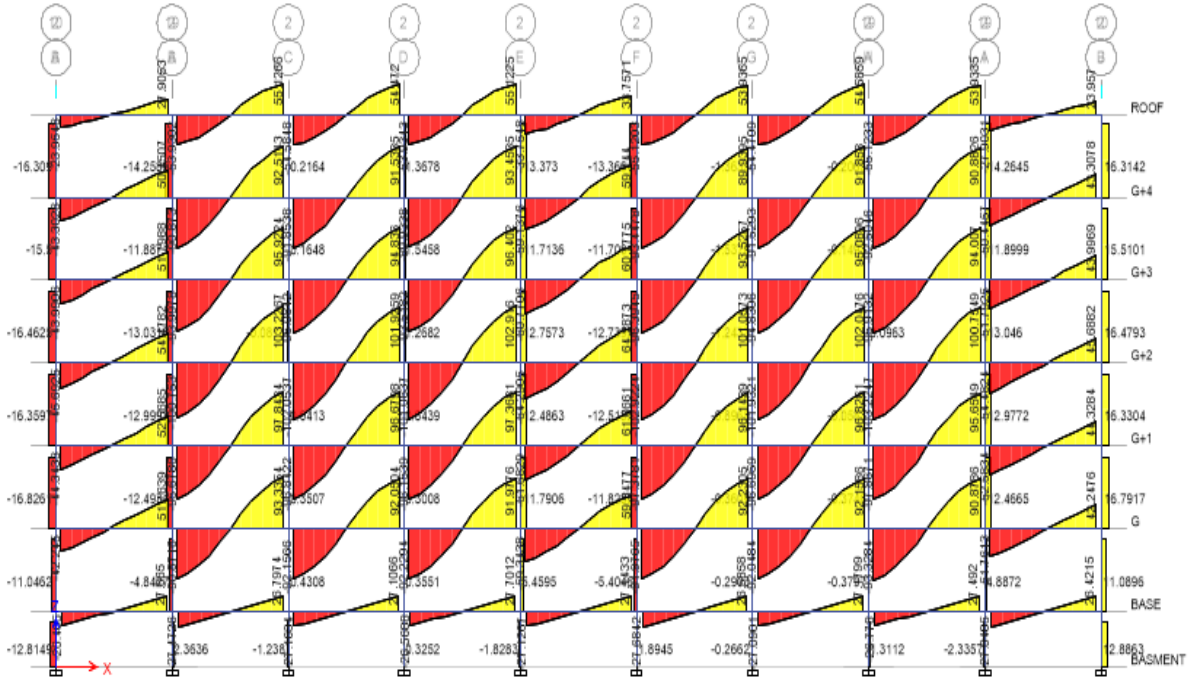



Figure 6. 23: Shear force diagram for axis 2

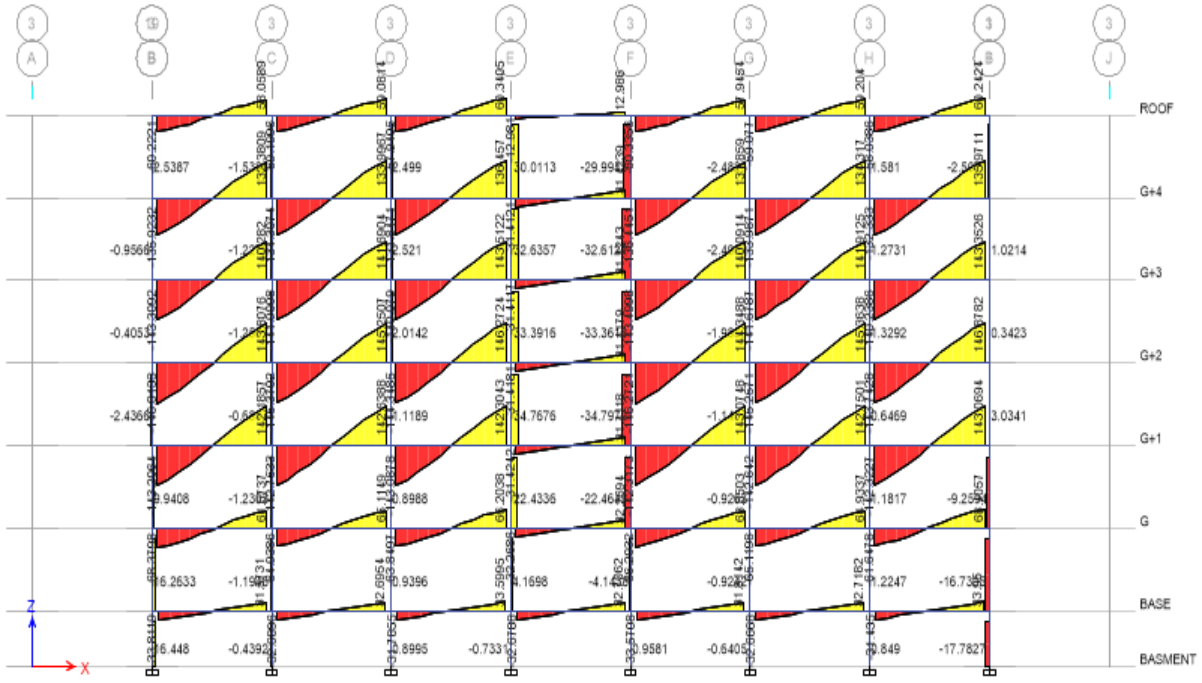


Figure 6. 24: Shear force diagram for axis 3

### 6.2.3. Bending moment diagram

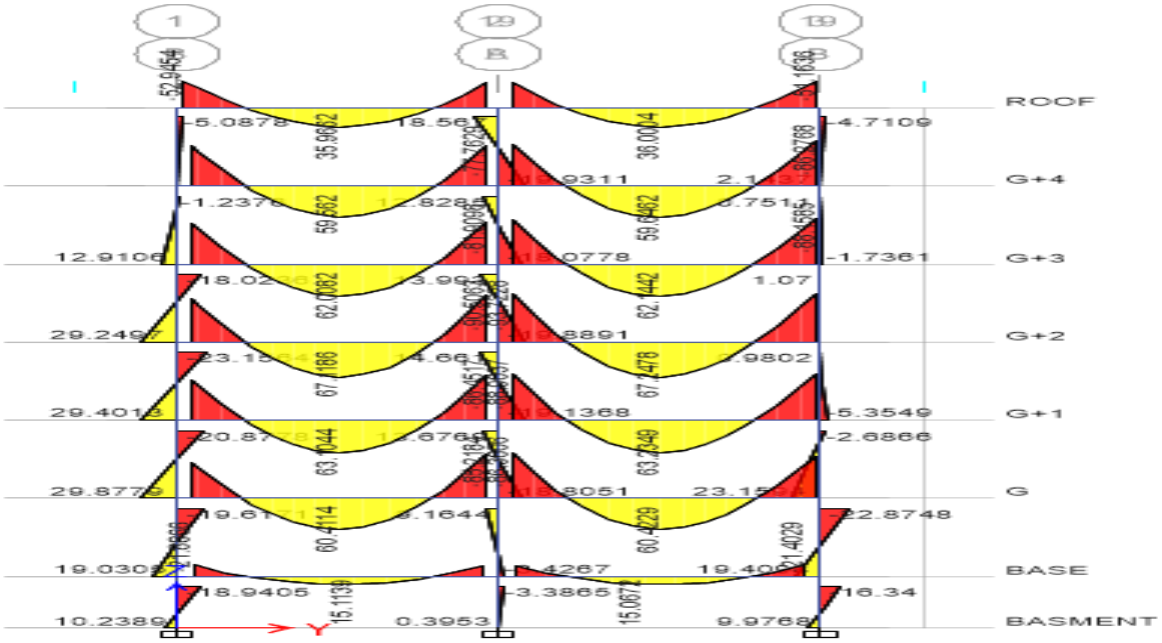



Figure 6. 25: Bending moment diagram for axis B

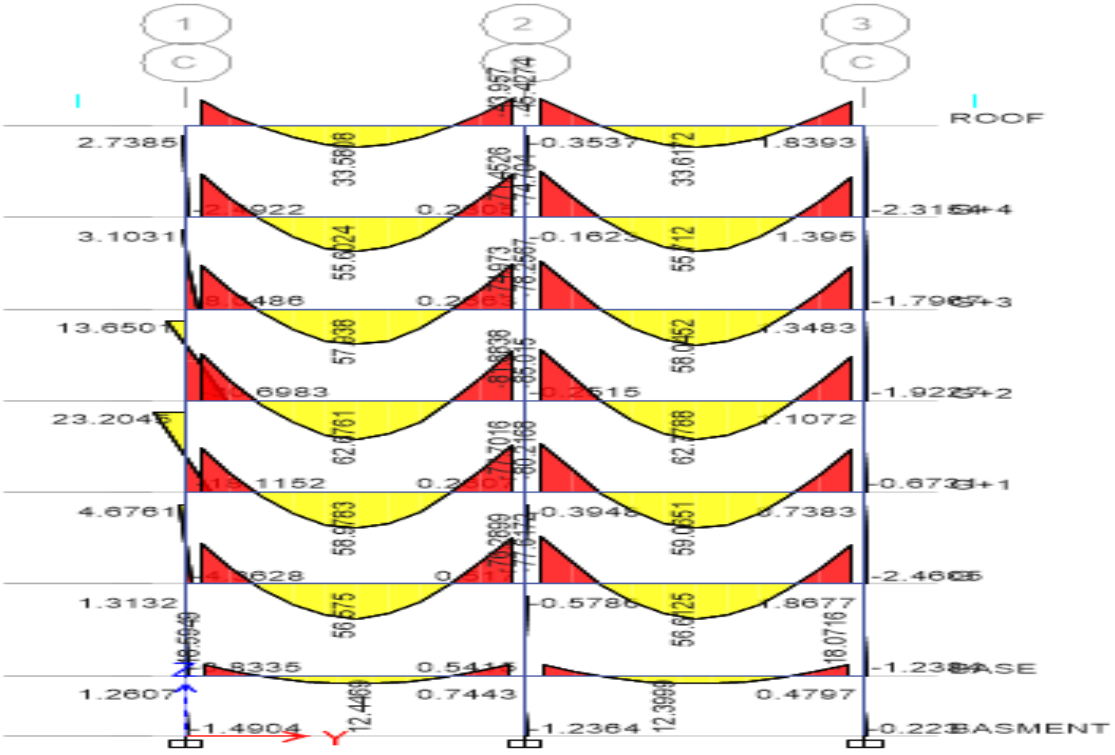


Figure 6. 26: Bending moment diagram for axis C

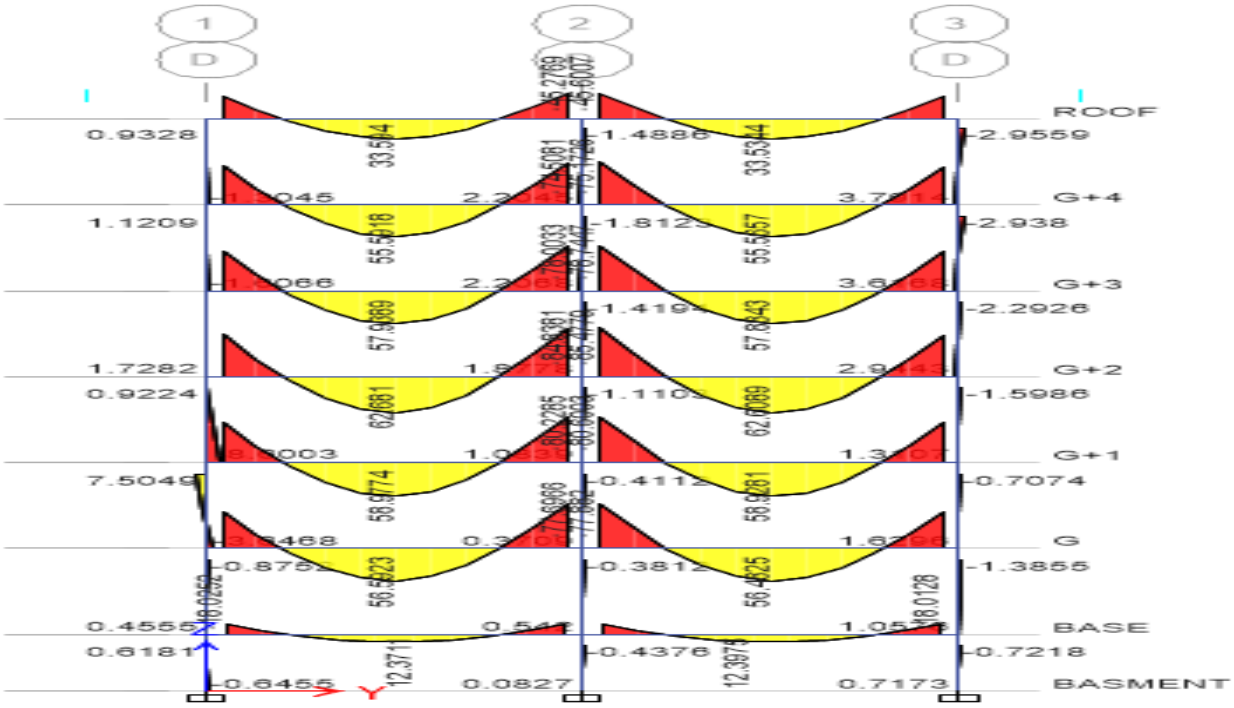



Figure 6. 27: Bending moment diagram for axis D

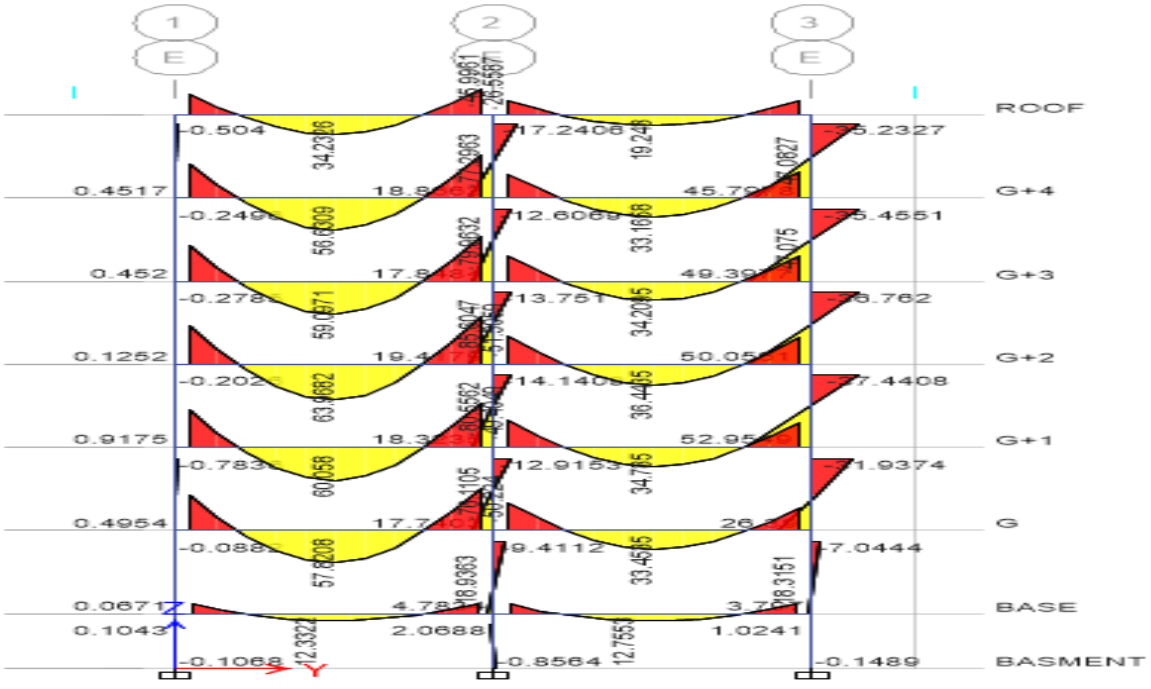



Figure 6. 28: Bending moment diagram for axis E

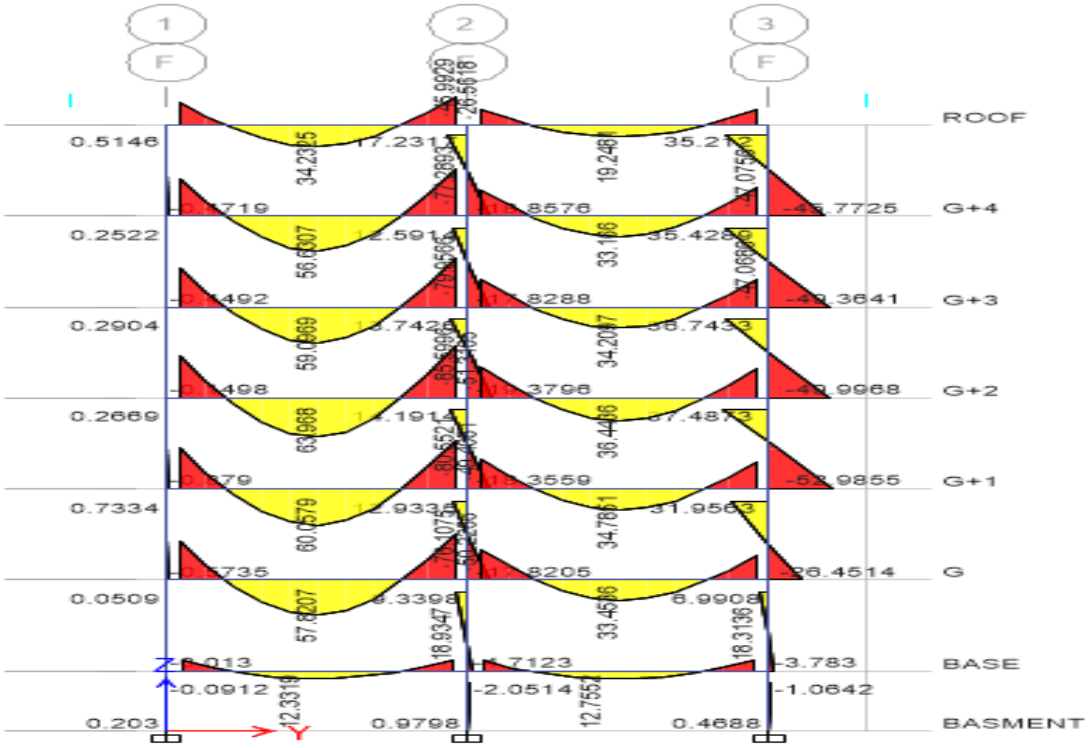



Figure 6. 29: Bending moment diagram for axis F

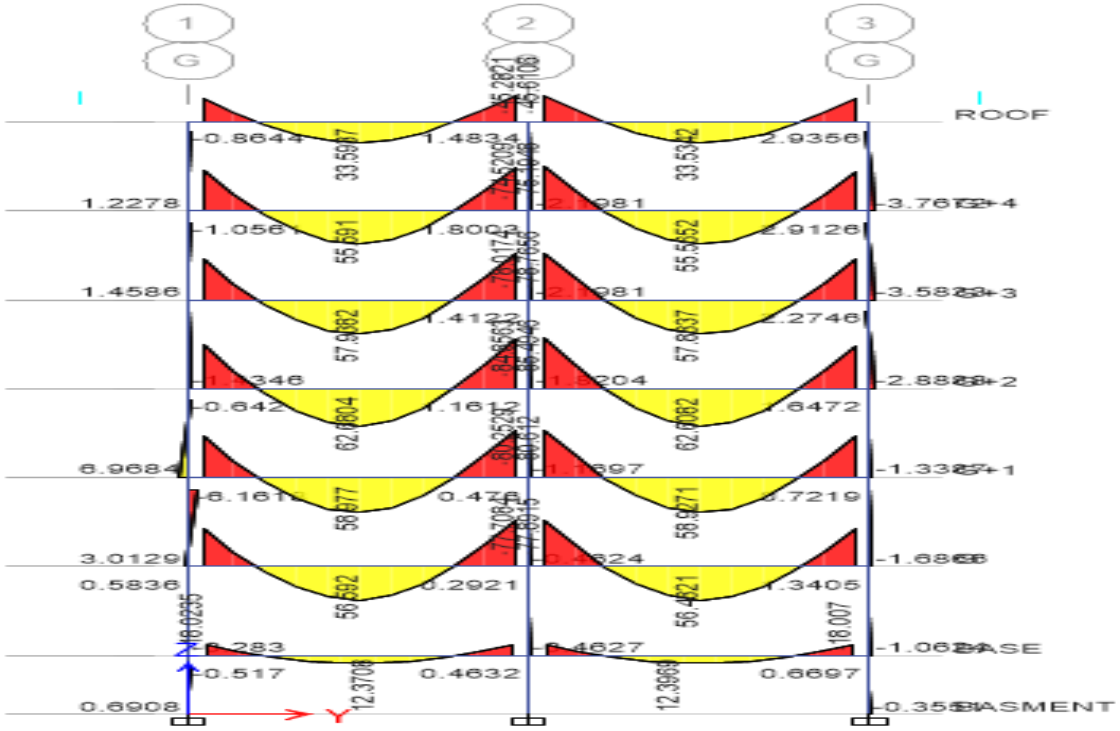


Figure 6. 30: Bending moment diagram for axis G

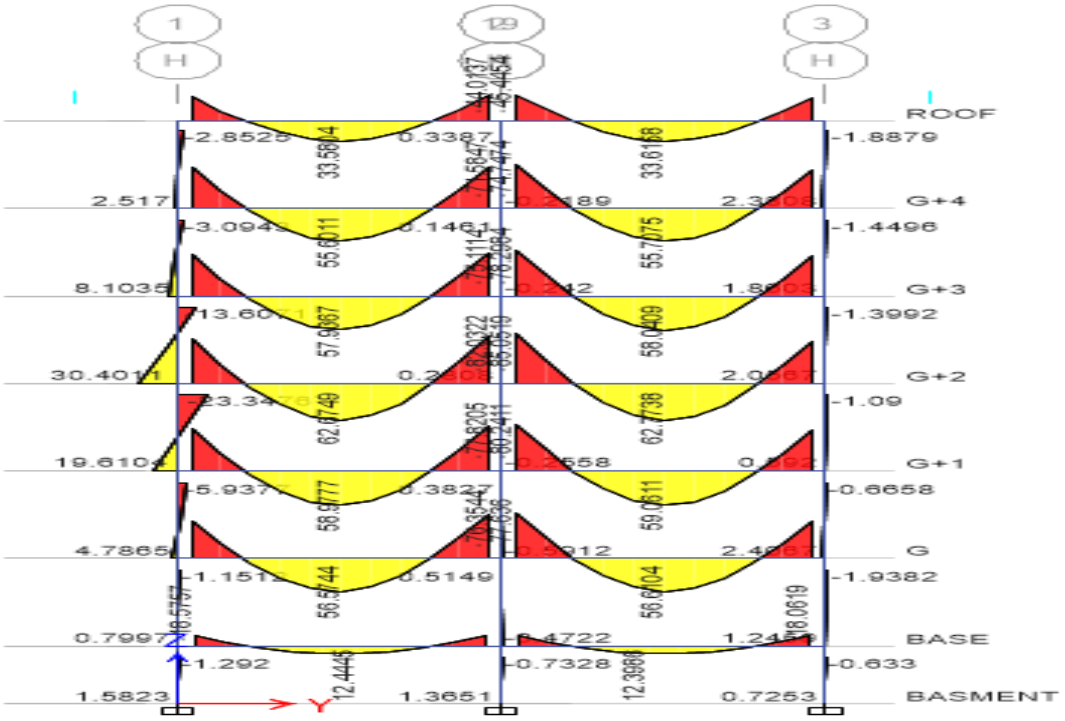



Figure 6. 31: Bending moment diagram for axis H

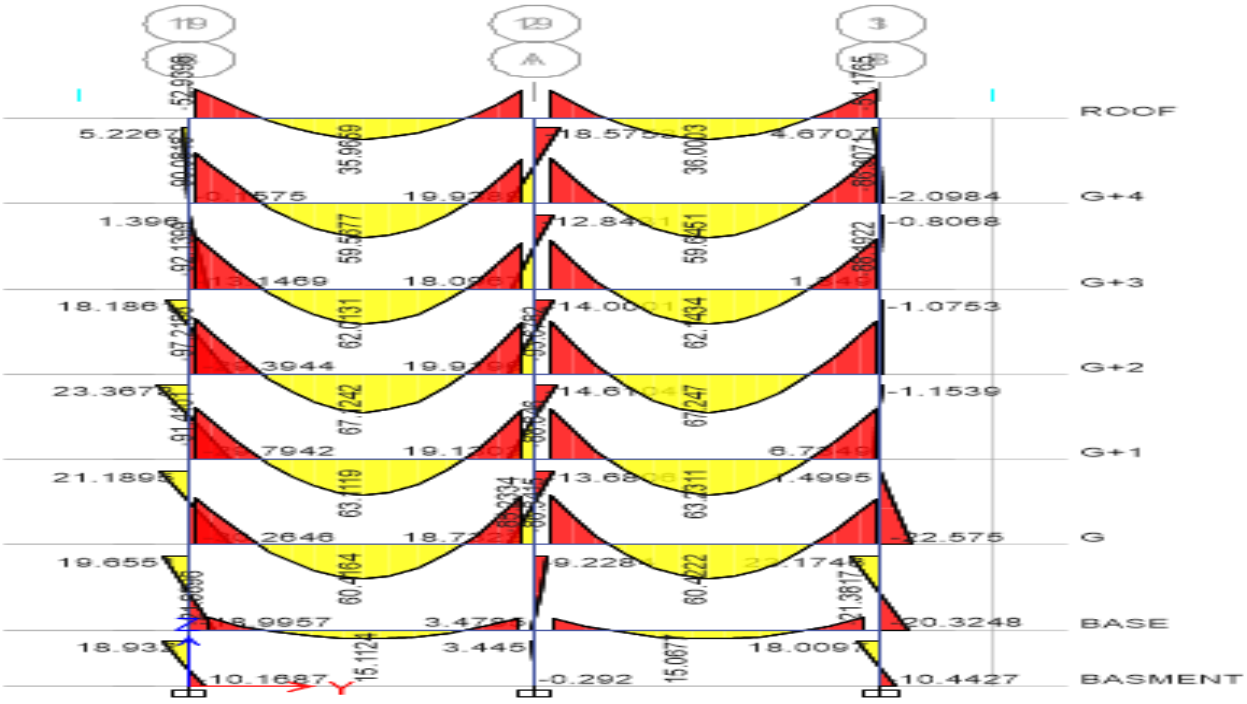


Figure 6. 32: Bending moment diagram for axis I

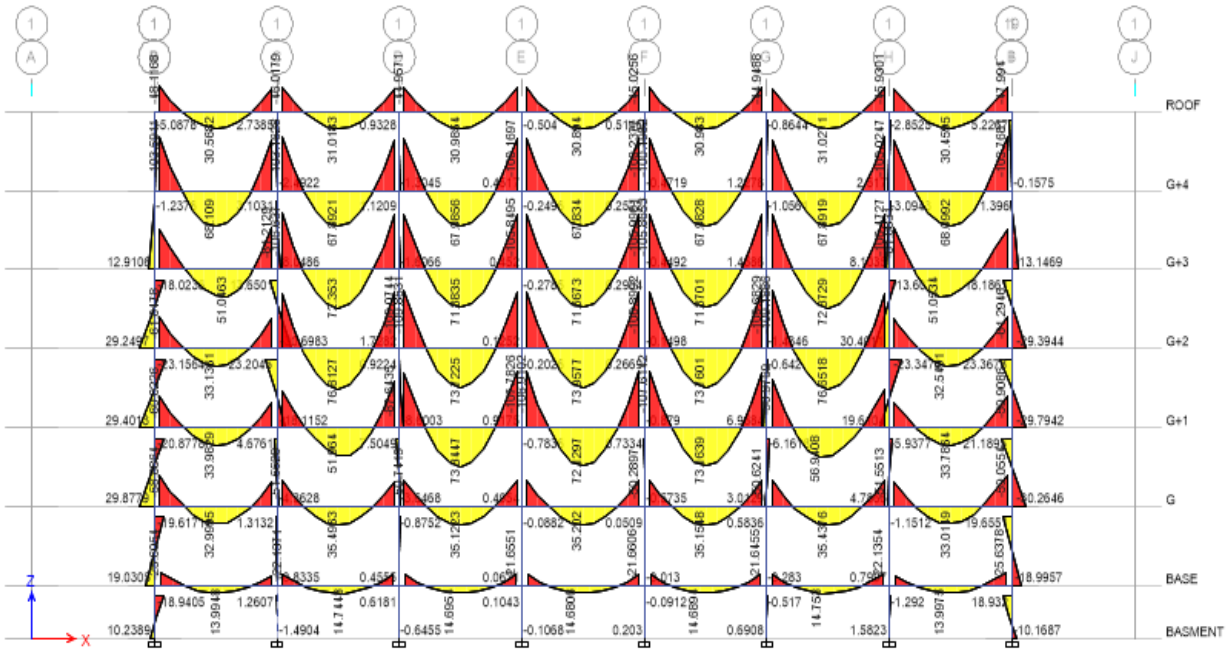



Figure 6. 33: Bending moment diagram for axis 1

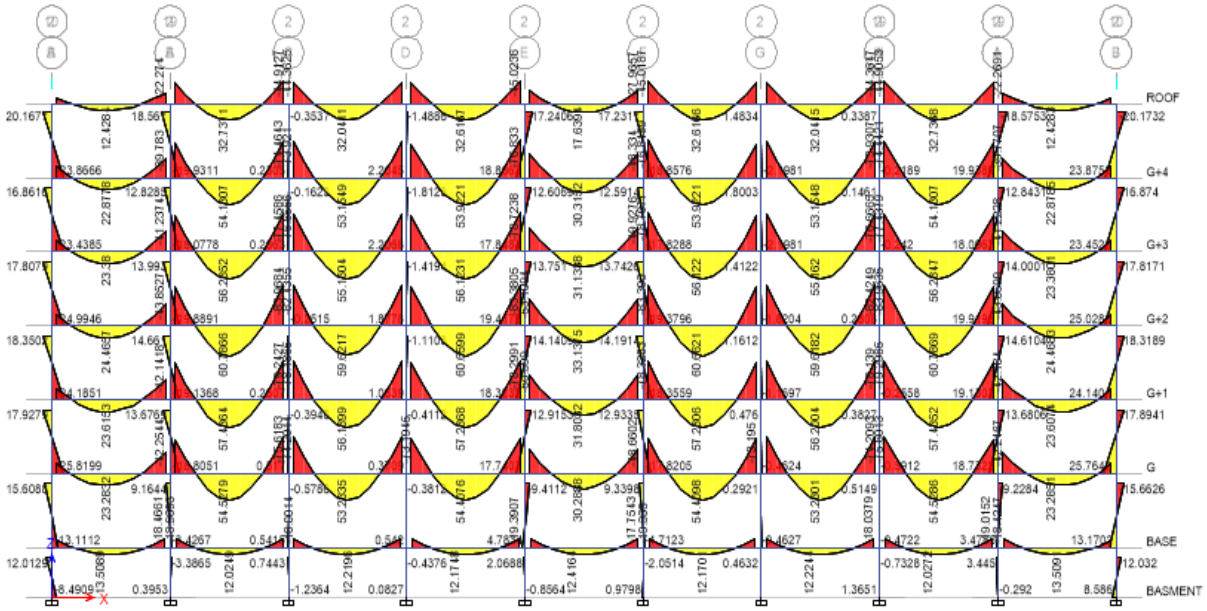



Figure 6. 34: Bending moment diagram for axis 2

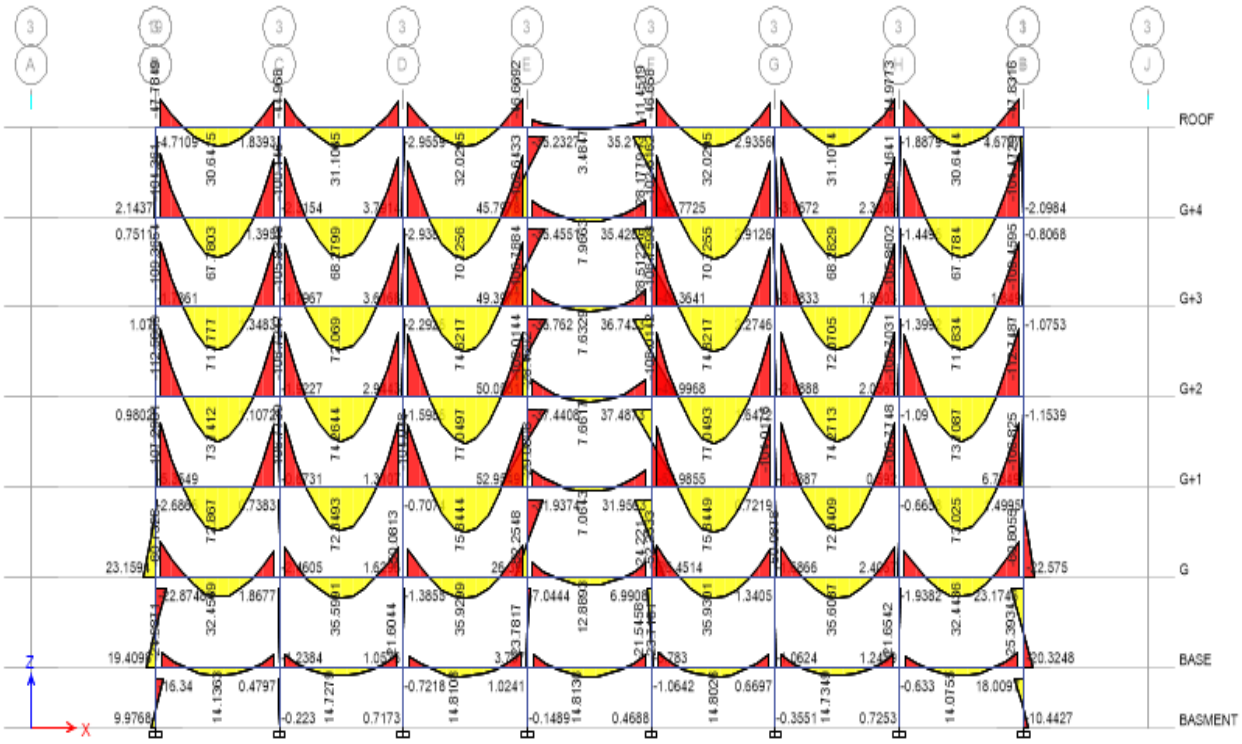



Figure 6. 35: Bending moment diagram for axis 3

# CHAPTER-SEVEN
## STRUCTURAL ANALAYSIS AND DESIGN OF BEAM

### 7.1. Introduction

Beams are flexural members which are used to transfer the loads from slab to columns. Basically beams should be designed for flexure (moment). Furthermore, it is essential to check and design the beam sections for torsion and shear. Beams may be designed for flexural moment depending on the magnitude of the moment and the X- sectional dimensions.

On the other hand, the beam can be singly reinforced, doubly reinforced section. Doubly reinforced cross section Incase when the dimension of the section is limited The concrete may be subjected to higher compression stress. Thus additional steel bars are placed in the compression zone of the section. Beams are characterized by their manner of support, profile (shape of cross-section), length, and their material.

Table 7. 1: Types of beams

| **TYPES OF BEAM** | | |
|---|---|---|
| **According to support condition** | **According to amount of reinforcement** | **According to location of reinforcement** |
| Simply supported | Balanced section | Singly reinforced section |
| Cantilever | Under reinforced section | Doubly reinforced section |
| Propped | Over reinforced section | |
| Overhanging | | |
| Continuous | | |

- Singly reinforced beam is reinforced with steel bars only at the tension zone.
- Doubly reinforced beam is reinforced in both zones (tension & compression zone).

If a section of a beam is limited in depth, it cannot develop the compressive force required to resist the applied bending moment. If it's a small increase in moment, over reinforced beam section can be used (not recommended in design).

In such case, providing a reinforcement in the compression zone assists the concrete in resisting compressive force. This kind of beam section is called doubly reinforced beam. If the required depth is also unacceptable, doubly reinforced beam is provided.

## 7.2. Flexural Design

**STEP 1: <u>Design Data</u>**

- **<u>Material data</u>**:
  - ✓ Grade of concrete C-30
  - ✓ Steel grade S-500
  - ✓ Ø 16 bar and Ø 20 for flexure
  - ✓ Bar for shear
  - ✓ Use concrete cover C = 30mm
- **<u>Cross sections of beams are</u>**
  - ✓ Top tie beam =300mm*250mm
  - ✓ Intermidiate beam—Ground floor beam, 1stfloor beams ,2nd floor beams,3rd floor ,4th floor beams = 400*250mm
  - ✓ Grade beam, =400*300mm
- **<u>Design constants</u>**

- **Material**
  - ✓ Concrete**:** Class I workmanship.
  - ✓ Grade of concrete we used C-30
  - ✓ Unit weight of concrete, ϒc = 25KN/$m^3$
  - ✓ Partial Safety factor for ordinary loading γc=1.5…...EBCS-2, 2015 Table 2.1N (Page 20).
- **Design strength value**

**iii. Design strength of concrete(fcd)**

✓ **In compression**

$$fcd = 0.85 * \frac{fck}{\gamma c}$$ …….EBCS-2, 2015 Page 20.

Where: fck - Characteristic of compressive strength of concrete.

γc - Partial Safety factor for ordinary loading=1.5.

**Characteristic of compressive strength of concrete (fck)**

For C-30 fck =0.8*30Mpa=**24Mpa** or from EBCS-2, 2015 Table 3.1 (Page 25).

$$fcd = 0.85 * \frac{24}{1.5} =$$ **13.6 Mpa**

✓ **In tension**

$$fctd = \frac{fctk}{\gamma c}$$…….EBCS-2, 2015 Page 20

Where: fctd - Design of tensile strength of concrete.

fctk - Characteristic tensile strength of concrete.

γc - Partial Safety factor for ordinary loading=1.5.

**Characteristic of tensile strength of concrete(fctk),**

fctk =0.7*fctm……..EBCS-2, 2015 Page 25

Where: fctm -Characteristiccylinder compressive strength.

**Characteristic cylinder compressive strength(fctm),**

fctm = $0.3*(fck)^{2/3}$……..EBCS-2, 2015 Table 3.1 (Page 25)

Where: fck - Characteristic compressive strength of concrete=20Mpa.

fctm = $0.3*(24)^{2/3}$=$0.3(24)^{2/3}$ = **2.4961Mpa**

fctk = $0.7*(fctm)^{2/3}$=$0.7(2.4961)^{2/3}$ = **1.2880Mpa**

Then, fctd = $\frac{1.2880}{1.5}$Mpa= **0.8587 Mpa**

**iv. Design strength of steel(fyd)**

$$fyd = \frac{fyk}{\gamma s}$$

Where: fyk - Grade of steel, S-500 EBCS-2, 2015 (page 35)

γs-Reinforcing steel factor =1.15 Mpa for ordinary loading and class I work….EBCS-2, 1995 Table 3.1 (Page 22)

Then, fyd = $\frac{fyk}{\gamma s} = \frac{500}{1.15} =$ **434.78Mpa**

- ✓ Secant modulus of elasticity (Ecm)= 30Gpa….EBCS-2, 2015 Table 3.1 (Page25)
- ✓ Modulus of elasticity (Es)= 200Gpa….EBCS-2, 2015 (Page37)
- ✓ C = 0.0035
- ✓ S = Fyd/Es =434.78/200000 = **0.0021738**

**Step 3: Determination of minimum concrete cover design solid slab**

- **Exposure classes**

The exposure class we have selected for our building related to environmental is dry or permanently wet. Therefore, we have selected XC1 using the table found below.

Table 7. 2: Exposure classes related to environmental conditions in accordance with ES EN 2015

| Class Designation | Description of the Environment | Informative examples where exposure classes may occur |
|---|---|---|
| **2. Corrosion induced by carbonation** | | |
| XC1 | Dry or permanently wet | Concrete inside buildings with low air humidity Concrete permanently submerged in water |

| | | |
|---|---|---|
| XC2 | Wet, rarely dry | Concrete surfaces subject to long-term water contact Many foundations |
| XC3 | Moderate humidity | Concrete inside buildings with moderate or high air humidity External concrete sheltered from rain |
| XC4 | Cyclic wet and dry | Concrete surfaces subject to water contact, not within exposure class XC2 |

- **Indicative strength classes**

The choice of adequately durable concrete for corrosion protection of reinforcement and protection of concrete attack, requires consideration of the composition of concrete. This may result in a higher compressive strength of the concrete than is required for structural design. For our case we have selected C20/25 using the table below.

Table 7. 3: Indicative minimum strength class in accordance with ES EN 2015

| | **Exposure Classes according to EBCS** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Corrosion** | | | | | | | | | | |
| | Carbonation-induced corrosion | | | | Chloride-induced corrosion | | | Chloride-induced corrosion from sea-water | | |
| | XC1 | XC2 | XC3 | XC4 | XD1 | XD2 | XD3 | XS1 | XS2 | XS3 |
| Indicative Strength Class | C20/25 | C25/30 | C30/37 | | C30/37 | | C35/45 | C30/37 | C35/45 | |
| **Damage to Concrete** | | | | | | | | | | |
| | No risk | Freeze/Thaw Attack | | | Chemical Attack | | | | | |
| | X0 | XF1 | XF2 | XF3 | XA1 | XA2 | XA3 | | | |
| Indicative Strength Class | C12/15 | C30/37 | C25/30 | C30/37 | C30/37 | | C35/45 | | | |

- **Design working life**

In order to achieve the required design working life of the structure, adequate measures shall be taken to protect each structural element against the relevant environmental actions. For our building we considered design working life is for 50 years. Based on this the structural class for this building is S4 from EBCS-1, 2015.

Table 7. 4: Indicative design working life

| **Design working life category** | **Indicative design working life (years)** | **Examples** |
|---|---|---|
| 1 | 10 | Temporary structures(1) |
| 2 | 10 to 15 | Replaceable structural parts, e.g. gantry girders, bearings |
| 3 | 15 to 30 | Agricultural and similar structures |
| 4 | 50 | Building structures and other common structures |

| | | |
|---|---|---|
| 5 | 100 | Monumental building structures, bridges, and other civil engineering structures |
| (1) Structures or parts of structures that can be dismantled with a view to being re-used should not be considered as temporary. | | |

- **Structural classification**

We have considered a structural class by member with slab geometry (position of reinforcement not affected by construction process), since our exposure class we selected is XC1, therefore our structural class is S4 because the class is reduced by 1 using the table below.

Table 7. 5: Recommended structural classification

| **Structural Class** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Criterion** | **Exposure Class according to EBCS** | | | | | | |
| | X0 | XC1 | XC2 / XC3 | XC4 | XD1 | XD2/ XS1 | XD3/ XS2/ XS3 |
| Design working life of 100 years | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 |
| Strength Class[1)2)] | ≥C30/37 reduce class by 1 | ≥C30/37 reduce class by 1 | ≥C35/45 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C45/55 reduce class by 1 |
| Member with slab geometry (Position of reinforcement not affected by construction process) | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 |
| Special Quality Control of the concrete production ensured | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 |

- **Minimum concrete cover**

The concrete cover is the distance between the surface of the reinforcement closest to the nearest concrete surface (including links and stirrups and surface reinforcement where relevant) and the nearest concrete surface. The nominal cover shall be specified on the drawings. It is defined as,

$C_{nom} = C_{min} + \Delta C_{dev}$ ……EBCS-2 2015, (page 47).

where $C_{nom}$ :- Nominal cover.

$C_{min}$ :- Minimum cover.

$\Delta C_{dev}$:- Allowance in design for deviation.

- **Minimum cover (cmin)**

Minimum concrete cover, cmin shall be provided in order to ensure:

- The safe transmission of bond forces.
- The protection of the steel against corrosion (durability).
- An adequate fire resistance.

The greater value for $C_{min}$ satisfying the requirements for both bond and environmental conditions shall be used. $C_{min} = \max \{C_{min,b}; C_{min,dur}, 10\ mm\}$……..EBCS-2, 2015 (Page 47)

where: $C_{min,b}$……..:-Minimum cover due to bond requirement.

$C_{min,dur}$ …….:-Minimum cover due to environmental conditions.

In order to transmit bond forces safely and to ensure adequate compaction of the concrete, the minimum cover should not be less than $C_{min,b}$ given in from EBCS-2, 2015 (Page 48). We have selected separated bond requirement therefore; our minimum cover of bond is depending on diameter of bars using the table below. $C_{min,b}$=20mm dpending on the diameter of bar.

Table 7. 6: Minimum cover, $c_{min,b}$, requirements with regard to bond

| **Bond Requirement** | |
|---|---|
| Arrangement of bars | Minimum cover $c_{min,b}$* |
| Separated | Diameter of bar |
| Bundled | Equivalent diameter ($\phi_n$) (see 8.9.1) |
| *: If the nominal maximum aggregate size is greater than 32 mm, $C_{min,b}$, should be increased by 5 mm. | |

- **Requirements for durability**

The requirements for durability shall be included when considering the following According to EBCS-2:

- Structural conception,
- Material selection
- Construction details,
- Execution and Quality Control,
- Inspection and Verifications,

In our case the structural class we have selected is S3 then minimum concrete cover requirement with regard to durability is 10mm from table below.

Table 7. 7: Values of minimum cover, $c_{min,dur,}$ requirements with regard to durability for reinforcement steel in accordance with ES EN 2015

| **Environmental Requirement for $c_{min,dur}$ (mm)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Structural Class** | **Exposure Class according to EBCS** | | | | | | |
| | X0 | XC1 | XC2 / XC3 | XC4 | XD1/ XS1 | XD2/XS2 | XD3/XS3 |
| S1 | 10 | 10 | 10 | 15 | 20 | 25 | 30 |
| S2 | 10 | 10 | 15 | 20 | 25 | 30 | 35 |
| S3 | 10 | 10 | 20 | 25 | 30 | 35 | 40 |
| S4 | 10 | 15 | 25 | 30 | 35 | 40 | 45 |
| S5 | 15 | 20 | 30 | 35 | 40 | 45 | 50 |
| S6 | 20 | 25 | 35 | 40 | 45 | 50 | 55 |

- **Standard Fire resistance**

We have determined the standard fire resistance for each panel in according of EBCS using the following table. For our case we selected REI 60 =**15mm**

Table 7. 8: Minumum cover of concrete based on fire resistance

| Standard fire resistance | Minimum dimensions(mm) | | | |
|---|---|---|---|---|
| | Slab thickness hs(mm) | One way | Two way Ly/Lx ≤ 1.5 | Two way 1.5 ≤ Ly/Lx ≥ 2 |
| REI 30 | 60 | 10* | 10* | 10* |
| REI 60 | 80 | 20 | 10* | 15* |
| REI 90 | 100 | 30 | 15* | 20 |
| REI 120 | 120 | 40 | 20 | 25 |
| REI 180 | 150 | 55 | 30 | 40 |
| REI 240 | 175 | 65 | 40 | 50 |

- **Allowance in design for deviation**

The value of $\Delta c_{dev}$ for use in a Country may be found in its National Annex According to EBCS-2. The recommended value is 10 mm. so that we have selected also the recommended value 10mm.

Therefore, the nominal cover shall be specified on the drawings. It is defined as,

$$c_{nom} = c_{min} + \Delta c_{dev}$$ ……EBCS-2 2015, (page 47).

where $C_{nom}$ :- Nominal cover.
$C_{min}$ :- Minimum cover.
$\Delta C_{dev}$:- Allowance in design for deviation.

**For beam**

**For example Top tile beam concrete cover**

**Axis B on story 7 location 1**

- ✓ $c_{min,b}$ =20mm
- ✓ $c_{min,dur}$ = 10mm
- ✓ $C_{min}$ = max {20mm; 10mm, 10 mm}

- ✓ $C_{min}$ = 20mm
- ✓ $C_{nom} = C_{min} + \Delta C_{dev}$ from the above table we have listed $c_{min}$ = 20mm, $\Delta c_{dev}$ = 10mm
- ✓ $C_{nom}$ = 20+10=**30mm**
- ✓ Standard Fire resistance =**15mm**
- ✓ Therefore, the govering Concrete design cover for this panel is =**30mm**

**STEP 3: <u>Check depth for deflection</u>**

According to EBCS-2 2015(page 133) slab determination can be calculated by using the following formula and consideration.

$$\frac{l}{d} = N * K * F1 * F2 * F3$$

Where;

- ✓ $\frac{l}{d}$:- is the limit span/depth
- ✓ $N = \left[11 + 1.5\sqrt{f_{ck}}\frac{\rho_o}{\rho} + 3.2\sqrt{f_{ck}}\left(\frac{\rho_o}{\rho} - 1\right)^{\frac{3}{2}}\right]$ if $\rho \leq \rho_o$
- ✓ $N = \left[11 + 1.5\sqrt{f_{ck}}\frac{\rho_o}{\rho - \rho'} + \frac{1}{12}\sqrt{f_{ck}}\sqrt{\frac{\rho'}{\rho_o}}\right]$ if $\rho > \rho_o$
- ✓ $N = \left[11 + 1.5\sqrt{f_{ck}}\right]$ if $\rho = \rho_o$
- ✓ K: -is the factor to take into account the different structural systems
  - ✓ $\rho_o$:-is the reference reinforcement ratio ,

$$\rho_o = \frac{\sqrt{f_{ck}}}{1000}$$

- ✓ ρ: - is the required tension reinforcement ratio at mid-span to resist the moment due to the design loads (at support for cantilevers)
- ✓ ρ': - is the required compression reinforcement ratio at mid-span to resist the moment due to design loads (at support for cantilevers)
- ✓ $F1 = \frac{500}{f_{yk}}$
- ✓ $F2 = \frac{As,prov}{Asreq}$ < 1.5 For first Trial : use F 2= 1
- ✓ $F3$ = 1 [rectangular section, solid slab and T- section with b/bw≤ 3 ]
- ✓ $F3$= 0.8 for T section with b/bw> 3

Table 7. 9: Basic ratios of span/effective depth for reinforced concrete members without axial compression

| Structural System | K | Concrete highly stressed $\rho$ = 1.5% | Concrete lightly stressed $\rho$ = 0.5% |
|---|---|---|---|
| Simply supported beam, one – or two-way spanning simply supported slab | 1.1 | 14 | 20 |
| End span of continuous beam or one-way continuous slab or two-way spanning slab continuous over one long side | 1.3 | 18 | 26 |
| Interior span of beam or one-way or two-way spanning slab | 1.5 | 20 | 30 |
| Slab supported on columns without beams (flat slab) (based on longer span) | 1.2 | 17 | 24 |
| Cantilever | 0.4 | 6 | 8 |
| **Note 1:** The values given have been chosen to be generally conservative and calculation may frequently show that thinner members are possible.<br>**Note 2:** For 2-way spanning slabs, the check should be carried out on the basis of the shorter span. For flat slabs the longer span should be taken.<br>**Note 3:** The limits given for flat slabs correspond to a less severe limitation than a mid-span deflection of span/250 relative to the columns. Experience has shown this to be satisfactory. | | | |

Taking L/d=26 for end span L/d = 30 for interior span from ES EN 1992:2015 9 table 7.4N

Where L= effective length of the beam

d = effective depth but those value is for steel grade 500,

We must have to modify it. In our case, Modification factor =500/500=1

- Therefore, End span, 26*1=26
- Interior span, 30*1=30
- Cantilever, 8*1=8
- L= 5000mm
- End span, d = $\frac{L}{26} = \frac{5000mm}{26} =$ **192.31mm**

- Interior span, $d = \frac{L}{30} = \frac{5000mm}{30} =$ **166.67mm**

**Effective Depth determination for beam**

Depth determination: Serviceability Requirement for end panel

Using Φ12mm bar and clear cover of 22mm

- Total depth $D = dmin + cover + \frac{bar\ \Phi}{2}$
  - ✓ $D = 192.31 + \frac{20}{2} + 30 =$ **232.31mm**

Therefore, $D_{provideed}$ =300mm $\geq D_{required}$ = **232.31mm**….**okey!!!**

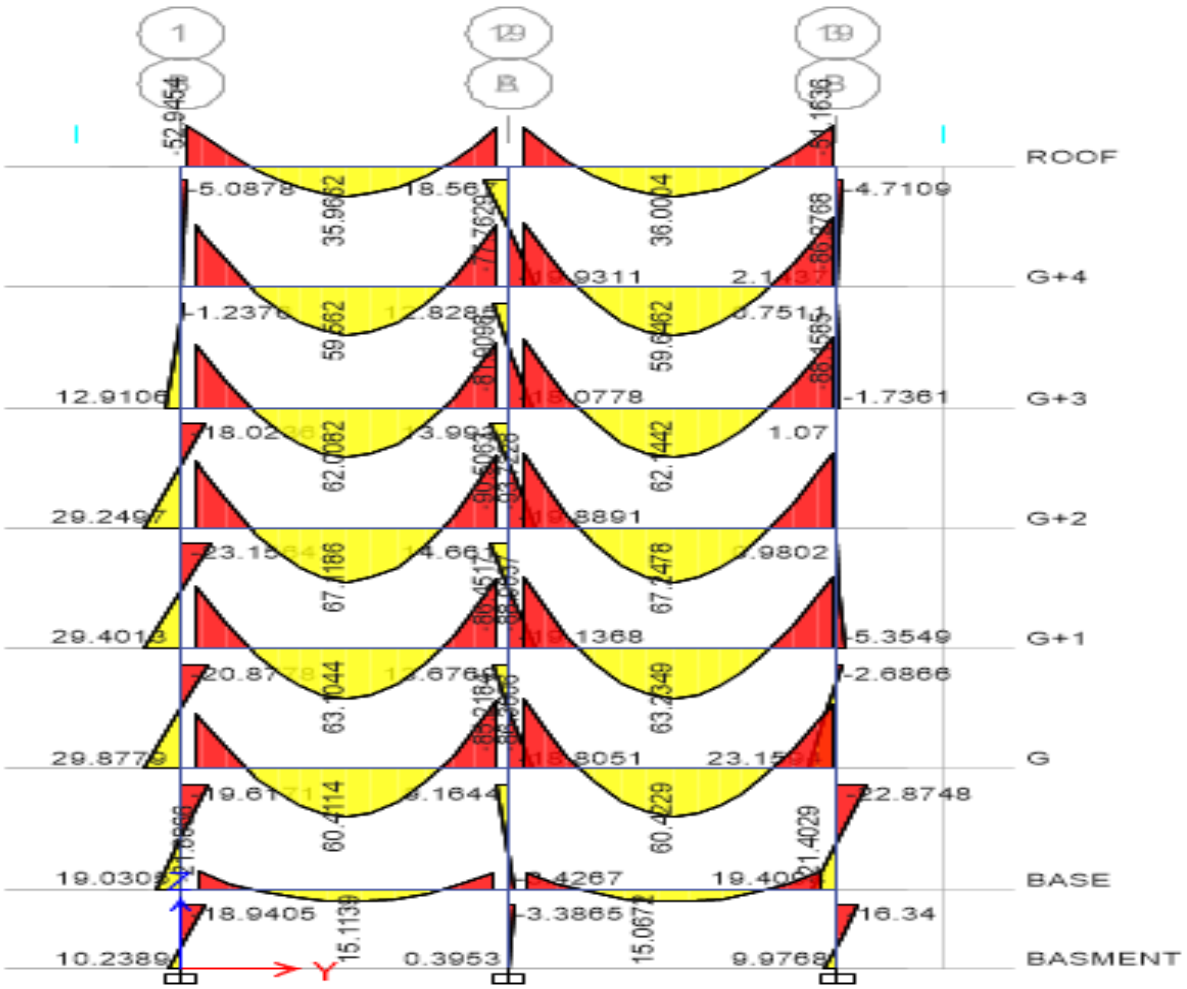



Figure 7. 1: Bending moment diagram (M3-3 on axis B)

**STEP 3**: **Check whether the beam is singly or doubly reinforced.**

- A beam should be treated as singly reinforced if K < 0.167.
- A beam should be treated as doubly reinforced if K > 0.167.
- d= effective depth-diameter of bar- concrete cover = 300-16-30 =**254mm**
- Where K =$\left(\frac{\text{Msd}}{\text{d}^2*\text{b}*\text{fck}}\right) = \left(\frac{52.9*1000000}{254*254*1000*24}\right)$ = **0.0551 < 0.167 singly reinforced.**

**STEP 4**: **Provide reinforcement**

- Z =$\left(\text{d}(0.5+\sqrt{0.25-\text{K}/1.134})\right)$

=$\left(254(0.5+\sqrt{0.25-0.0551/1.134})\right)$ = **240.98**

- As,cal =$\left(\frac{\text{Msd}}{0.87*\text{fyd}*\text{Z}}\right) = \left(\frac{52.9*10^6}{0.87*434.78*240.98}\right)$ = **504.898mm$^2$**

**STEP 5**: **Check for minimum & maximum reinforcement area**

- $\text{As}_{\text{min}} = \text{Max}\begin{Bmatrix}0.26\left(\frac{\mathbf{fctm}}{\mathbf{fyk}}\right)\text{btd} > \text{Asmax} = 0.04\text{bd} \\ 0.00013btd\end{Bmatrix}$

$= \text{Max}\begin{Bmatrix}0.26\left(\frac{\mathbf{2.4961}}{500}\right)*250*300 = \mathbf{97.34mm^2} \\ 0.0013*250*300 = \mathbf{97.5mm^2}\end{Bmatrix}$

- $\text{As}_{\text{min}}$ = **97.5mm$^2$**
- Asmax = 0.04bd= 0.04*250*300 =**3000mm$^2$**
- **Therefore,** $\text{AS,}_{\text{min}} \leq \text{AS,}_{\text{cal}} \leq \text{AS,}_{\text{max}}$
- $\text{AS,}_{\text{provided}} = \text{AS,}_{\text{cal}}$ =**504.898mm$^2$**

**STEP 6**: **No of steel, n**

- as = $\frac{\pi D^2}{4}$ =$\frac{3.14*16*16^2}{4}$ = **200.96mm$^2$**
- n = $\frac{AS,cal}{as} = \frac{504.898}{200.96}$ **= 2.5124 ≅ 3**
- **Therefore, provide 3Ø16**

**For Location span 1&2 on axis B**

**STEP 1: Concrete cover = 30mm**

**STEP 2: Check depth for deflection**

- d= effective depth-diameter of bar- concrete cover = 300-16-30 =**254mm**

**STEP 3**: **Check whether the beam is singly or doubly reinforced.**

- A beam should be treated as singly reinforced if K < 0.167.
- A beam should be treated as doubly reinforced if K > 0.167.
- Where K =$\left(\frac{\text{Msd}}{\text{d}^2*\text{b}*\text{fck}}\right) = \left(\frac{35.96*1000000}{254*254*1000*24}\right)$ = **0.0375 < 0.167 singly reinforced.**

**STEP 4**: **Provide reinforcement**

- Z =$\left(\text{d}(0.5+\sqrt{0.25-\text{K}/1.134})\right)$

=$\left(254(0.5+\sqrt{0.25-0.0375/1.134})\right)$ = **245.31**

- As,cal =$\left(\frac{\text{Msd}}{0.87*\text{fyd}*\text{Z}}\right) = \left(\frac{35.96*10^6}{0.87*434.78*245.31}\right)$ = **337.16467mm$^2$**

**STEP 5**: **Check for minimum & maximum reinforcement area**

- $\text{As}_{\text{min}} = \text{Max}\left\{\begin{matrix}0.26\left(\frac{\mathbf{fctm}}{\mathbf{fyk}}\right)\text{btd} > \text{Asmax} = 0.04\text{bd} \\ 0.00013btd\end{matrix}\right\}$

$= \text{Max}\left\{\begin{matrix}0.26\left(\frac{\mathbf{2.4961}}{500}\right)*250*300 = \mathbf{97.34mm^2} \\ 0.0013*250*300 = \mathbf{97.5mm^2}\end{matrix}\right\}$

- $\text{As}_{\text{min}}$ = **97.5mm$^2$**
- Asmax = 0.04bd= 0.04*250*300 =**3000mm$^2$**
- **Therefore,** $\text{AS,}_{\text{min}} \leq \text{AS,}_{\text{cal}} \leq \text{AS,}_{\text{max}}$
- $\text{AS,}_{\text{provided}} = \text{AS,}_{\text{cal}}$ =**337.16467mm$^2$**

**STEP 6**: **No of steel, n**

- as = $\frac{\pi D^2}{4} = \frac{3.14*16*16^2}{4}$ = **200.96mm$^2$**
- n = $\frac{AS,cal}{as} = \frac{337.16467}{200.96}$ **=1.6778≅ 2**
- **Therefore, provide 2∅16**

## 7.3. Shear Design

The concrete itself can resist shear by a combination of un-cracked concrete in the compression zone. The dowelling action of the bending reinforcement and aggregate interlocking across tension crack but, because concrete is weak in tension, the shear reinforcement is designed to resist all the tensile stress caused by the shear force.

Even where the shear force is small near the Centre span of beam a minimum amount of reinforcement in the form of links must be provided in order to form a cage supporting the longitudinal reinforcement and to resist any tensile stresses due to factors such as thermal movement and shrinkage of concrete.

Behavior of beams without web reinforcement.

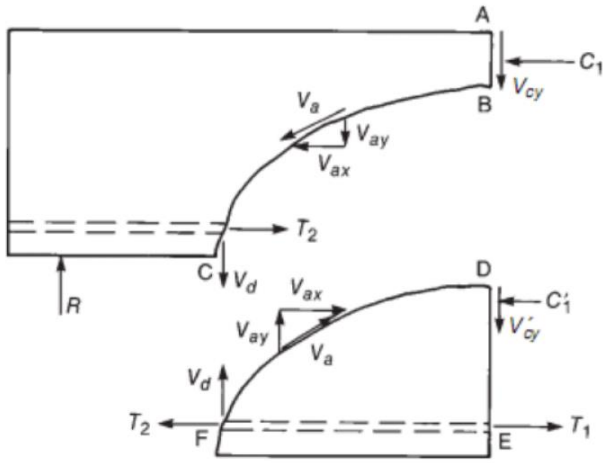



Figure 7. 2: Internal forces in a cracked beam without web reinforcement

Shear is transferred across line A-B-C by Vcy , the shear in the compression zone, by Vay , the vertical component of the shear transferred across the crack by interlock of the aggregate articles on the two faces of the crack, and by Vd , the dowel action of the longitudinal reinforcement. Immediately after inclined cracking, as much as 40 to 60 percent of the total shear is carried by Vd and Vay together.

**Behavior of beams with web reinforcement**

Inclined cracking causes the shear strength of beams to drop below the flexural capacity. The purpose of web reinforcement is to ensure that the full flexural capacity can be developed. Prior to inclined cracking, the strain in the web reinforcement is equal to the corresponding strain of the concrete. Because concrete cracks at a very small strain, the stress in the web reinforcements prior to inclined cracking will not exceed 3 to 6 ksi.

Thus, web reinforcements do not prevent inclined cracks from forming; they come into play after the cracks have formed.

For the verification of the shear resistance the following symbols are defined:

- VRd,c is the design shear resistance of the member without shear reinforcement.
- VRd,s is the design value of the shear force which can be sustained by the yielding shear reinforcement.
- VRd,max is the design value of the maximum shear force which can be sustained by the member, limited by crushing of the compression struts.

In regions of the member where VEd ≤ VRd,c, no calculated shear reinforcement is necessary. VEd is the design shear force in the section considered resulting from external loading and prestressing (bonded or unbonded).

When, on the basis of the design shear calculation, no shear reinforcement is required, minimum shear reinforcement should nevertheless be provided according to 9.2.2.

In regions where VEd > VRd,c, sufficient shear reinforcement should be provided in order that VEd ≤ VRd .

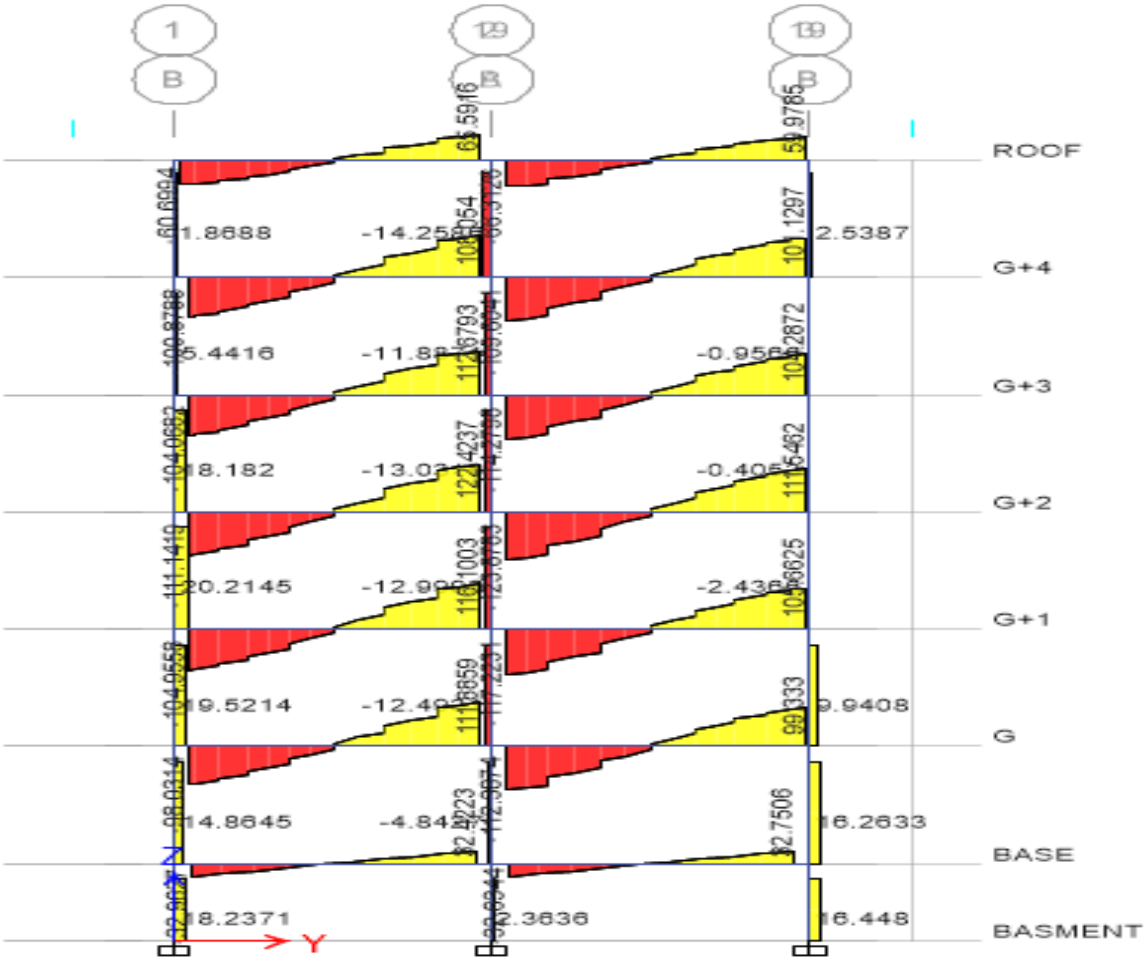



Figure 7. 3: Shear force diagram of beam in axis B

Sample example design shear 1 on axis B at for story 7

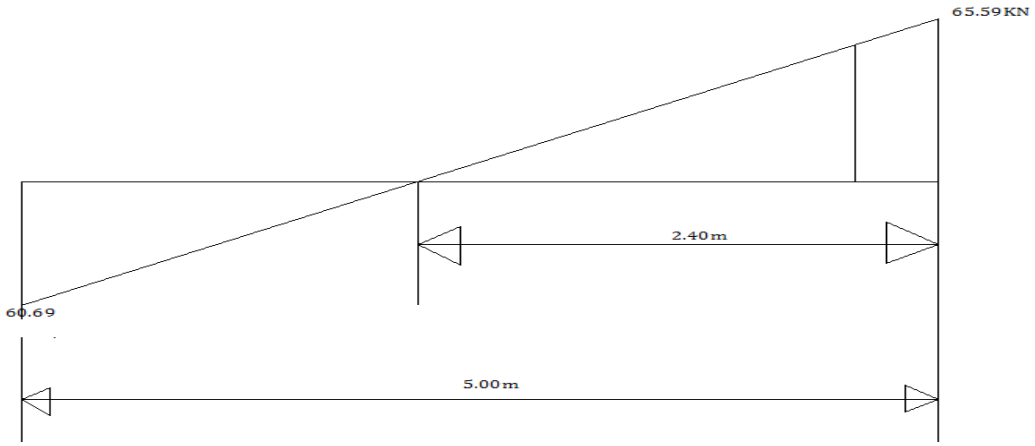



Figure 7. 4: Shear force diagram sample

$\frac{65.5916}{2.4} = \frac{VEd}{2.4-0.254}$ ……**VEd = 58.6607KN**

A. **Concrete capacity**

The design value for the shear resistance VRd, c is given by:

- VRd,c= $[C_{Rd,c}K(100\ \rho 1 fck)^{1/3} + k1\sigma cp]\ b_w d$ with a minimum of VRd,c= $(Vmin + k1\sigma cp)\ b_w d$

  Where:
  - ✓ fck = 24Mpa
  - ✓ k = $1+\sqrt{\frac{200}{d}} \geq 2.0 = 1+\sqrt{\frac{200}{254}} = 1.887 \geq 2.0$……Not okey therefore, k = **1.887**
  - ✓ $V_{min}=0.035*k^{3/2*}fck^{1/2} = 0.4444$
  - ✓ $Ast$ is the area of the tensile reinforcement = 337.16467mm$^2$
  - ✓ $bw$ is the smallest width of the cross-section in the tensile area (mm) = 250mm
  - ✓ $\rho_1 = \frac{Ast}{b_w d} \leq 0.02 = \frac{337.16467}{250*254} = 0.0053 \leq 0.02$…… its okey therefore $\rho_1$= **0.0053**
  - ✓ $Ac$ is the area of concrete cross-section (mm2)
  - ✓ $\sigma_{cp}=\frac{N_{Ed}}{A_c}$ = **0N**

    $N_{Ed}$ is the axial force in the cross-section due to loading or prestressing [in N] ($N_{Ed}$> 0 for compression). The influence of imposed deformations on $N_{Ed}$may be ignored. $A_c$is the area of concrete cross section [mm$^2$].
  - ✓ VRd,c is in (N)
  - ✓ $C_{Rd,c} = \frac{0.18}{\gamma c} = \frac{0.18}{1.5}$ = **0.12**
  - ✓ $K1$= 0.15
- VRd,c = $[C_{Rd,c}K(100\ \rho 1 fck)^{1/3} + k1\sigma cp]\ b_w d$

  = $[0.12*1.887(100*0.0053 * 24)^{1/3} + 0.15*0]\ 250 * 254$ =**33585.622N**

  = **33.585KN**
- Vmin= $(Vmin + k1\sigma cp)\ b_w d$

= (0.4444+ 0.15*0) $250 * 254$ = **28219.4N**

**= 28.219KN**

- Maximum shear acting take **33.585KN**
- Thus, VRd,c > $V_{Ed}$…. **33.585KN < 58.66KN….it is okey Shear reinforcement is required.**

B. **Diagonal compression check of concrete**

Where v is a strength reduction factor for concrete cracked in shear.

V = 0.6 for $f_{ck} \leq 60MPa$ from ESEN 1992-1:2015

$$V_{Rd,max} = \alpha_{cw} b_w \, Z \, v_1 f_{cd} \left(\frac{1}{cot\theta + tan\theta}\right)$$

Where:

- ✓ $\alpha_{cw}$= 1 and cot$\theta$=2.5
- ✓ $b_w$ = 250mm
- ✓ Z = 0.9d = 0.9*254 =**228.6mm**

For C-30 fck =0.8*30Mpa=**24Mpa** or from EBCS-2, 2015 Table 3.1 (Page 25).

fcd =$0.85 * \frac{24}{1.5}$= **13.6 Mpa**

- ✓ $v_1$= 0.6 ( 1- $\frac{f_{ck}}{250}$) = 0.6 (1-24/250) = **0.5424**
  - ✓ $V_{Rd,max} = \alpha_{cw} b_w \, Z \, v_1 f_{cd} \left(\frac{1}{cot\theta + tan\theta}\right)$

= $1 * 250 * 228.6 * 0.5424 * 13.6 * \left(\frac{1}{2.5 + 0.4}\right)$ = **145.370KN > VEd…its okey!!**

C. **Calculate the required shear reinforcement**

The ratio of shear reinforcement is given by;

$$\rho_w = \frac{As_w}{(S * bw - \sin\alpha)}$$

Where:

- ✓ $\rho_w$ : is the shear reinforcement ratio

  $\rho_w$ should not be less than $\rho_w, min$
- ✓ $As_w$ : is the area of shear reinforcement within length s
- ✓ S: is the spacing of the shear reinforcement measured along the longitudinal axis of the member
- ✓ bw : is the breadth of the web of the member
- ✓ $\alpha$ : is the angle between shear reinforcement and the longitudinal axis.

✓ $\rho_{w,min} = \frac{0.08\sqrt{f_{ck}}}{f_{yk}} = \frac{0.08\sqrt{24}}{500}$ =0.000784

- The maximum longitudinal spacing between shear assemblies should not exceed $Sl_{,max}$ .

$Sl_{max}$ =0.75d( 1+ cot $\alpha$)

Where $\alpha$ is the inclination of the shear reinforcement to the longitudinal axis of the beam.

$Sl_{max}$ =0.75*254( 1+ cot 90) = **190.5mm**

- The maximum longitudinal spacing of bent-up bars should not exceed. $Sl_{,max}$ .

$Sl_{,max}$ = 0.6d( 1 + cot $\alpha$) = 0.6*254(1+cot90) =**152.4mm**

- The transverse spacing of the legs in a series of shear links should not exceed $St_{,max}$ .

$St_{,max}$ = 0.75d = 0.75*254 = **190.5mm $\leq$ 600mm**

- $As_w = \frac{\pi d^2}{4} = \frac{3.14*8^2}{4}$ = **50.24mm²**
- $S_{min} = \frac{As_w}{(\rho_w * bw * \sin\alpha)} = \frac{50.24}{(0.000784 * 250 * \sin 90)}$ = **256.326mm**
- Required shear reinforcement

$$\frac{As_w}{S} = \frac{V_{Ed}}{0.78*fyk\cot\theta}$$

$S_{cal} = \frac{As_w*0.78*d*fyk*\cot\theta}{V_{Ed}} = \frac{50.24*0.78*254*500*2.5}{49.021}$ = **253.808mm**

$S_{prov}$= min$\{Sl_{,max}, Sl_{,max}, St_{,max}\}$……but $S_{prov} \geq S_{min}$

$S_{prov}$= min$\{190.5, 152.4, 253.808\}$……but $S_{prov} \geq 256.326$mm

$S_{prov}$=152.4mm $\geq S_{min}$ =256.326**…..okey!!**

Therefore, Use dia of 8mm c/c 250mm.

### 7.4. Anchorage of longitudinal reinforcement

Reinforcing bars, wires or welded mesh fabrics shall be so anchored that the bond forces are safely transmitted to the concrete avoiding longitudinal cracking or spalling. Transverse reinforcement shall be provided if necessary.

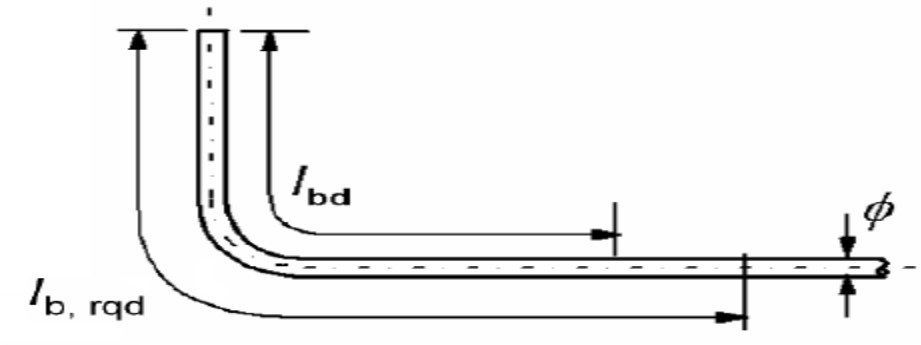



Figure 7. 5: Basic tension anchorage length, $l_{b.rqd}$, for any shape measured along the centerline

- $l_{b.rqd} = (\frac{\emptyset}{4})(\frac{fyd}{fbd})$

For bent bars the basic required anchorage length, $l_{b.rqd}$, and the design length, $l_{bd}$, should be measured along the centre-line of the bar. The calculation of the required anchorage length shall take into consideration the type of steel and bond properties of the bars. The ultimate bond strength shall be sufficient to prevent bond failure.

The design value of the ultimate bond stress, *fbd*, may be taken as:

fbd = 2.25*$\mu 1 * \mu 2 *$fctd

Where:

fctd: is the design value of concrete tensile strength, fctd = fctk/1.5 = 0.8587

$\mu 1$ : is a coefficient related to the quality of the bond condition and the position of the bar during concreting.

$\mu 1 = 1.0$ when 'good" conditions are obtained and

$\mu 1 = 0.7$ for all other cases and for bars in structural elements built with slip-forms, unless it can be shown that 'good' bond conditions exist.

Therefore, $\boldsymbol{\mu 1 = 1.0}$

$\mu 2$ is related to the bar diameter:

$\mu 2$ = 1.0 for$\emptyset$ 32mm

$\mu 2$ = (132-$\emptyset$) /100 for 32mm

Therefore $\mu 2$ = 1.0 since $\emptyset$=16mm $\leq$32mm

fbd = 2.25*$\mu 1 * \mu 2 *$fctd = 2.25*1*1*0.8587 = **1.93MPa**

$l_{b.rqd} = (\frac{\emptyset}{4})(\frac{fyd}{fbd})$ = (16/4)( 434.78/1.93) = **901.098mm**

The design anchorage length, lbd, is:

- $lbd = \alpha_1 * \alpha_2 * \alpha_3 * \alpha_5 * \alpha_6 \ \ l_{b.rqd} \geq l_{b,min}$

  where

  $\alpha_1, \alpha_2, \alpha_3, \alpha_4,$ and $\alpha_5$ are coefficients given in Table 8.2:

  $\alpha_1$ is for the effect of the form of the bars assuming adequate cover

  $\alpha_2$ is for the effect of concrete minimum cover

  $\alpha_3$ is for the effect of confinement by transverse reinforcement

  $\alpha_4$ is for the influence of one or more welded transverse bars ( $\emptyset t > 0.6\emptyset$) along the design anchorage length lbd

  $\alpha_5$ is for the effect of the pressure transverse to the plane of splitting along the design anchorage length

The product $(\alpha_2 \ \alpha_3 \ \alpha_5) \geq 0.7$

- lb,rqd is basic anchorage length, obtained earlier.
- lb,min is the minimum anchorage length if no other limitation is applied:
  - ✓ for anchorages in tension: lb,min ≥ max{0.3lb,rqd ; 10∅; 100 mm}
  - ✓ for anchorages in compression: lb,min ≥ max{0.6lb,rqd ; 10∅; 100 mm}

Table 7. 10: Value of $\alpha_1, \alpha_2, \alpha_3, \alpha_4,$ and $\alpha_5$ coefficients

| Influencing factor | Type of anchorage | Reinforcement bar | |
|---|---|---|---|
| | | In tension | In compression |
| Shape of bars | Straight | $\alpha_1$=1.0 | $\alpha_1$= 1.0 |
| | Other than straight (see Figure 8.1 (b), (c) and (d) | $\alpha_1$ = 0.7 if *cd* > 3∅ otherwise $\alpha_1$ = 1.0 (see Figure 8.3 for values of *c*d) | $\alpha_1$ = 1.0 |
| Concrete cover | Straight | $\alpha_2 = 1 - 0.15\ (cd - 3\emptyset)/\emptyset$ ≥ 0.7 ≤ 1.0 | $\alpha_2$ = 1.0 |
| | Other than straight (see Figure 8.1 (b), (c) and (d)) | $\alpha_2 = 1 - 0.15\ (cd - 3\emptyset)/\emptyset$ ≥ 0.7 ≤ 1.0 (see Figure 8.3 for values of *c*d) | $\alpha_2$ = 1.0 |

| | | | |
|---|---|---|---|
| Confinement by transverse reinforcement not welded to main reinforcement | All types | $\alpha_3 = 1 - K\mu$<br>$\geq 0.7$<br>$\leq 1.0$ | $\alpha_3 = 1.0$ |
| Confinement by welded transverse reinforcement* | All types, position and size as specified in Figure 8.1 (e) | $\alpha_4 = 0.7$ | $\alpha_4 = 0.7$ |
| Confinement by transverse pressure | All types | $\alpha_5 = 1 - 0.04p$<br>$\geq 0.7$<br>$\leq 1.0$ | -- |

lbd = $\alpha_1 * \alpha_2 * \alpha_3 * \alpha_5 * \alpha_6$ $l_{b.rqd} \geq l_{o,min}$= 1x0.7x0.7x0.7x0.7x901.098= **216.35mm**

But, lbd ≥ lb,min

- **For anchorages in tension:**
  - ✓ lb,min ≥ max{0.3lb,rqd ; 10Ø; 100 mm}
  - ✓ lb,min ≥ max{0.3x901.098=270.33mm ; 10Ø =200mm; 100 mm}
    lb,min ≥ max{270mm; 200mm; 100 mm}
    lb,min ≥ 270mm
- **For anchorages in compression:**
  - ✓ lb,min ≥ max{0.3lb,rqd ; 10Ø; 100 mm}
  - ✓ lb,min ≥ max{0.3x901.098=270.33mm ; 10Ø =200mm; 100 mm}
    lb,min ≥ max{270mm; 200mm; 100 mm}
    lb,min ≥ 270mm
- **The design anchorage length, lbd, is:**
  - ✓ For tension, lbd =280mm
  - ✓ For compression, lbd =280mm

**Anchorage of bottom reinforcement at intermediate supports**

The anchorage length should not be less than 10Ø (for straight bars) or not less than the diameter of the mandrel (for hooks and bends with bar diameters at least equal to 16 mm) or twice the diameter of the mandrel. This reinforcement should be continuous which may be achieved by means of lapped bars.

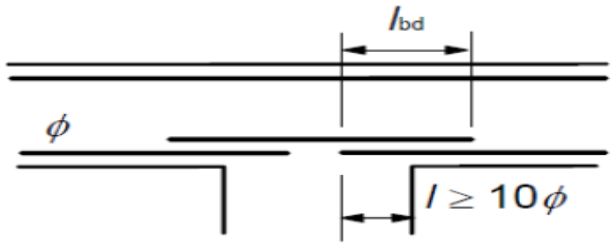



Figure 7. 6: Anchorage at intermediate supports

### 7.5. Laps

- Forces are transmitted from one bar to another by:
  - ✓ **Lapping of bars**, with or without bends or hooks;
  - ✓ Welding;
  - ✓ Mechanical devices assuring load transfer in tension-compression or in compression only.
- The detailing of laps between bars shall be such that:
  - ✓ The transmission of the forces from one bar to the next is assured;
  - ✓ Spalling of the concrete in the neighborhood of the joints does not occur;
  - ✓ Large cracks which affect the performance of the structure do not occur.
  - ✓ between bars should normally be staggered and not located in areas of high moments /forces (e.g. plastic hinges).
  - ✓ at any section should normally be arranged symmetrically.
- The arrangement of lapped bars should comply with Figure 8.7:
  - ✓ The clear distance between lapped bars should not be greater than 4Ø or 50 mm, otherwise the lap length should be increased by a length equal to the clear space where it exceeds 4Ø or 50 mm;
  - ✓ The longitudinal distance between two adjacent laps should not be less than 0.3 times the lap length,$l0$;
  - ✓ In case of adjacent laps, the clear distance between adjacent bars should not be less than 2Ø or 20 mm.

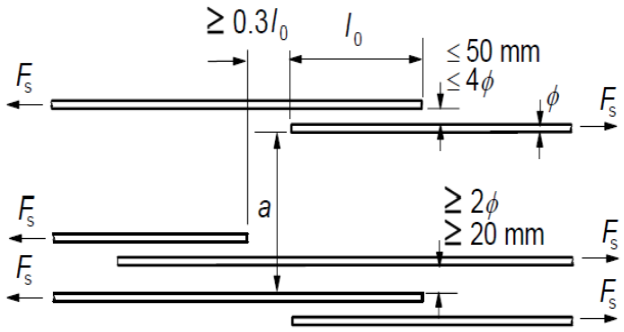



Figure 7. 7: Adjacent laps

### 7.5.1. Lap Length

**The design lap length is:**

- $l_o = \alpha_1 * \alpha_2 * \alpha_3 * \alpha_5 * \alpha_6 \ l_{b.rqd} \geq l_{o,min}$

  where: $l_{b.rqd}$ is basic anchorage length

  $l_{o,min} \geq \max \{0.3 \ \alpha_6 \ l_{b.rqd}; 15\emptyset; 200 \text{ mm}\}$

  Values of $\alpha_1, \alpha_2, \alpha_3$ and $\alpha_5$ may be taken from table ;

  $\alpha_6$ = Values of $\alpha_6$ are given in Table belew.

Table 7. 11: Values of the coefficient $\alpha_6$

| Percentage of lapped bars relative to the total cross-section area | < 25% | 30% | 50% | > 50% |
|---|---|---|---|---|
| $\alpha_6$ | 1 | 1.15 | 1.4 | 1.5 |
| **Note:** Intermediate values may be determined by interpolation. | | | | |

- $l_o = \alpha_1 * \alpha_2 * \alpha_3 * \alpha_5 * \alpha_6 \ l_{b.rqd} \geq l_{o,min}$
  $= 1*0.7*0.7*0.7*1.4\&901.098 =$ **432.707mm** $\geq l_{o,min}$
- $l_{o,min} \geq \max \{0.3 \ \alpha_6 \ l_{b.rqd}; 15\emptyset; 200 \text{ mm}\}$
- $l_{o,min} \geq \max \{0.3*1.4* 901.098 = 378.461\text{mm}; 15* 16 = 240\text{mm}; 200 \text{ mm}\}$
- Therefore, Take $l_o$ = 400mm

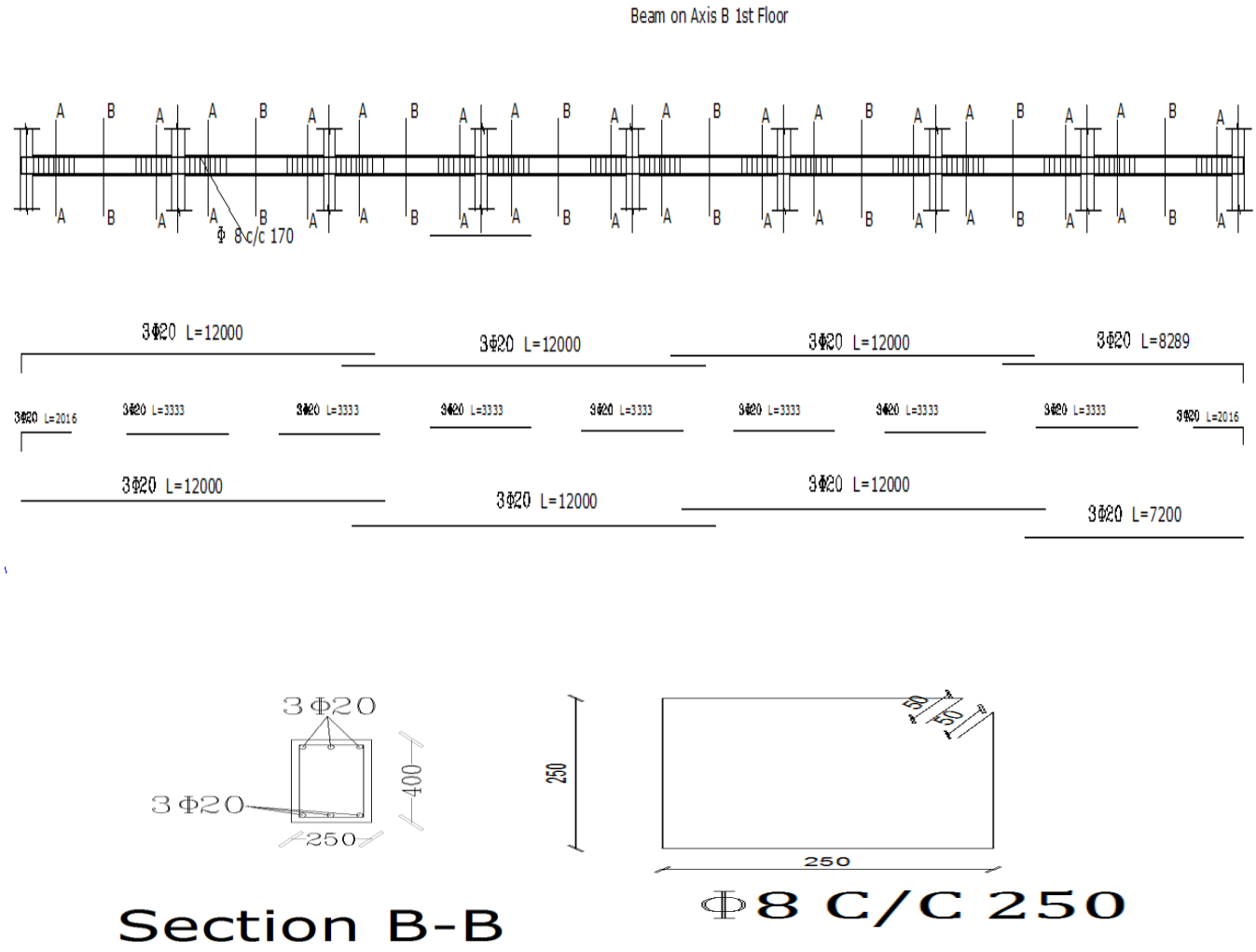



Figure 7. 8: beam detail on axis B 1st floor

# CHAPTER-EIGHT

# STRUCTURAL ANALYSIS AND DESIGN OF COLUMN

## 8.1. Introduction

A column is a vertical structural member transmitting axial compression loads with or without moments. The cross sectional dimensions of a column are generally considerably less than its height. Column support mainly vertical loads from the floors and roof and transmit these loads to the foundation.

The strength of a column depends on many factors including the following:

- The strength of the material
- Shape and size of the cross section
- Length
- The degree of positional and directional restraints at its end

Classification of columns

- Classification on the basis of geometry; rectangular, square, circular, etc. depending on the structural or architectural requirements.
- Classification on the basis of degree of slenderness; short column, slender(long) column.
- Classification on the basis of loading: axially loaded column, columns under uni-axial bending or columns under biaxial bending.
- Classification on the basis of lateral reinforcement; tied columns, spiral columns.
- Classification on the basis of lateral stability is provided to the structure as a whole; braced or un braced column

Axial column; column subjected to axial loads accompanied by bending about one axis whereas biaxial, for column support axial force and bending about two perpendicular axes. A braced structure is one which contain bracing elements. These are vertical elements usually walls, which are so stiff relative to other vertical elements that may be assumed to be attract all horizontal forces. Braced structure may be defined as one where the bracing elements attract and transmits to the foundations, at least 90% of all horizontal forces applied to the structure.

Braced structure is one where side sway of the whole structure is unlikely to be significant while in unbraced structure sideways likely to be significant, and defined as lateral displacement of the ends of the column increasing the critical bending moment by more than 10% above calculated by ignoring the displacement.

## 8.2. Design procedure

- Determination of concrete cover
- Determination of effective buckling of compressive member

- ✓ $l_0 = 0.5 * 1 * \sqrt{\left(1 + \frac{K1}{0.45+K1}\right)\left(1 + \frac{K2}{0.45+K2}\right)}$

- Check the frame is sway non sway
  - ✓ Ned/Ncr >0.01 sway otherwise Non sway
- Checking for slenderness limit
  - ✓ ʎlim=20ABC/√ n

    Where: A=0.7 B=1.1 C=1.7-rm

    rm= m1/m 2 and n= Ned/Ac.fcd .

  If ʎ> ʎlim slender column, otherwise its short column
- Determination of accidental eccentricity
  - ✓ ea= lo/400 >20
- Determination of equivalent first order eccentricity
  - ✓ ee = max ( 0.6e02 +0.4e01,0.4e01)

    where : e02 = M02/Nsd

    e01 = M01/Nsd
- Second order moment if it's slender column
  - ✓ Can be calculate in to two method the second order moment Using nominal curvature method
  - ✓ e2= lo2/r.c

    Where c=10 for constant cross-section

    1/r = kr.k Φro , where kΦ =1+ßΦeff

    ß=0.35+fck/200- ʎ/150

    1/ro=Ɛ yd/ 0.45dkr =( nu-n )/nu-nbal, where; nu =1+ω̃ ,and n=Ned/ Ac.fcd
- Calculate the total of eccentricity
  - ✓ etot = eo+ ee+e2 & etot= e02+ea

    take maximum values
- Determination of the normalized axial and bending moment
- If it's biaxial column calculate
  - ✓ vsd=Ned/fcd.bh
  - ✓ Msd = Nsd*etot then, $\mu sd$,y = Msd,y/(fcd.Ac.h)
  - ✓ Msd = Nsd*etot then, $\mu sd$,x = Msd,x/(fcd.Ac.h)
- If it's uniaxial column calculate

- ✓ vsd = Nsd/fcd.bh
- ✓ $\mu sd$ = Msd /fcd.bd

➢ Determination of mechanical steel ratio (ω) from uniaxial and biaxial interaction chart using

- ✓ For biaxial column vsd , $\mu$sd,y and $\mu$sd,x
- ✓ For uniaxial column vsd and $\mu$sd

➢ Determination of reinforcement using the following formulas

- ✓ As.tot =ω *fcd *b* d/fyd

➢ Check with maximum and minimum reinforcement limit

- ✓ As,min =max of 0.1NED/fyd & 0.002Ac
- ✓ As,max = 0.04Ac

**Rectangular column sample calculation for C-3 4th floor column**

➢ **Given data**

Table 8. 1:Top beam cross section

| Top beam | depth(m) | width(m) | length(m) |
|---|---|---|---|
| b1(x,x) | 0.4 | 0.25 | 5.000 |
| b2(x,x) | 0.4 | 0.25 | 5.000 |
| b1(y,y) | 0.4 | 0.25 | 5.000 |
| b2(y,y) | 0.4 | 0.25 | 5.000 |

Table 8. 2: Bottom cross section

| Bottom beam | depth(m) | width(m) | length(m) |
|---|---|---|---|
| b3(x,x) | 0.4 | 0.25 | 5.000 |
| b4(x,x) | 0.4 | 0.25 | 5.000 |
| b3(y,y) | 0.4 | 0.25 | 5.000 |
| b4(y,y) | 0.4 | 0.25 | 5.000 |

Table 8. 3: Dimension of column

| Column | depth(m) | width(m) | length(m) |
|---|---|---|---|
| C-3 | 0.4 | 0.4 | 3.00 |

Mtopx-x=1.38KNm Mtopy-y=10.72KNm

Mbotx-x=1.91KNm Mboty-y=22.71KNm

NED=609.74KN

Where: NED is axial compression

**Step 1: concrete cover**

The concrete cover is the distance from the surface of the reinforcement closest to the nearest concrete surface (including links and stirrups and surface reinforcement where relevant) and the nearest concrete surface. Based on ES EN 2015 governing design cover is obtained as following;

**Procedure for determining minimum concrete cover**

- ✓ Determine panel selection and naming.
- ✓ Determine corrosion type Based on exposure class from EBCS-2,2015 Table 4.1 (Page 46).
- ✓ Determine Indicative strength classes based on corrosion type.
- ✓ Determine structural class based on design working life.
- ✓ Determine the minimum bond cover with regard to bond.
- ✓ Determine the minimum durability cover based on structural class S3.
- ✓ Determine the Allowance in design for deviation based on national annex.
- ✓ Determine the nominal cover of the concrete.
- ✓ Determine the govering concrete cover.

➢ **Exposure classes**

The exposure class we have selected for our building related to environmental is dry or permanently wet. Therefore, we have selected XC2 using the table found below.

Table 8. 4: Exposure classes related to environmental conditions in accordance with ES EN 2015

| Class Designation | Description of the Environment | Informative examples where exposure classes may occur |
|---|---|---|
| **3. Corrosion induced by carbonation** | | |
| XC1 | Dry or permanently wet | Concrete inside buildings with low air humidity Concrete permanently submerged in water |
| XC2 | Wet, rarely dry | Concrete surfaces subject to long-term water contact Many foundations |
| XC3 | Moderate humidity | Concrete inside buildings with moderate or high air humidity External concrete sheltered from rain |
| XC4 | Cyclic wet and dry | Concrete surfaces subject to water |

| | | |
|---|---|---|
| | | contact, not within exposure class XC2 |

- **Indicative strength classes**

The choice of adequately durable concrete for corrosion protection of reinforcement and protection of concrete attack, requires consideration of the composition of concrete. This may result in a higher compressive strength of the concrete than is required for structural design. For our case we have selected C25/30 using the table below.

Table 8. 5: Indicative minimum strength class in accordance with ES EN 2015

| | **Exposure Classes according to EBCS** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Corrosion** | | | | | | | | | | |
| | Carbonation-induced corrosion | | | | Chloride-induced corrosion | | | Chloride-induced corrosion from sea-water | | |
| | XC1 | XC2 | XC3 | XC4 | XD1 | XD2 | XD3 | XS1 | XS2 | XS3 |
| Indicative Strength Class | C20/25 | C25/30 | C30/37 | | C30/37 | | C35/45 | C30/37 | C35/45 | |
| **Damage to Concrete** | | | | | | | | | | |
| | No risk | Freeze/Thaw Attack | | | Chemical Attack | | | | | |
| | X0 | XF1 | XF2 | XF3 | XA1 | XA2 | XA3 | | | |
| Indicative Strength Class | C12/15 | C30/37 | C25/30 | C30/37 | C30/37 | | C35/45 | | | |

- **Design working life**

In order to achieve the required design working life of the structure, adequate measures shall be taken to protect each structural element against the relevant environmental actions. For our building we considered design working life is for 50 years. Based on this the structural class for this building is S4 from EBCS-1, 2015.

Table 8. 6: Indicative design working life

| **Design working life category** | **Indicative design working life (years)** | **Examples** |
|---|---|---|
| 1 | 10 | Temporary structures(1) |
| 2 | 10 to 15 | Replaceable structural parts, e.g. gantry girders, bearings |
| 3 | 15 to 30 | Agricultural and similar structures |
| 4 | 50 | Building structures and other common structures |
| 5 | 100 | Monumental building structures, bridges, and other civil engineering structures |
| (1) Structures or parts of structures that can be dismantled with a view to being re-used should not be considered as temporary. | | |

- **Structural classification**

We have considered a structural class by member with slab geometry (position of reinforcement not affected by construction process), since our exposure class we selected is XC1, therefore our structural class is S4 because the class is reduced by 1 using the table below.

Table 8. 7: Recommended structural classification

| **Structural Class** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Criterion** | **Exposure Class according to EBCS** | | | | | | |
| | X0 | XC1 | XC2 / XC3 | XC4 | XD1 | XD2/ XS1 | XD3/ XS2/ XS3 |
| Design working life of 100 years | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 | Increase class by 2 |
| Strength Class[1)2)] | ≥C30/37 reduce class by 1 | ≥C30/37 reduce class by 1 | ≥C35/45 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C40/50 reduce class by 1 | ≥C45/55 reduce class by 1 |
| Member with slab geometry (Position of reinforcement not affected by construction process) | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 |
| Special Quality Control of the concrete production ensured | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 | reduce class by 1 |

- **Minimum concrete cover**

The concrete cover is the distance between the surface of the reinforcement closest to the nearest concrete surface (including links and stirrups and surface reinforcement where relevant) and the nearest concrete surface. The nominal cover shall be specified on the drawings. It is defined as,

$C_{nom} = C_{min} + \Delta C_{dev}$ ……EBCS-2 2015, (page 47).

where $C_{nom}$ :- Nominal cover.

$C_{min}$ :- Minimum cover.

$\Delta C_{dev}$:- Allowance in design for deviation.

- **Minimum cover (cmin)**

Minimum concrete cover, cmin shall be provided in order to ensure:

- The safe transmission of bond forces.
- The protection of the steel against corrosion (durability).

- An adequate fire resistance.

The greater value for $C_{min}$ satisfying the requirements for both bond and environmental conditions shall be used. $C_{min} = \max \{C_{min,b}; C_{min,dur}, 10\ mm\}$……..EBCS-2, 2015 (Page 47)

where: $C_{min,b}$……..:-Minimum cover due to bond requirement.

$C_{min,dur}$ …….:-Minimum cover due to environmental conditions.

In order to transmit bond forces safely and to ensure adequate compaction of the concrete, the minimum cover should not be less than $C_{min,b}$ given in from EBCS-2, 2015 (Page 48). We have selected separated bond requirement therefore; our minimum cover of bond is depending on diameter of bars using the table below.

Table 8. 8: Minimum cover, $c_{min,b}$, requirements with regard to bond

| **Bond Requirement** | |
|---|---|
| Arrangement of bars | Minimum cover $c_{min,b}$* |
| Separated | Diameter of bar |
| Bundled | Equivalent diameter ($\phi_n$) (see 8.9.1) |
| *: If the nominal maximum aggregate size is greater than 32 mm, $C_{min,b}$, should be increased by 5 mm. | |

- **Requirements for durability**

The requirements for durability shall be included when considering the following According to EBCS-2:

- Structural conception,
- Material selection
- Construction details,
- Execution and Quality Control,
- Inspection
- Verifications,

In our case the structural class we have selected is S3 then minimum concrete cover requirement with regard to durability is 10mm from table below.

Table 8. 9: Values of minimum cover, $c_{min,dur,}$ requirements with regard to durability for reinforcement steel in accordance with ES EN 2015

| **Environmental Requirement for $c_{min,dur}$ (mm)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Structural Class** | **Exposure Class according to EBCS** | | | | | | |
| | X0 | XC1 | XC2 / XC3 | XC4 | XD1 / XS1 | XD2 / XS2 | XD3 / XS3 |
| S1 | 10 | 10 | 10 | 15 | 20 | 25 | 30 |
| S2 | 10 | 10 | 15 | 20 | 25 | 30 | 35 |
| S3 | 10 | 10 | 20 | 25 | 30 | 35 | 40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S4 | 10 | 15 | 25 | 30 | 35 | 40 | 45 |
| S5 | 15 | 20 | 30 | 35 | 40 | 45 | 50 |
| S6 | 20 | 25 | 35 | 40 | 45 | 50 | 55 |

- **Standard Fire resistance**

We have determined the standard fire resistance for each panel in according of EBCS using the following table.

Table 8. 10: Minumum cover of concrete based on fire resistance

| Standard fire resistance | Minimum dimensions(mm) | | | |
|---|---|---|---|---|
| | Slab thickness hs(mm) | One way | Two way Ly/Lx ≤ 1.5 | Two way 1.5 ≤ Ly/Lx ≥ 2 |
| REI 30 | 60 | 10* | 10* | 10* |
| REI 60 | 80 | 20 | 10* | 15* |
| REI 90 | 100 | 30 | 15* | 20 |
| REI 120 | 120 | 40 | 20 | 25 |
| REI 180 | 150 | 55 | 30 | 40 |
| REI 240 | 175 | 65 | 40 | 50 |

- **Allowance in design for deviation**

The value of $\Delta c_{dev}$ for use in a Country may be found in its National Annex According to EBCS-2. The recommended value is 10 mm. so that we have selected also the recommended value 10mm. Therefore, the nominal cover shall be specified on the drawings. It is defined as,

$c_{nom} = c_{min} + \Delta c_{dev}$ ……EBCS-2 2015, (page 47).

where $C_{nom}$ :- Nominal cover.
$C_{min}$ :- Minimum cover.
$\Delta C_{dev}$:- Allowance in design for deviation.

**For Column**

**For example, for column 3**

- ✓ $c_{min,b} = 24mm$
- ✓ $c_{min,dur} = 10mm$
- ✓ $C_{min}$ = max {24mm; 10mm, 10 mm}
- ✓ $C_{min}$ = 24mm
- ✓ $C_{nom} = C_{min} + \Delta C_{dev}$ from the above table we have listed $c_{min}$ = 24mm, $\Delta c_{dev}$ = 10mm
- ✓ $C_{nom}$ = 24+10=**34mm**
- ✓ Standard Fire resistance =**10mm**
- ✓ Therefore, the govering Concrete design cover for this column =**34mm**

- **Material data**

**In compression**

$$fcd = 0.85 * \frac{fck}{\gamma c}$$ …….EBCS-2, 2015 Page 20.

Where: fck - Characteristic of compressive strength of concrete.

γc - Partial Safety factor for ordinary loading=1.5.

**Characteristic of compressive strength of concrete (fck)**

For C-30 fck =0.8*30Mpa=**24Mpa** or from EBCS-2, 2015 Table 3.1 (Page 25).

$$fcd = 0.85 * \frac{24}{1.5} = \mathbf{13.6\ Mpa}$$

**Design strength of steel(fyd)**

$$fyd = \frac{fyk}{\gamma s}$$

Where: fyk - Grade of steel, S-500 EBCS-2, 2015 (page 35)

γs-Reinforcing steel factor =1.15 Mpa for ordinary loading and class I work….EBCS-2, 1995 Table 3.1 (Page 22)

Then, $fyd = \frac{fyk}{\gamma s} = \frac{500}{1.15} = \mathbf{434.78Mpa}$

**Step 2: Determination of effective length of the column**

Effective length is used to account for the shape of the deflection curve: it can also be defined as buckling length i.e. the length of pin-ended column with constant normal force, having the same cross section and buckling load.

- Effective length (lo) for braced member From EBCS EN 1992-1-1:2014 (5:15)

$$l_0 = 0.5 * 1 * \sqrt{\left(1 + \frac{K1}{0.45+K1}\right)\left(1 + \frac{K2}{0.45+K2}\right)}$$

Where:

K1,K2-relative flexibilities of rotational restraint at both ends 1,2

l- length of column

K1-stiffness at end 1

K2-stiffness at end 2

- Stiffness at each end (K) =column stiffness/∑beam stiffness

$$K1_{X-X} = \left(\frac{\left(\frac{EI}{l}\right)c}{\left(\frac{2*EI}{l}\right)b}\right) \geq 0.1$$

- ✓ $I_{Column} = bh^3/12 = 400*400^3/12 = \mathbf{2,133,333,333mm^4}$
- ✓ $I_{beam} = bh^3/12 = 250*400^3/12 = \mathbf{133333333mm^4}$

- ✓ K1x-x=$\frac{2,133,333,333E/3000}{\left(\frac{1333333.3E}{5000}\right)+\left(\frac{1333333.3}{5000}\right)}=\frac{711111.1}{533333.1}$=**1.333**
- ✓ K1y-y=$\frac{2,133,333,333E/3000}{\left(\frac{1333333.3E}{5000}\right)+\left(\frac{1,333,333,333}{5000}\right)}=\frac{711111.1}{533333.3}$=**1.333**
- ✓ $I_{Column}$ =$bh^3/12$ =$400*400^3/12$=**2,133,333.3mm$^4$**
- ✓ $I_{beam}$ =$bh^3/12$=$250*400^3/12$=**1,333,333.3mm$^4$**
- ✓ K2x-x=$\frac{2,133,333,333E/3000}{\left(\frac{1333333.3E}{5000}\right)+\left(\frac{1333333.3}{5000}\right)}=\frac{711111.1}{533333.3}$=**1.333**
- ✓ K2y-y=$\frac{2,133,333,333E/5000}{\left(\frac{893,229.17E}{5000}\right)+\left(\frac{1333333.3}{5000}\right)}=\frac{711111.1}{533333.3}$=**1.333**

- $lo_{X-X}$ = 0.5 *$\sqrt{((1+\frac{K1_{X-X}}{0.45+K1_{X-X}})(1+\frac{K2_{X-X}}{0.45+K2_{X-X}}))}$

Lox-x= $0.5*3.0*\frac{\sqrt{((1+1.333}}{0.45+1.333})(1+\frac{1.333}{0.45+1.33}))$ =**2.621m**

- $lo_{Y-Y}$ = 0.5 *$\sqrt{((1+\frac{K1_{Y-Y}}{0.45+K1_{Y-Y}})(1+\frac{K2_{Y-Y}}{0.45+K2_{Y-Y}}))}$

Loy-y= $0.5*3.0*\frac{\sqrt{((1+1.333}}{0.45+1.333})(1+\frac{1.333}{0.45+1.33}))$ =**2.621m**

**Step 3: maximum and minimum reinforcement calculations**

- As,min= max $\begin{cases}(0.1*NED/fyd) = 0.1*609.74/434.78 = \textbf{140mm}^2\\ 0.002*Ac = 0.002*400*400 = \textbf{320mm}^2\end{cases}$

As,min=**320mm$^2$**

- As,max=$0.04*Ac$ = $0.04*400*400$ = **6400mm$^2$**

**Step 4: Design of eccentricity**

The effect of imperfection taken from According to ES EN 1992: Art 5.2.7

- Eix-x=max $\begin{cases}lo/400=2621/400= \textbf{6.55}mm\\ h/30=300/30= \textbf{10}mm\\ 20mm\end{cases}$

Eix-x=**20mm**

- Eiy-y=max { $l_0$/400=2621/400= **6.55*mm***; $h$/30=300/30= **10*mm***; 20mm }

Eiy-y=20mm

Note: The first order effect includes the geometric imperfection, but not consideration of slenderness. The second order effect is considered the slenderness of structural members or deformation of the structure.

**First order iteration**

- MED=max {MO2, Moe+M2, Mo1+0.5M2}
  - ✓ M01=min {|Mtop|,|Mbottom|+ei*NED}
  - ✓ M02=max {|Mtop|,|Mbottom|+ei*NED}
  - ✓ Moe=0.4*M01+0.6*M02≥0.4*M02

**For first order moment M2=0**

- In the X-dirn
  - ✓ M01x-x=min {|Mtopx-x|,|Mbottomx-x|+ei*NED}
  - ✓ M01x-x=min {|1.38|, |1.91|+0.02*609.74}
  - ✓ M01x-x=**1.38KNm**
  - ✓ M02x-x=max {|Mtopx-x|,|Mbottomx-x|+ei*NED}
  - ✓ M02x-x=max {|1.38|, |1.91|+0.02*609.74}
  - ✓ M02x-x=**12.19KNm**
  - ✓ Moex-x=0.4*M01x-x+0.6*M02x-x≥0.4*M02x-x
  - ✓ Moex-x=0.4*1.38+0.6*12.19≥0.4*12.19
  - ✓ Moex-x=**7.86KNm**

MEDx-x=**12.19KNm**

- In the Y-dirn
  - ✓ M01y-y=min {|Mtopy-y|,|Mbottomy-y|+ei*NED}
  - ✓ M01y-y=min {|10.72|,|22.71|+0.02*609.74}
  - ✓ M01y-y=**10.72KNm**
  - ✓ M02y-y=max {|Mtopy-y|, |Mbotty-y|+ei*NED}

- ✓ M02y-y=max {|10.72|,|22.71|+0.02*609.74}
- ✓ M02y-y=**22.71KNm**
- ✓ Moey-y=0.4*M01y-y+0.6*M02y-y≥0.4*M02y-y
- ✓ Moey-y=0.4*10.72+0.6*22.71≥0.4*22.71
- ✓ Moey-y=**17.914KNm**

MEDy-y=**22.71KNm**

**Step 5: Check slenderness**

- ➢ Slenderness ratio λ =$lo/i$

Where: lo-effective length of column

i-is radius of gyration of the uncracked concrete

- ✓ λx-x=$lox-x/i$ but i=$\sqrt{\frac{Ic}{Ac}}$
- ✓ i=$\sqrt{2133333333/160000}$= **115.47mm**
- ✓ λx-x=2621/115.47=**22.69**
- ✓ λy-y=$loy-y/i$=2621/115.47= **22.69**

**The minimum limiting value of slenderness is**

- ➢ λlim=20*A*B*C/$\sqrt{n}$
- ➢ λlimx-x=20*A*B*C/$\sqrt{n}$

Where: A = 1/ (1 + 0.2$\varphi ef$), $\varphi ef$-effective creep ratio

B = √1 + 2$\omega$,-Asfyd/Acfcd, mechanical reinforcement ratio

C = 1.7-rm

n=NEd/Acfcd, relative normal force

rm,moment ratio=Mo1x-x/Mo2x-x=1.38/12.19=**0.113**

Mo1, Mo2 are the first order end moments, |Mo2|≥|Mo1|

If $\varphi ef$ is not known, A=0.7

If $\omega$ is not known, B=1.1

**<u>For rectangular column</u>**

- ✓ rm =Mo1x-x/Mo2x-x=1.38/12.19=**0.113**
- ✓ C=1.7-0.113=**1.587**

- ✓ Ac=$b * h$ = 400 * 400 = **160000mm²**
- ✓ n=NEd/Acfcd=(609.74*1000)/(160000*13.6)=**0.28**

Therefore, slenderness limit (ƛlimx-x) =20*A*B*C/√$n$=20*0.7*1.1*1.587*/√0.28

ƛlimx-x = **46.16mm**

ƛlimy-y=20*A*B*C/√$n$

- ✓ A=**0.7**
- ✓ B=**1.1**
- ✓ C=1.7-(10.72/22.71)=**1.22**
- ✓ n=NEd/Acfcd=(609.74*1000/(160000*13.6)=**0.28**

Therefore, slenderness limit (λlimy-y) =20*A*B*C/√$n$=**35mm**

- ✓ λx-x >λ limx-x, slender column otherwise short column
- ✓ λy- y>λ limy-y, slender column otherwise short column
- ✓ λx-x < λ limx-x= 22.7< 46.16, short column
- ✓ λy- y< λ limy-y= 22.7< 35, short column

- vsd=Nsd/(Ac*fcd,) =906.74*1000/ (400*400*13.6) =**0.28**
- $\mu sd$x-x=MEDx-x/(fcd*Ac*h)=12.19*1000000/ (13.6*160000*400) =**0.014**
- $\mu sd$y-y= MEDy-y/(fcd*Ac*h) =22.71*1000000/ (13.6*160000*400) =**0.03**

**Using biaxial rectangular chart number**

- ω=0.1

## 8.3. Reinforcement design

The total amount of longitudinal reinforcement for column should not be less than As,min and should not exceed AS,max .

**Step 5 reinforcement calculation**

- Longitudinal reinforcement

  As,tot=ω*Ac*fcd/fyd

- ✓ As,tot=0.1*160000*13.6/434.78 = **500.48mm²**
- ✓ As min=**320mm²** and As max=**6400mm²**
- ✓ As min <As<As max……**NOT OK**
- ✓ Take Ø24$mm$, as=3.14*(24)²/4=**452mm²**
- ✓ Number of bar=As/as=500.48mm²/452mm²=**1.107≈2bar**

Therefore, Provide 4 Ø24mm

## 8.4. Lateral reinforcement

**Functions of Lateral Reinforcement**

- They hold the longitudinal bars in position in the forms while the concrete is being placed
- They prevent the slender longitudinal bars from buckling out ward by bursting the thin concrete cover.

For reinforced concrete section to resist shear force ties are used as transverse reinforcement. The diameter of the transverse reinforcement should not be less than 6mm or one quarter of the maximum diameter of the longitudinal bars. The diameter of transverse reinforcement should not be less than 6mm or one quarter of the longitudinal bars:

- For shear reinforcement

$$\text{Diameter of bar}=\max\begin{cases} ¼*\text{longitudinal bar diameter}=24/4 = \mathbf{6mm} \\ 6mm \\ \text{Diameter of stirrup} = \mathbf{8mm} \end{cases}$$

  - ✓ From above take Ø8mm

$$\text{Spacing of shear reinforcement}= \min\begin{cases} 20*Ø\text{long}, =20*24mm=\mathbf{480mm} \\ \text{lesser dimension of column} =\mathbf{300mm} \\ \mathbf{400mm} \end{cases}$$

Finally, provide Ø8 c/c 300$mm$

- The space of the transverse reinforcement along the column is should not exceed

## 8.5. Laps

- Forces are transmitted from one bar to another by:
  - ✓ **Lapping of bars**, with or without bends or hooks;
  - ✓ Welding;
  - ✓ Mechanical devices assuring load transfer in tension-compression or in compression only.
- The detailing of laps between bars shall be such that:
  - ✓ The transmission of the forces from one bar to the next is assured;
  - ✓ Spalling of the concrete in the neighborhood of the joints does not occur;

- ✓ Large cracks which affect the performance of the structure do not occur.
- ✓ between bars should normally be staggered and not located in areas of high moments /forces (e.g. plastic hinges).
- ✓ at any section should normally be arranged symmetrically.

➢ The arrangement of lapped bars should comply with Figure 8.7:

- ✓ The clear distance between lapped bars should not be greater than 4Ø or 50 mm, otherwise the lap length should be increased by a length equal to the clear space where it exceeds 4Ø or 50 mm;
- ✓ The longitudinal distance between two adjacent laps should not be less than 0.3 times the lap length,*l*0;
- ✓ In case of adjacent laps, the clear distance between adjacent bars should not be less than 2Ø or 20 mm.

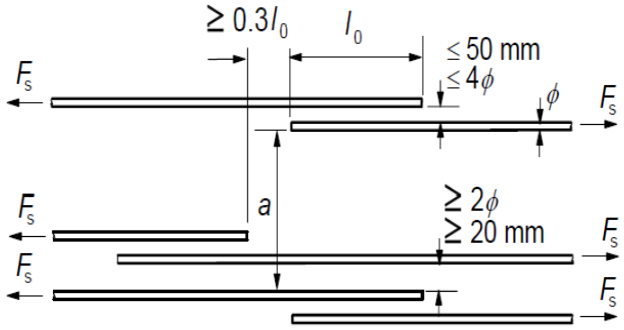



Figure 8. 1: Adjacent laps

### 8.5.1. Lap Length

**The design lap length is:**

➢ $l_o = \alpha_1 * \alpha_2 * \alpha_3 * \alpha_5 * \alpha_6 \; l_{b.rqd} \geq l_{o,min}$

where: $l_{b.rqd}$ is basic anchorage length

$l_{o,min} \geq \max \{0.3 \; \alpha_6 \; l_{b.rqd}; 15Ø; 200 \text{ mm}\}$

Values of $\alpha_1, \alpha_2, \alpha_3$ and $\alpha_5$ may be taken from table ;

$\alpha_6$ = Values of $\alpha_6$ are given in Table belew.

Table 8. 11: Values of the coefficient $\alpha_6$

| Percentage of lapped bars relative to the total cross-section area | < 25% | 30% | 50% | > 50% |
|---|---|---|---|---|
| $\alpha_6$ | 1 | 1.15 | 1.4 | 1.5 |

**Note:** Intermediate values may be determined by interpolation.

- fbd = 2.25*$\mu 1 * \mu 2$ *fctd = 2.25*1*1*0.8587 = **1.93MPa**
- $l_{b.rqd}$ =$(\emptyset/4)(\sigma sd$/fbd) = (24/4(434.78/1.93) =**1351.648**
- $l_o = \alpha_1 * \alpha_2 * \alpha_3 * \alpha_5 * \alpha_6 \ l_{b.rqd} \geq l_{o,min}$
  = 1*0.7*0.7*0.7*1.15*1351.648 =**533.157mm**$\geq l_{o,min}$
- $l_{o,min} \geq$ max $\{0.3 \ \alpha_6 \ l_{b.rqd}; 15\emptyset; 200$ mm$\}$
- $l_{o,min} \geq$ max $\{0.3*1.15* 1351.648 = 466.32; 15* 24 =360$mm; 200 mm$\}$
- Therefore, Take $l_o$ = 500mm

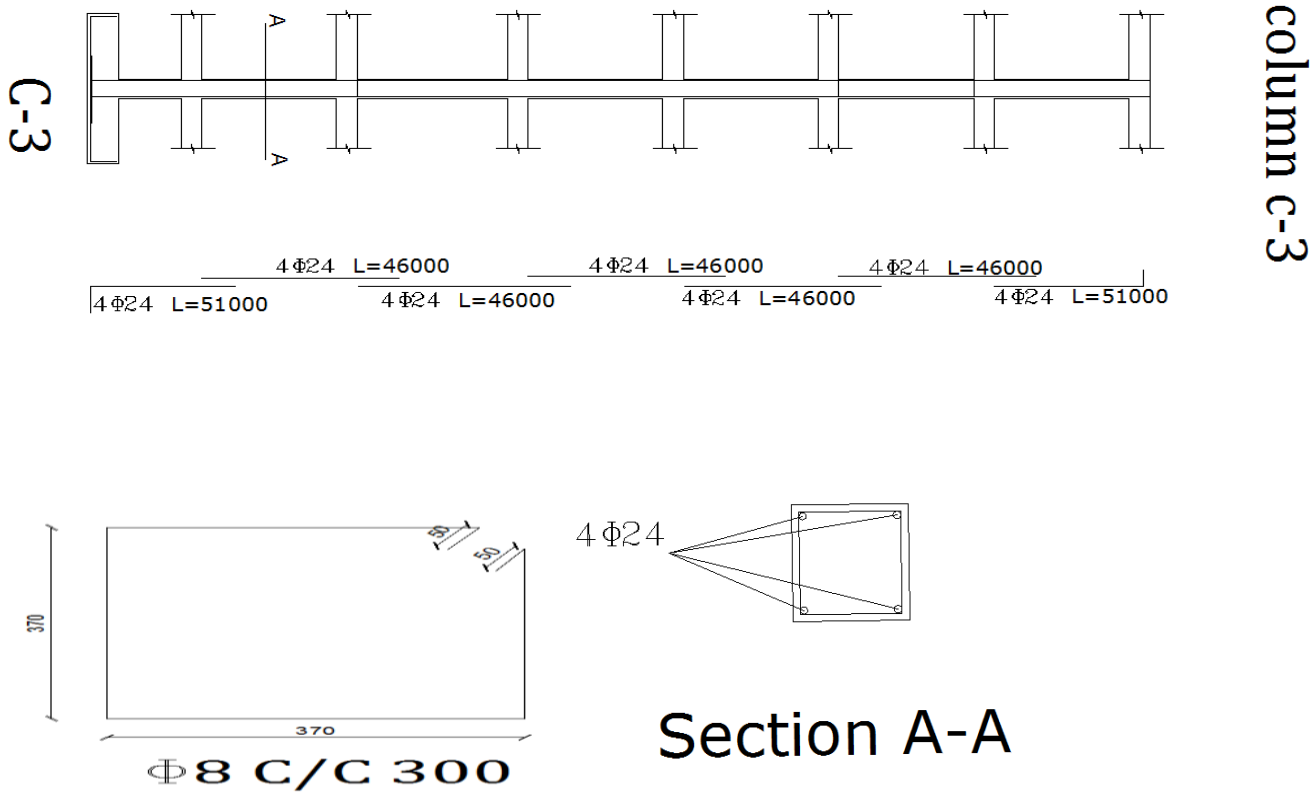






Figure 8. 2: Detail lay out of column 3

# CHAPTER-NINE
# STRUCTURAL ANALAYSIS AND DESIGN OF FOUNDATION

## 9.1. GENERAL

Foundation design is concerned primarily with ensuring that the movements of a foundation are within the limits that can be tolerated by the proposed structure without adversely affecting its functional requirements. Structures vary widely in their function be considered as interrelated problems.

For the satisfactory design of foundations it is important to have an understanding of the local geology and the type, thickness, parameters, properties and design baring pressures of the soil or rock layers to which the foundation transfers the loads. Knowledge of the ground water and flooding conditions and also the chemical composition of the subsoil water, particularly with respect to its sulphate content, is also necessary. Attention must be drawn to new construction which may lead to additional settlement of adjacent structures. The design of foundations should, therefore, take this possibility into account.

The foundation is designed for the two cases; i.e.

1. Maximum axial load and accompanying moment.
2. Maximum moment and accompanying axial load.

The allowable bearing capacity of the soil is 280KPa. Since the load from the supper structure is factored i.e. the live load is factored by 1.5 and the dead load is factored by 1.35Therefore, the allowable bearing capacity of the soil must be factored. (For conventional situations equal to 1.7 may be used ES EN 2015-1991-Part 1-7. In this particular project the ultimate limit state design method is employed.

Table 9. 1:For combination for Service limit state

| **Load Case/Combo** | pd | Mx | My | | Pd | Mx | My |
|---|---|---|---|---|---|---|---|
| Comb2 | 2009.6821 | -7.1898 | -10.4538 | Comb2 | 1615.7695 | 5.7482 | -0.6874 |
| Comb2 | 2814.988 | -0.1375 | 0.5287 | Comb2 | 2479.0935 | -4.7764 | -0.5408 |
| Comb2 | 2262.4799 | 7.0035 | -10.3374 | Comb2 | 2872.7591 | -0.0954 | -0.2472 |
| Comb2 | 2199.8221 | -4.9634 | 1.1744 | Comb2 | 2485.0161 | 4.9247 | 0.8783 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Comb2 | 2880.3148 | -0.0832 | 2.1927 | Comb2 | 2214.1184 | -4.9803 | -1.2613 |
| Comb2 | 2484.1621 | 4.9507 | -0.391 | Comb2 | 2880.7222 | -0.1035 | -2.3275 |
| Comb2 | 2475.2009 | -4.7645 | 0.5086 | Comb2 | 2483.914 | 4.9254 | -0.1181 |
| Comb2 | 2872.6506 | -0.082 | 0.1223 | Comb2 | 2015.5611 | -7.2143 | 10.3913 |
| Comb2 | 2485.0558 | 4.9388 | -1.2472 | Comb2 | 2815.0191 | -0.1785 | -0.6376 |
| Comb2 | 2489.9926 | -4.2804 | 0.0657 | Comb2 | 2263.0867 | 6.9934 | 10.7972 |
| Comb2 | 2374.9932 | -1.7855 | 1.3897 | Comb2 | 2097.0736 | -0.2475 | -9.2151 |
| Comb2 | 1615.7842 | 5.7521 | 0.3609 | Comb2 | 2096.8412 | -0.2183 | 9.117 |
| Comb2 | 2489.9327 | -4.2842 | -0.162 | | | | |
| Comb2 | 2374.9906 | -1.7897 | -1.5191 | | | | |

From etabs result, there are 26 different factored column load and moments from super structures.

Thus, let categorize into 3 groups and take the largest factored load and moment.

Table 9. 2: Categorizing foundation in to groups based on their factord load

| pd | Mx | My | foundation group |
|---|---|---|---|
| 1615.784 | -7.1898 | -10.4538 | F1 |
| 2009.682 | -0.1375 | 0.5287 | |
| 2199.822 | 7.0035 | -10.3374 | |
| 2262.48 | -4.9634 | 1.1744 | F2 |
| 2374.991 | -0.0832 | 2.1927 | |
| 2374.993 | 4.9507 | -0.391 | |
| 2475.201 | -4.7645 | 0.5086 | |
| 2483.914 | -0.082 | 0.1223 | |
| 2484.162 | 4.9388 | -1.2472 | |

| | | | |
|---|---|---|---|
| 2484.162 | -4.2804 | 0.0657 | |
| 2485.016 | -1.7855 | 1.3897 | |
| 2485.056 | 5.7521 | 0.3609 | |
| 2485.056 | -4.2842 | -0.162 | |
| 2489.933 | -1.7897 | -1.5191 | |
| 2489.933 | 5.7482 | -0.6874 | |
| 2489.993 | -4.7764 | -0.5408 | |
| 2489.993 | -0.0954 | -0.2472 | |
| 2814.988 | 4.9247 | 0.8783 | F3 |
| 2814.988 | -4.9803 | -1.2613 | |
| 2815.019 | -0.1035 | -2.3275 | |
| 2872.651 | 4.9254 | -0.1181 | |
| 2872.651 | -7.2143 | 10.3913 | |
| 2872.759 | -0.1785 | -0.6376 | |
| 2880.315 | 6.9934 | 10.7972 | |
| 2880.315 | -0.2475 | -9.2151 | |
| 2880.722 | -0.2183 | 9.117 | |

1. **Group I 1600KN – 2200KN**

There are 3 factored loads and its moments, from these the largest load is **2199.822KN,**

- ✓ Mx = 7KNm and My = 10.33KN.m

2. **Group II 2200KN – 2500KN**

There are 14 factored loads and its moments, from these the largest load is **2489.993KN,**

- ✓ Mx =-0.0954KNm and My =**-0.2472 KN.m**

3. **Group III 2500KN – 3000KN**

There are 9 factored loads and its moments, from these the largest load is **2880.72KN,**

- ✓ Mx =-0.2183 KNm and My = **9.117KN.m**

**For Foundation**

**For example foundation concrete cover**

- ✓ $c_{min,b}$ =12mm
- ✓ $c_{min,dur}$ = 25mm
- ✓ $C_{min}$ = max {12mm; 25mm, 10 mm}
- ✓ $C_{min}$ = 25mm
- ✓ $C_{nom} = C_{min} + \Delta C_{dev}$ from the above table we have listed $c_{min}$ = 25mm, $\Delta c_{dev}$ = 10mm
- ✓ $C_{nom}$ = 25+10=**35mm**
- ✓ Standard Fire resistance =**15mm**

- ✓ Therefore, the govering Concrete design cover for this panel is =**35mm**

## 9.2. Design of Isolated Footing

**The proportioning will be done using presumptive method**

- Assume, L/B = 1.0

Due to moment (eccentric load) the base area should be modified or the axial force shifts from the geometric centre of the footing.

### 9.2.1. For Group I footings

Maximum load from supper structure, Ps = **2199.19KN**

- Depth of footing below NGL = **2 m**
- $\sigma_{soil} = 280\,KN/m^2$

Since the load from the superstructure is factored. Therefore, the allowable bearing capacity of the soil must be factored by an average i.e. $\frac{1.35+1.5}{2} \cong 1.4$

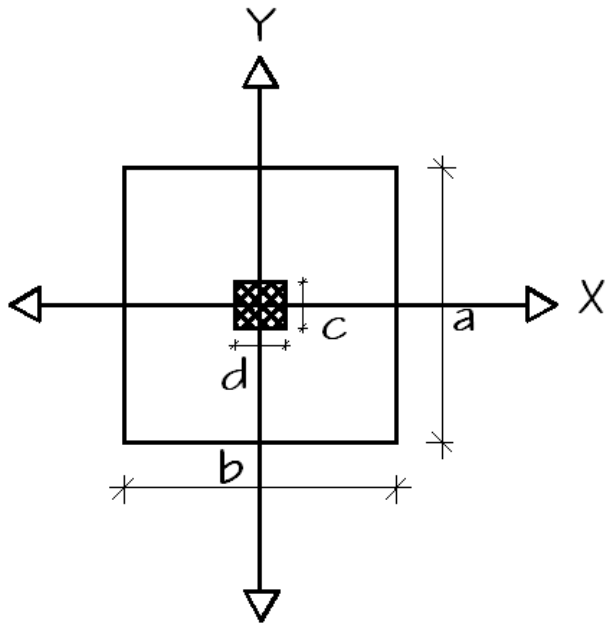
$$\sigma_{all} = 1.4 * 280\,KN/m^2 = 399\,KN/m^2$$

Assume soil weight and Own weight of footing is equal to 10%-15% of supper structure load

- Total design load, $P_{max}$ = 2199.19KN +0.15*2199.19= **2529.07KN**

Mx = 7KNm My = 10.33KN.m

Column dimension, $c = 0.40m$, $d = 0.40m$




$$\sigma = \frac{P}{A}\left(1 \pm \frac{6e_a}{a} \pm \frac{6e_b}{b}\right)$$

Where; $\sigma$ = the allowable soil pressure

A = a * b, assume $\frac{a}{b} = 1$

a = length of footing

b = width of footing

P = load sustain by the footing

$$e_a = \frac{M_x}{p} = \frac{7KN.m}{2529.07KN} = 0.0028m$$

$$e_b = \frac{M_y}{P} = \frac{10.33KN.m}{2529.07KN} = 0.0041m \ \sigma_{all} = \frac{P_{\max}}{A}\left(1 \pm \frac{6e_a}{a} \pm \frac{6e_b}{b}\right)$$

**Proportioning of the footing**

**Critical case,** $\sigma_{all} = \frac{P_{\max}}{A}\left(1 + \frac{6e_a}{a} + \frac{6e_b}{b}\right)$

$$399KN/m^2 = \frac{2529.04KN}{a^2}\left(1 + \frac{6(0.0028m)}{a} + \frac{6(0.0041m)}{a}\right)$$

By rearranging you will get, $0.1578a^3 - a - 0.0414 = 0$

Then by trial and error solving for a; **a = 2.9m, take a = 2.9m**

Therefore, **a = b = 2.90m**

$$\sigma_1 = \frac{2529.04KN}{(2.90m)^2}\left(1 + \frac{6*(0.0028m)}{2.90m} + \frac{6*(0.0041)}{2.90m}\right) = 343.89KN/m^2$$

$$\sigma_2 = \frac{2529.04KN}{(2.90m)^2}\left(1 + \frac{6*(0.0028m)}{2.90m} - \frac{6*(0.0041)}{2.90m}\right) = 292.79KN/m^2$$

$$\sigma_3 = \frac{2529.04KN}{(2.90m)^2}\left(1 - \frac{6*(0.0028m)}{2.90m} + \frac{6*(0.0041)}{2.90m}\right) = 309.05KN/m^2$$

$$\sigma_4 = \frac{2529.4KN}{(2.90m)^2}\left(1 - \frac{6*(0.0028m)}{2.90m} - \frac{6*(0.0041)}{2.90m}\right) = 257.57KN/m^2$$

$$\sigma_{avg} = \frac{\sigma_1 + \sigma_2 + \sigma_3 + \sigma_4}{4} = \frac{343.89 + 292.79 + 309.05 + 257.571}{4} = 300.72KN/m^2$$

$\sigma_{avg} = 300.72KN/m^2 < \sigma_{all} = 399KN/m^2$ ……..ok!

**Determination of Depth, D**

In the structural design of footings adequacy of the thickness of the footing and provide the necessary reinforcement to withstand punching shear and shear diagonal tension (wide beam shear) moment and bond stress should be checked.

- **Using Punching Shear**
  - ✓ Net punching shear force, $P_p$

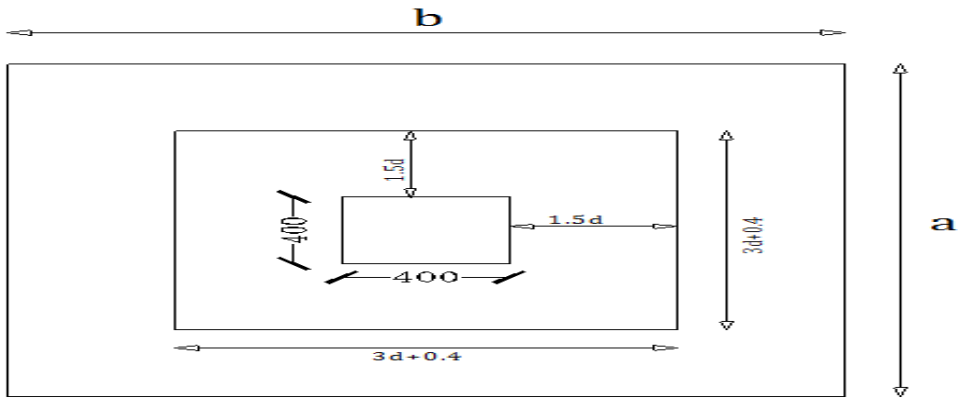



Figure 9. 1: Depth of footing dimentsion Footing 1

- $P_p = P_T - \sigma_{avg} A_c$ ---------- (1)

Where; $P_T$ = factored axial load

Ac = Critical section area

$\sigma_{avg}$ = average contact pressure

For the structural design, a simplifying assumption is made in which the contact pressure distribution is assumed uniform and it magnitude is taken as the average of the each side contact pressure.

Hence: $\sigma_{avg} = 300.72 KN/m^2 < \sigma_{all} = 399 KN/m^2$ …….OK!

- Punching shear resistance, $\nu_{Rd1} = 0.25 f_{ctd} K_1 K_2 \upsilon d$ ---------- (2)

Where; $f_{ctd} = \dfrac{0.21 f_{ck}^{2/3}}{\gamma_c}$, $f_{ck} = 0.8 f_{cu}$

$K_1 = 1 + 50\rho \le 2.0$, $\rho = steel\,ratio = \dfrac{A_s}{bd}$

$K_2 = 1.6 - d \ge 1.0$

$d = \dfrac{d_x + d_y}{2}$

$\rho = \rho_{\min} = \dfrac{0.6}{f_{yk}}$

$\upsilon$ = perimeter of critical section

d = effective depth

$\rho = \rho_{\min} = \dfrac{0.6}{500} = 0.0012$

$K_1 = 1 + 50\rho = 1 + 50*0.0012 = 1.06 \le 2.0 .....OK!$

$K_2 = 1.6 - d \ge 1.0$,

$$f_{ctd} = \frac{0.21(0.8*30)^{2/3}}{1.5} = 1.177MPa$$

Ac = (0.4 + 3d) (0.4 + 3d)

$\upsilon$ = 4(0.40 + 3d) = (12d + 1.6)

Net punching shear force, $P_p = P_T - \sigma_{avg}A_c$

= 2529.04 – 300.72 * (0.4 + 3d) (0.4 + 3d)

= 2529.04 – 300.72* ($9d^2$ + 2.4d + 0.16)

$P_p = 2529.04 - 2706.48d^2 - 721.73d - 48.11$ ---------- (*)

Punching shear resistance, $\nu_{Rd1} = 0.25 f_{ctd} K_1 K_2 \upsilon d$

$\nu_{Rd1} = 0.25 * 1.177 * 10^3 * 1.06 * 1.6 - d * [4(0.40 + 3d)] * d$

$\nu_{Rd1} = 0.25 * 1.177 * 10^3 * 1.06 * 1.6 - d * (12d + 1.6)d$

$\nu_{Rd1} = 5489.46d^2 - 3742.18d^3 + 798.4d$ ----------(**)

Equating Eq. (*) and Eq. (**) you will get,

$2529.04 - 2706.48d^2 - 712.73d - 48.11 = 5489.46d^2 - 3742.5d^3 + 798.4d$

Solving for d by trial and error, **d = 0.58m=0.6**

**D =** 600+35+20/2**=645mm**

**Check d for wide beam shear**

- The check will do for critical section at d distance from the face of column.

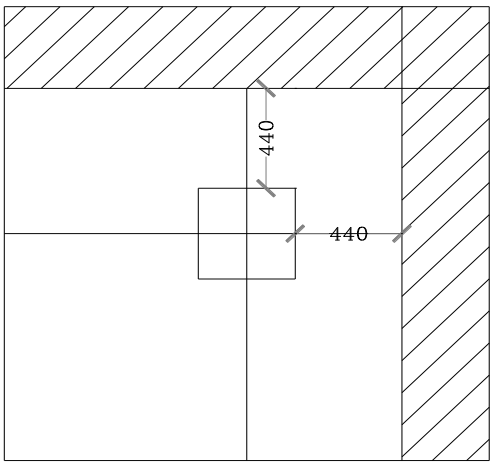


Figure 9. 2: Cross section of footing 1

Shear force carried by a concrete perimeter (wide beam shear resistance)

$$\upsilon_c = 0.25 f_{ctd} k_1 k_2 b_w d$$

= 0.25 * (1.177* $10^3$) * 1.06 * 1.0 * 1.0 * 0.60= **187.14KN/m**

Shear force per meter width

$$\upsilon_w = \sigma_{avg} Area < \upsilon_c$$

= 300.17KN/$m^2$ * 0.4m * 1m = 120.06KN/m < $\upsilon_c$ = **187.14KN/m** **ok**!

Therefore, **the section is adequate for shear.**

**Design for Flexure**

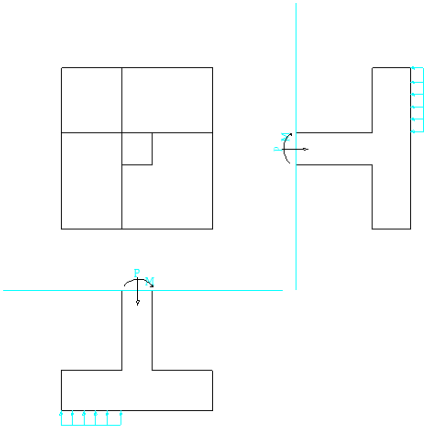


Figure 9. 3 Design for Flexure footing 1

Design moment at the face of column

$M_{1\text{-}1}$ = 300.17KN/m * (1.25m) $^2$/2= 234.5KN.m

$M_{2\text{-}2}$ = 300.17KN/m * (1.25m) $^2$/2= 234.5KN.m

**RENFORCMENT**

$$\rho_{min} = \frac{0.6}{f_{yk}} = \frac{0.6}{500} = 0.0012$$

As, $_{min}$ = $\rho_{min}$ $b_w d$ = 0.0012 * 1 * 0.60 * $10^6$

= 720$mm^2$

$M_{1\text{-}1}$ = 234.5KN.m

$$f_{cd} = \frac{0.85 f_{ck}}{\gamma_c} = \frac{0.85 * 24}{1.5} = 13.60 MPa$$

$f_{ctm} = 0.3 f_{ck}^{2/3}$ and $f_{ctd} = 0.7 f_{ctm} \Leftrightarrow f_{ctd} = \frac{f_{ctk}}{\gamma_c}$

$$\rho = \left[ \frac{1 - \sqrt{1 - \frac{2M}{bd^2 f_{cd}}}}{\left( \frac{f_{yd}}{f_{cd}} \right)} \right] \qquad \rho = \left[ \frac{1 - \sqrt{1 - \frac{2 * 234.5 * 10^6}{1000 * 600^2 * 13.60}}}{\left( \frac{434.78}{13.60} \right)} \right] = 0.0015 > \rho_{\min} = 0.0012$$

As = $\rho b_w d$ = 0.0015* 1000mm * 600mm = 900mm$^2$

Use Φ12 mm

⇨ Spacing, $S = \frac{a_s b}{A_s} = \frac{113.04mm^2 * 1000mm}{900mm^2} = 120mm$

∴ **Provide Φ12mm @ 120mm for both direction**

**Development Length**

$\ell_b = \frac{\phi_b}{4} \left\{ \frac{f_{yd}}{f_{bd}} \right\}$ Where: $f_{yd} = \frac{f_{yk}}{\gamma_s} = \frac{500}{1.15} = 434.78MPa$

$$f_{bd} = f_{ctd} = 1.177MPa$$

$\rightarrow \ell_b = \frac{12}{4} \left\{ \frac{434.78}{1.177} \right\} = 1108.19mm > 950mm - 35mm = 915mm$

-Bending up the bar is needed because $\ell_b > \ell_{available}$

**2. For Group II footings**

Maximum load from supper structure, Ps = 2489.9KN

- Depth of footing below NGL = 2.0m
- $\sigma_{soil} = 280 KN/m^2$

Since the load from the superstructure is factored. Therefore, the allowable bearing capacity of the soil must be factored by an average i.e. $\frac{1.35 + 1.5}{2} \cong 1.4$

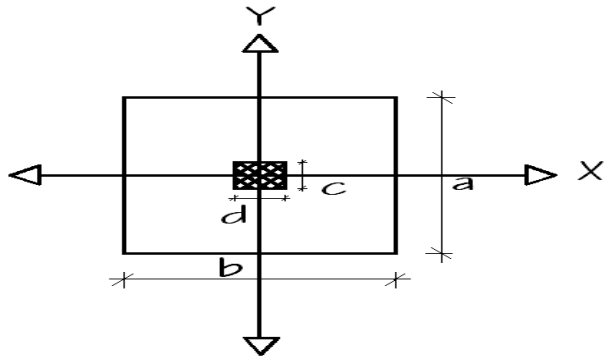
$\sigma_{all} = 1.4 * 280 KN/m^2 = 399 KN/m^2$

Assume soil weight and Own weight of footing is equal to 10%-15% of supper structure load

Total design load, $P_{max}$ = 2489.9KN +0.15*2489.9= 2863.38KN

Mx =-0.0954KNm and My =-0.247 KN.m

Column dimension, $c = 0.40m$
$d = 0.40m$




$$\sigma = \frac{P}{A}\left(1 \pm \frac{6e_a}{a} \pm \frac{6e_b}{b}\right)$$

Where; $\sigma$ = the allowable soil pressure

A = a * b, assume $\frac{a}{b} = 1$

a = length of footing

b = width of footing

P = load sustain by the footing

$$e_a = \frac{M_x}{p} = \frac{0.0954KN.m}{2863.38KN} = 0.00005$$

$$e_b = \frac{M_y}{P} = \frac{0.247KN.m}{2863.38KN} = 0.000085m$$

$$\sigma_{all} = \frac{P_{\max}}{A}\left(1 \pm \frac{6e_a}{a} \pm \frac{6e_b}{b}\right)$$

Proportioning of the footing

Critical case, $\sigma_{all} = \frac{P_{\max}}{A}\left(1 - \frac{6e_a}{a} - \frac{6e_b}{b}\right)$

$$399KN/m^2 = \frac{2863.3KN}{a^2}\left(1 - \frac{6(0.00005m)}{a} - \frac{6(0.000085m)}{a}\right)$$

Then by trial and error solving for a; a = 2.7m,

Therefore, a = b = 2.70m

$$\sigma_1 = \frac{2863.38KN}{(2.70m)^2}\left(1 + \frac{6*(0.00005m)}{2.70m} + \frac{6*(0.000085)}{2.70m}\right) = 392.78KN/m^2$$

$$\sigma_2 = \frac{2863.38KN}{(2.70m)^2}\left(1 + \frac{6*(0.000005m)}{2.70m} - \frac{6*(0.000085)}{2.70m}\right) = 392.78KN/m^2$$

$$\sigma_3 = \frac{2863.38KN}{(2.70m)^2}\left(1 - \frac{6*(0.00005m)}{2.70m} + \frac{6*(0.000085)}{2.70m}\right) = 392.78KN/m^2$$

$$\sigma_4 = \frac{2863.38KN}{(2.70m)^2}\left(1 - \frac{6*(0.00005m)}{2.70m} - \frac{6*(0.000085)}{2.70m}\right) = 392.78KN/m^2$$

$$\sigma_{avg} = \frac{\sigma_1 + \sigma_2 + \sigma_3 + \sigma_4}{4} = \frac{392.78 + 392.78 + 392.78 + 392.78}{4} = 392.78KN/m^2$$

$$\sigma_{avg} = 392.78KN/m^2 < \sigma_{all} = 399KN/m^2 \qquad \text{ok!}$$

Determination of Depth, D

In the structural design of footings adequacy of the thickness of the footing and provide the necessary reinforcement to withstand punching shear and shear diagonal tension (wide beam shear) moment and bond stress should be checked.

- Using Punching Shear
  - ✓ Net punching shear force, $P_p$

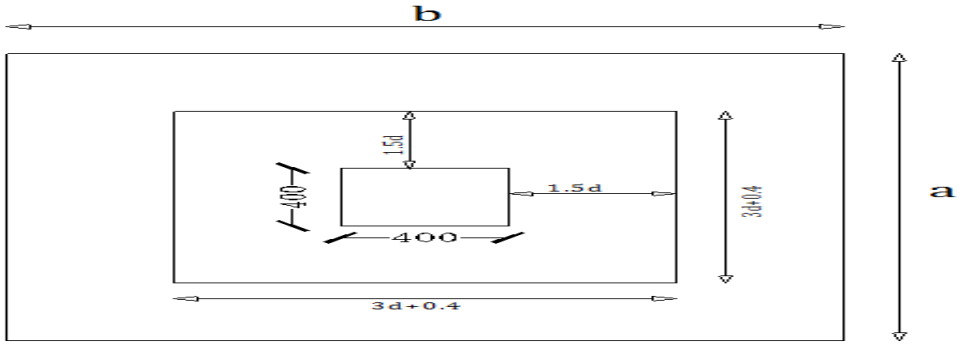



Figure 9. 4: Depth of footing dimentsion Footing 2

$P_p = P_T - \sigma_{avg}A_c$ ---------- (1)

Where; $P_T$ = factored axial load

Ac = Critical section area

$\sigma_{avg}$ = average contact pressure

For the structural design, a simplifying assumption is made in which the contact pressure distribution is assumed uniform and it magnitude is taken as the average of the each side contact pressure.

Hence: $\sigma_{avg} = 392.78KN/m^2 < \sigma_{all} = 399KN/m^2$ OK!

Punching shear resistance, $\nu_{Rd1} = 0.25 f_{ctd} K_1 K_2 \upsilon d$ ---------- (2)

Where; $f_{ctd} = \frac{0.21 f_{ck}^{2/3}}{\gamma_c}$, $f_{ck} = 0.8 f_{cu}$

$K_1 = 1 + 50\rho \le 2.0$, $\rho = steel\,ratio = \frac{A_s}{bd}$

$K_2 = 1.6 - d \ge 1.0$

$d = \frac{d_x + d_y}{2}$

$\rho = \rho_{\min} = \frac{0.6}{f_{yk}}$

$\upsilon$ = perimeter of critical section

d = effective depth

$\rho = \rho_{\min} = \frac{0.6}{500} = 0.0012$

$K_1 = 1 + 50\rho = 1 + 50 * 0.0012 = 1.06 \le 2.0$ *OK*!

$K_2 = 1.6 - d \ge 1.0$,

$f_{ctd} = \frac{0.21(0.8*30)^{2/3}}{1.5} = 1.177 MPa$

Ac = (0.4 + 3d) (0.4 + 3d)

$\upsilon$ = 4(0.40 + 3d) = (12d + 1.6)

Net punching shear force, $P_p = P_T - \sigma_{avg} A_c$

= 2863.38– 392.78 * (0.4 + 3d) (0.4 + 3d)

= 2863.38 – 392.78 * ($9d^2$ + 2.4d + 0.16)

$P_p = 2863.38 - 3535.02d^2 - 942.67d - 62.8$ ---------- (*)

Punching shear resistance, $\nu_{Rd1} = 0.25 f_{ctd} K_1 K_2 \upsilon d$

$\nu_{Rd1} = 0.25 * 1.177 * 10^3 * 1.06 * 1.6 - d * [4(0.40 + 3d)] * d$

$\nu_{Rd1} = 0.25 * 1.177 * 10^3 * 1.06 * 1.6 - d * (12d + 1.6) d$

$\nu_{Rd1} = 5489.46 d^2 - 3742.8 d^3 + 798.8 d$ ----------(**)

Equating Eq. (*) and Eq. (**) you will get,

$2863.38 - 3535.02d^2 - 942.67d - 62.8 = 5489.46 d^2 - 3742.8 d^3 + 798.8 d$

Solving for d by trial and error , **d = 0.52m=0.6**

**D = 600+35+20/2=645mm**

**Check d for wide beam shear**

The check will do for critical section at d distance from the face of column.

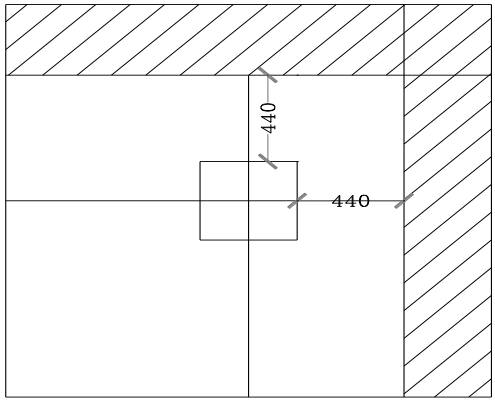



Figure 9. 5: Cross section of footing 2

Shear force carried by a concrete perimeter (wide beam shear resistance)

$$\upsilon_c = 0.25 f_{ctd} k_1 k_2 b_w d$$

= 0.25 * (1.177 * $10^3$) * 1.06 * 1.0 * 1.0 * 0.66= 187.14KN/m

Shear force per meter width

$$\upsilon_w = \sigma_{avg} Area < \upsilon_c$$

= 392.78KN/$m^2$ * 0.4m * 1m = 157.112KN/m < $\upsilon_c$ = 187KN/m ok!

Therefore, **the section is adequate for shear.**

**Design for Flexure**

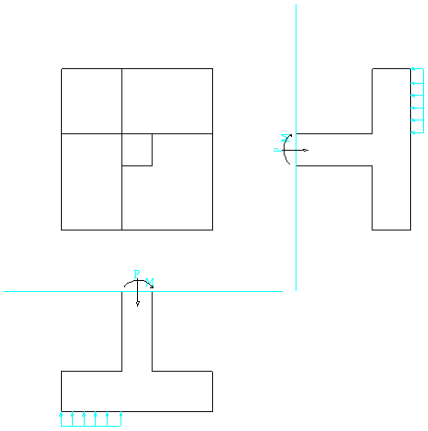


Figure 9. 6:Design for Flexure footing 2

Design moment at the face of column

$M_{1-1}$ = 392.78KN/m * (1.15m) $^2$/2= 259.7KN.m

$M_{2-2}$ = 392.78KN/m * (1.15m) $^2$/2= 259.72KN.m

**Renforcement**

$$\rho_{min} = \frac{0.6}{f_{yk}} = \frac{0.6}{500} = 0.0012$$

As, $_{min}$ = $\rho_{min}$ $b_w d$ = 0.0012 * 1 * 0.6 * $10^6$

= 720mm$^2$

$M_{1-1}$ = 259KN.m

$$f_{cd} = \frac{0.85 f_{ck}}{\gamma_c} = \frac{0.85 * 24}{1.5} = 13.60MPa$$

$$f_{ctm} = 0.3 f_{ck}^{2/3} \quad \text{and} \quad f_{ctd} = 0.7 f_{ctm} \Leftrightarrow f_{ctd} = \frac{f_{ctk}}{\gamma_c}$$

$$\rho = \left[ \frac{1 - \sqrt{1 - \frac{2M}{bd^2 f_{cd}}}}{\left( \frac{f_{yd}}{f_{cd}} \right)} \right] \qquad \rho = \left[ \frac{1 - \sqrt{1 - \frac{2 * 259 * 10^6}{1000 * 600^2 * 13.60}}}{\left( \frac{434.47}{13.60} \right)} \right] = 0.0017 > \rho_{min} = 0.0012$$

As = $\rho b_w d$ = 0.0017 * 1000mm * 600mm = 1020mm$^2$

Use Φ12 mm

⇨ Spacing, $S = \frac{a_s b}{A_s} = \frac{113.04mm^2 * 1000mm}{1020mm^2} = 100mm$

Take; S = 100mm c/c:

∴ Provide Φ12mm @ 100mm for both direction

***Development Length***

$$\ell_b = \frac{\phi_b}{4} \left\{ \frac{f_{yd}}{f_{bd}} \right\} \qquad \text{Where: } f_{yd} = \frac{f_{yk}}{\gamma_s} = \frac{500}{1.15} = 434.78MPa$$

$$f_{bd} = f_{ctd} = 1.177MPa$$

$$\rightarrow \ell_b = \frac{12}{4} \left\{ \frac{434.78}{1.177} \right\} = 1108mm > 950mm - 35mm = 915mm$$

-Bending up the bar is needed because $\ell_b > \ell_{available}$

**Group III 2500KN – 3000KN**

There are 9 factored loads and its moments, from these the largest load is **2880.72KN,**

- ✓ Mx= -0.2183KNm and My **= 9.117KN.m**

**Design of Isolated Footing**

**The proportioning will be done using presumptive method**

- Assume, L/B = 1.0

Due to moment (eccentric load) the base area should be modified or the axial force shifts from the geometric centre of the footing.

**3. For Group III footings**

Maximum load from supper structure, Ps = **2880.72KN**

- Depth of footing below NGL = **2 m**
- $\sigma_{soil} = 280\,KN/m^2$

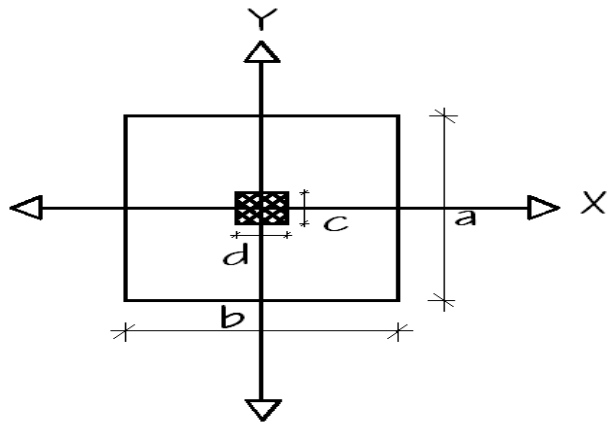
Since the load from the superstructure is factored. Therefore, the allowable bearing capacity of the soil must be factored by an average i.e. $\frac{1.35+1.5}{2} \cong 1.4$

$\sigma_{all} = 1.4 * 280\,KN/m^2 = 399\,KN/m^2$

Assume soil weight and Own weight of footing is equal to 10%-15% of supper structure load

Total design load, $P_{max}$ = 2880.72KN +0.15* 2880.72= **3312.3KN**

Mx -0.2183KNm My = **9.117KN.m**




**Column dimension,** $c = 0.40m$, $d = 0.40m$

$$\sigma = \frac{P}{A}\left(1 \pm \frac{6e_a}{a} \pm \frac{6e_b}{b}\right)$$

Where; $\sigma$ = the allowable soil pressure

A = a * b, assume $\frac{a}{b} = 1$

a = length of footing

b = width of footing

P = load sustain by the footing

$$e_a = \frac{M_x}{p} = \frac{-0.2183KN.m}{= 3312.3KN} = -0.00\mathbf{0066}m$$

$$\mathbf{e_b = \frac{M_y}{P} = \frac{9.117KN.m}{3312.3KNKN} = 0.00275m}$$

**Proportioning of the footing**

Critical case, $\sigma_{all} = \frac{P_{max}}{A}\left(1+\frac{6e_a}{a}+\frac{6e_b}{b}\right)$

$$399KN/m^2 = \frac{3312.72KN}{a^2}\left(1+\frac{6(0.000066m)}{a}+\frac{6(0.00275m)}{a}\right)$$

By rearranging you will get, $0.1578a^3 - a - 0.0414 = 0$

Then by trial and error solving for a; **a = 2.9m, take a = 2.9m**

Therefore, **a = b = 2.90m**

$$\boldsymbol{\sigma_1 = \frac{3312.72KN}{(2.90m)^2}\left(1+\frac{6*(0.000066m)}{2.90m}+\frac{6*(0.000275)}{2.90m}\right) = 396.2KN/m^2}$$

$$\boldsymbol{\sigma_2 = \frac{3312.72KN}{(2.90m)^2}\left(1+\frac{6*(0.000066m)}{2.90m}-\frac{6*(0.00275)}{2.90m}\right) = 391.72KN/m^2}$$

$$\boldsymbol{\sigma_3 = \frac{33312.724KN}{(2.90m)^2}\left(1-\frac{6*(0.000066m)}{2.90m}+\frac{6*(0.00275)}{2.90m}\right) = 396.09KN/m^2}$$

$$\boldsymbol{\sigma_4 = \frac{3312.72KN}{(2.90m)^2}\left(1-\frac{6*(0.000066m)}{2.90m}-\frac{6*(0.00275)}{2.90m}\right) = 391.6KN/m^2}$$

$$\delta = \frac{\delta1+\delta2+\delta3+\delta4}{4} = \frac{396.2+391.72+396.06+391.6}{4} = 393.9KN/m^2$$

$393.9KN/m^2 \leq 399KN/m^2$ …….Ok

**Determination of Depth, D**

In the structural design of footings adequacy of the thickness of the footing and provide the necessary reinforcement to withstand punching shear and shear diagonal tension (wide beam shear) moment and bond stress should be checked.

- **Using Punching Shear**
  - ✓ Net punching shear force, $P_p$

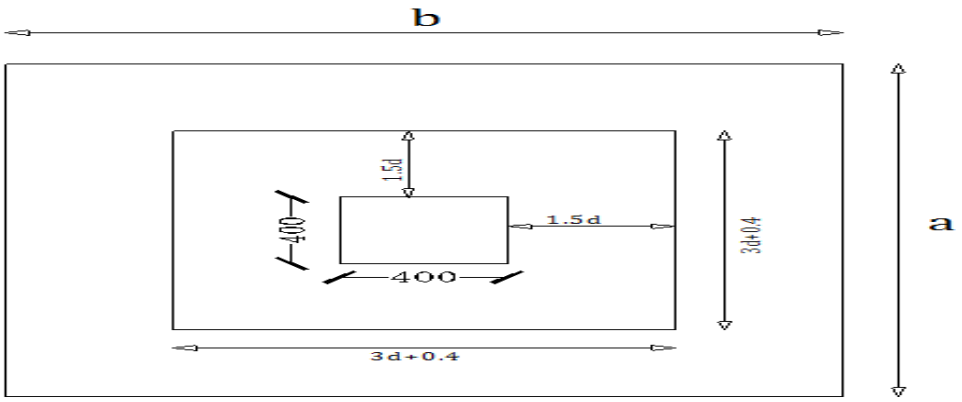



Figure 9. 7: Depth of footing dimention for footing 3

$P_p = P_T - \sigma_{avg}A_c$ ---------- (1)

Where; $P_T$ = factored axial load

Ac = Critical section area

$\sigma_{avg}$ = average contact pressure

For the structural design, a simplifying assumption is made in which the contact pressure distribution is assumed uniform and it magnitude is taken as the average of the each side contact pressure.

Hence: $\sigma_{avg} = 300.72 KN/m^2 < \sigma_{all} = 399 KN/m^2$ OK!

Punching shear resistance, $\nu_{Rd1} = 0.25 f_{ctd} K_1 K_2 \upsilon d$ ---------- (2)

Where; $f_{ctd} = \dfrac{0.21 f_{ck}^{2/3}}{\gamma_c}$, $f_{ck} = 0.8 f_{cu}$

$f_{ck} = 0.8 * 30 = 24$

$f_{ctd} = \frac{0.21*24^{\frac{2}{3}}}{1.5} = 1.165$

$f_{ck} = 0.8 * 30 = 24$

$K_1 = 1 + 50\rho \le 2.0$, $\rho = steel\,ratio = \dfrac{A_s}{bd}$

$K_2 = 1.6 - d \ge 1.0$

$d = \dfrac{d_x + d_y}{2}$

$\rho = \rho_{\min} = \dfrac{0.6}{f_{yk}}$

$\upsilon$ = perimeter of critical section

d = effective depth

$$\rho = \rho_{min} = \frac{0.6}{500} = 0.0012$$

$K_1 = 1 + 50\rho = 1 + 50*0.0012 = 1.06 \le 2.0$ *OK*!

$K_2 = 1.6 - d \ge 1.0$,

Ac = (0.4 + 3d) (0.4 + 3d)

$\upsilon$ = 4(0.40 + 3d) = (12d + 1.6)

↳ Net punching shear force, $P_p = P_T - \sigma_{avg}A_c$

= 3312.72 –393.9* (0.4 + 3d) (0.4 + 3d)

=3312.72– 393.9* ($9d^2$ + 2.4d + 0.16)

$P_p$ = 3312.9 – 3545.1$d^2$ – 945.4d –63.02---------- (*)

↳ Punching shear resistance, $\nu_{Rd1} = 0.25 f_{ctd} K_1 K_2 \upsilon d$

$v_{Rd1} = 0.25 * 1.165 * 10^3 * 1.06 * 1.6 - d * 4(0.40 + 3d) * d$

$v_{Rd1} = 790.34d - 5433.6d^2 - 3704.8d^3$ ----------(**)

Equating Eq. (*) and Eq. (**) you will get,

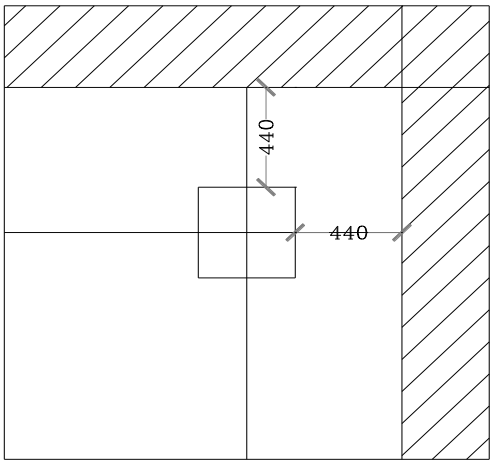
3312.9 – 3545.1$d^2$ – 945.4d –63.02= $790.34d + 5433.6d^2 - 3704.8d^3$

Solving for d by trial and error, d = 0.657m=0.7m

**D** = 700+35+20/2**=745mm**

**Check d for wide beam shear**

- The check will do for critical section at d distance from the face of column.




Shear force carried by a concrete perimeter (wide beam shear resistance)

$$\upsilon_c = 0.25 f_{ctd} k_1 k_2 b_w d$$

= 0.25 * (1.165* $10^3$) * 1.06 * 1.0 * 1.0 * 0.60= 185.23KN/m

Shear force per meter width

$$\upsilon_w = \sigma_{avg} Area < \upsilon_c$$

= 393.9KN/$m^2$ * 0.35m * 1m = 137.87KN/m < $\upsilon_c$ = 187.14KN/m ok!

Therefore, **the section is adequate for shear.**

**Design for Flexure**

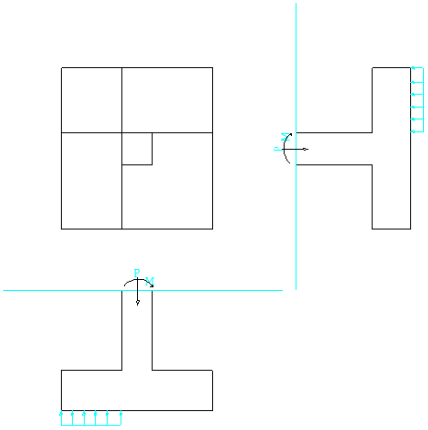


Figure 9. 8: Design for flexure for footing 3

Design moment at the face of column

$M_{1-1}$ = 399KN/m * (1.36m) $^2$/2= **368.9KN.m**

$M_{2-2}$ = 399KN/m * (1.36m) $^2$/2**= 368.9KN.m**

**Renforcement**

$$\rho_{min} = \frac{0.6}{f_{yk}} = \frac{0.6}{500} = 0.0022$$

As, $_{min}$ = $\rho_{min}$ $b_w d$ = 0.0012 * 1 * 0.60 * $10^6$

= 720$mm^2$

$M_{1-1}$ = 368.9KN.m

$$f_{cd} = \frac{0.85 * 24}{1.5} = 13.6$$

$f_{ctm} = 0.3 f_{ck}^{2/3}$ and

$$\rho = \left[\frac{1-\sqrt{1-\frac{2M}{bd^2 f_{cd}}}}{\left(\frac{f_{yd}}{f_{cd}}\right)}\right] \qquad \rho = \left[\frac{1-\sqrt{1-\frac{2*368..9*10^6}{1000*600^2*13.6}}}{\left(\frac{434.78}{13.6}\right)}\right] = 0.0038 > \rho_{min}$$

$As = \rho b_w d = 0.0038 * 1000mm * 600mm = 2280mm^2$

Use Φ20 mm

⇨ Spacing, $S = \frac{a_s b}{A_s} = \frac{314.2mm^2 * 1000mm}{2280mm^2} = 137mm \cong 130mm$

∴ **Provide Φ20mm @ 130mm for both direction**

**Development Length**

Bending up the bar is needed because $\ell_b > \ell_{available}$

$$\ell_b = \frac{\phi_b}{4}\left\{\frac{f_{yd}}{f_{bd}}\right\} \qquad \text{Where: } f_{yd} = \frac{f_{yk}}{\gamma_s} = \frac{500}{1.15} = 434.78MPa$$

$$f_{bd} = f_{ctd} = 1.165MPa$$

$$\rightarrow \ell_b = \frac{20}{4}\left\{\frac{434.78}{1.165}\right\} = 18866.01mm > 950mm - 35mm = 915mm$$

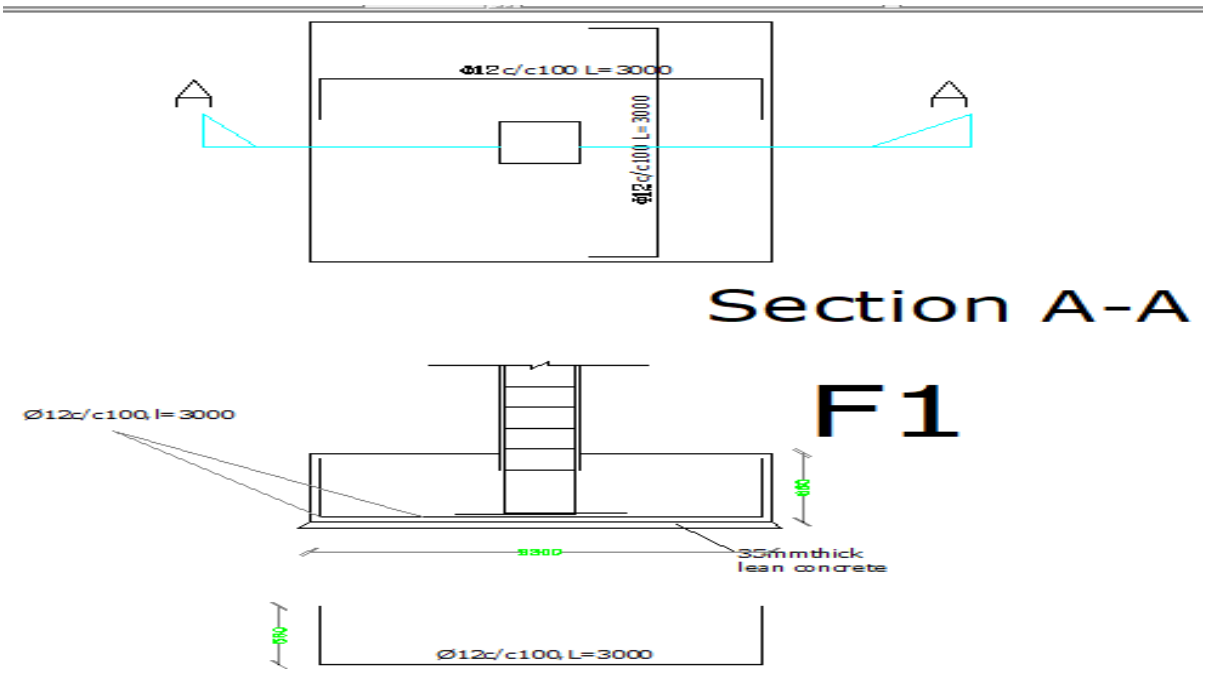



Figure 9. 9: Detail lay out of footing

# CHAPTER-TEN
# STRUCTURAL ANALAYSIS AND DESIGN OF SHEAR WALL

## 10.1. General

Structural shear wall: is a wall designed to resist lateral/horizontal shear forces parallel to the plane of the wall. Shear wall is part of lateral force resisting system, it is a cantilever walls extended from Foundation to the top of the building. They primarily resist lateral loads due to wind or earthquakes' acting on the building.

## 10.2. Lateral Load Determination

Mostly earth quake is the governing lateral load for frame analysis. our site is in Dire Dewa earth quake is sensitive and wind load is negligible.

From Irish lift service technical specification. Standards lift shaft and car size for side opening electrical traction is listed below

- Capacity of lift=450kg for 1 entrance
- Number of person to accommodate=6

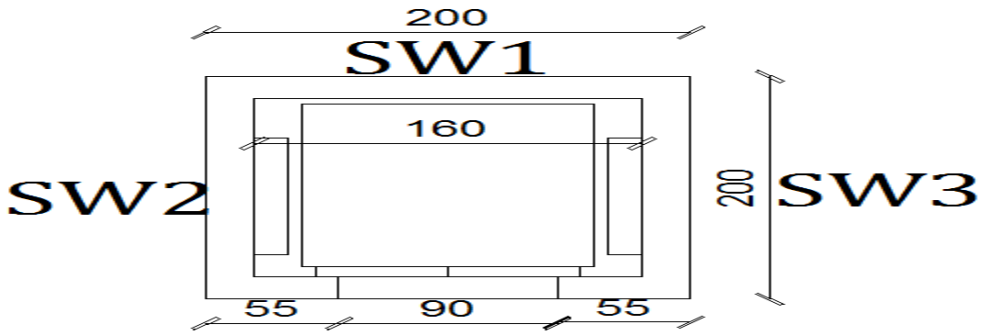



Figure 10. 1: Lay out of shear wall for lift

## 10.3. Base Shear Determination

The base shear is given by the following formula

- F= $S_d$ ($T_1$) W

  Where: $F_b$=base shear

  W=Total weight of the building

  $S_d$ ($T_1$)=ordinate of the design spectrum at period $T_1$

- $S_d$ ($T_1$)=αβγ

  Where: α= ratio of the design bed rock acceleration to the acceleration of gravity, g.

  it is given by $\alpha=\propto_0 I$

- $\alpha=\propto_0 I$

  Where: $\propto_0$= The bed rock acceleration ratio for the site and depends on the seismic zone.

  $\propto_0$=0.1 for earth quake zone 3 (DireDawa)

  I=Importance factor of the structure I=1.2 thus α=0.1*1.2=**0.12**

  $\beta$= Is the design response factor for the site and is given by

- $\beta=1.2S/T^{(2/3)} \leq 2.5$

  Where: S=site coefficient of soil characteristics

  S=1.2 (for sub soil class

  $T_1$= the fundamental period of vibration of the structure (in seconds) for translational motion in the direction of the motion. For structures up to 80m height, the value of $T_1$ may be approximated by $T1=C_1H^{3/4}$

- $T1=C_1H^{3/4}$

  Where: H=Height of the structure above the base in meter=34m

- $C_1 = \frac{0.075}{\sqrt{Ac}}$

- $A_c=\sum(A_i( 0.2 + \frac{{L_{wi}}^2}{H}))$

  Where: Ac=combined effective area of the shear in the first story of the building, in $m^2$

  Ai=X-sectional area of the shear Wall-I in story of the building, in $m^2$

  Lwi =length of the shear walls in the first story in the direction parallel to the applied forces, in meters with the restriction that $L_{wi}/H$ shall not exceed 0.9. $L_{wi}$=2.1m

**When the lateral force acting in the Y-axis:**

- ✓ $A_1=A_2=0.2*4.26=$**$0.852m^2$**
- ✓ $Ac=2*0.85*(0.2+ (4.26^2/17.75))$ = **2.078**
- ✓ $C_1=0.075/\sqrt{2.078}$ = **0.052**
- ✓ $T_1=0.084*(17.75)^{0.75}$ = **0.726**
- ✓ $\beta=1.2*1.2/(0.726)^{0.667} \leq 2.5$ **=1.783≤ 2.5**

**When the lateral force acting in the X-axis:**

- ✓ A1=0.2*4.26=**$0.852m^2$**
- ✓ A2=0.2*(0.726+0.726) =**$0.105m^2$**

- ✓ Ac=**2.078**
- ✓ c1=$\frac{0.075}{\sqrt{2.078}}$=**0.052**
- ✓ $T_1$=0.052*(17.75)$^{0.75}$ = **0.449**
- ✓ β=1.2*1.2/ (0.449)$^{0.667}$ ≤ 2.5 = **0.845<2.5……..It is okey!!!**

Hence, take **β=0.845**…. for safety

- ➢ $\Upsilon=\gamma_0 \times k_D \times k_r \times k_w$

Where: $\gamma_0$=basic type of behavior factor, dependent on the structural type 3

=0.3 (For core system)

$K_D$=factor reflecting the ductility class =1.5 (lower ductility)

$K_R$=factor reflecting the structural regularity in elevation =1 (frame system)

$K_w$ =factor reflecting the prevailing failure mode in the structural system with wall =1.5 (for core system)

- ✓ γ= 0.3 × 1.5 × 1 × 1.5 = **0.675**

Therefore, The design spectrum $S_d$ ($T_1$) =0.12×1.5675×0.675=**0.1277**

The base shear forces shall be distributed over the height of the structure in conformance

- ➢ $F_t$ { 0 for T<0.7; 0.07 $T_1$

- ➢ $F_b \leq 0.25\ f_b$ for T>0.7
  - ✓ Since $T_1$=1.331sec
  - ✓ $F_t$ = 0.07 $T_1 f_b \leq 0.25 f_b$
    = 0.07×1.179×$f_b$
    = **0.1148$f_b$**
- ➢ $f_b = S_d(T_1)$ W
- ➢ fb= 0.1277$W$ =0.1253*2284.975=**286.3074**
- ➢ $f_b = S_d(T_1)$ W
- ➢ fb= 0.1277$W$ =0.1253*2284.975=**286.3074**

## 10.4. Center of mass and center of stiffness of the shear Wall

Table 10. 1: Center of mass & center of stiffness for shear wall

| Name | ht | t | L | Area | Volume | g | Weight | x | y | Mx | My |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SW1 | 3 | 0.2 | 3.1 | 0.62 | 1.86 | 25 | 46.5 | 0.09 | 1.23 | 57.195 | 3.9525 |
| SW2 | 3 | 0.2 | 1.8 | 0.36 | 1.08 | 25 | 27 | 1 | 2.5 | 67.5 | 27 |
| SW3 | 3 | 0.2 | 1.8 | 0.36 | 1.08 | 25 | 27 | 1.9 | 1.23 | 33.21 | 51.3 |
| | **total** | | | | | | **100.5** | | | **157.91** | **82.253** |
| | | | | | | | | | **xm** | **1.5712** | |
| | | | | | | | | | **ym** | **0.8184** | |

## 10.5. Distribution of the horizontal seismic forces to each Story

The base shear force is distributed over the height of the structure at each floor level according to the following formula:

- $Fi = ((Fb)\, WiHi) / \Sigma WjHj$

Where:- Fi = the concentrated lateral force acting at floor i

Hi= Height above the base to level i

Table 10. 2: Horizontal seismic forces on each story

| level | hi | wi | hiwi | hiwi/∑hiwi | fb | fi |
|---|---|---|---|---|---|---|
| besment | 3 | 107.25 | 321.75 | 0.0625 | 286.3074 | 17.89421 |
| ground | 3 | 107.25 | 321.75 | 0.0625 | 286.3074 | 17.89421 |
| first | 6 | 107.25 | 643.5 | 0.125 | 286.3074 | 35.78843 |
| second | 9 | 107.25 | 965.25 | 0.1875 | 286.3074 | 53.68264 |
| third | 12 | 107.25 | 1287 | 0.25 | 286.3074 | 71.57685 |
| forth | 15 | 107.25 | 1608.75 | 0.3125 | 286.3074 | 89.47106 |
| **5148** | | | | | | |

**Moment of Inertia**

**For SW2 and SW3**

- ✓ T= **0.2m**,L=**1.8 m**
- ✓ I1y = I3y = $bd^3 / 12$ = 1.8* $(0.2)^3 / 12$ = **$0.0012m^4$**

**For SW1**

- ✓ T= **0.2 ,** L = **3.1**
- ✓ I1X = $db^3 / 12$ =0.2 $(3.1)^3 / 12$ = **$0.496m^4$**

Table 10. 3: Moment of inertia for the shear wall

| shear wall | xi | yi | ix | iy | ix*y | iyx |
|---|---|---|---|---|---|---|
| SW1 | 1.4 | 2.4 | 0.496 | 0 | 1.1904 | 0 |
| SW2 | 0.1 | 1 | 0 | 0.0012 | 0 | 0.0012 |
| SW3 | 2.5 | 1 | 0 | 0.0012 | 0 | 0.003 |
| | | **sum** | 0.496 | 0.0024 | 1.1904 | 0.0042 |
| | | | | | **xs** | 1.75 |
| | | | | | **ys** | 2.4 |

Table 10. 4: Torsional Correction for SW1

| Notation | EQ direction | lebel | Vx | Ex | Tsx | Tsy |
|---|---|---|---|---|---|---|
| SW1 | X-DIRECTION | basment | 17.9 | 0 | 0 | 17.89 |
| | | Ground | 17.9 | 0 | 0 | 17.89 |
| | | first | 35.8 | 0 | 0 | 35.78 |
| | | second | 53.7 | 0 | 0 | 53.68 |
| | | thitd | 71.6 | 0 | 0 | 71.58 |
| | | forth | 89.5 | 0 | 0 | 89.47 |

Table 10. 5: Torsional Correction for SW2 & SW3

| Notation | EQ direction | lebel | Vx | Ex | Tsx | Tsy |
|---|---|---|---|---|---|---|
| SW2&SW2 | Y-DIRECTION | basment | 17.89 | 0.5 | 8.945 | 35.78 |
| | | Ground | 17.89 | 0.5 | 8.945 | 35.78 |
| | | first | 35.78 | 0.5 | 17.89 | 71.56 |
| | | second | 53.68 | 0.5 | 26.84 | 107.36 |
| | | thitd | 71.58 | 0.5 | 35.79 | 143.16 |
| | | forth | 89.47 | 0.5 | 44.735 | 178.94 |

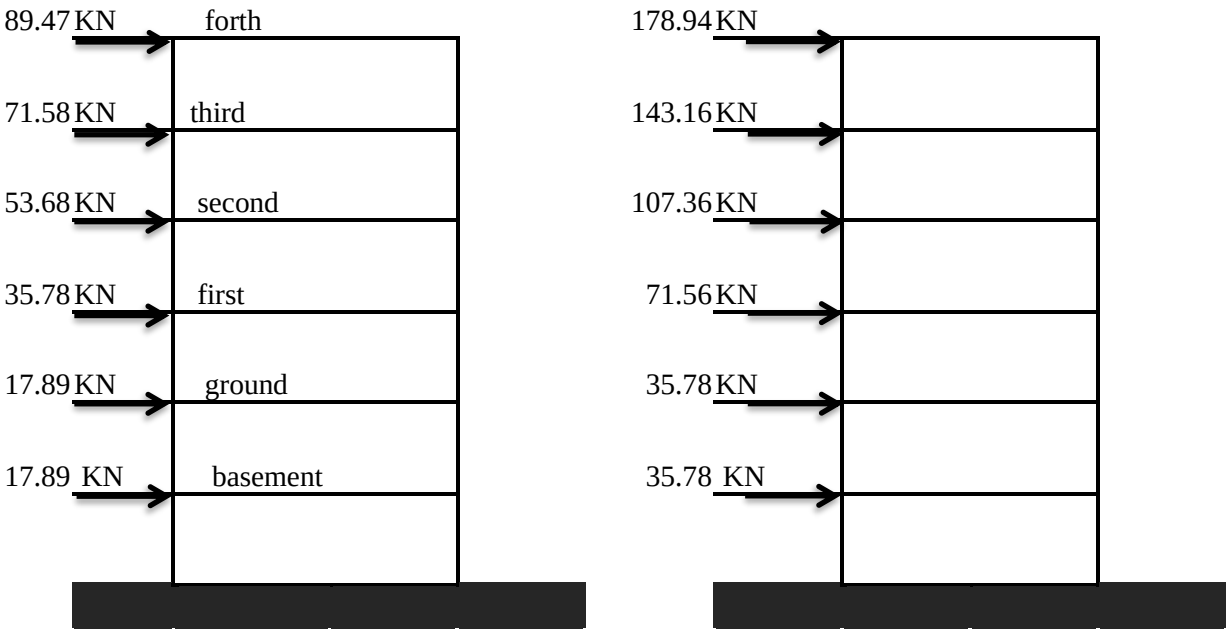



Figure 10. 2: Torsional force applied on the each floor

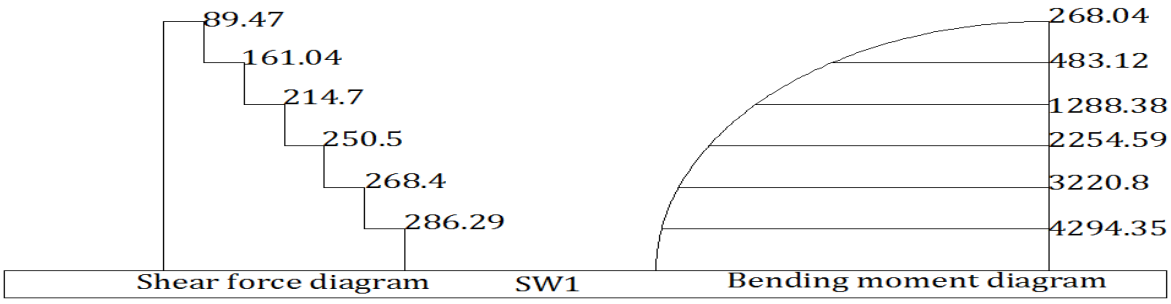



Figure 10. 3: Shear force and bending moment diagram for SW1

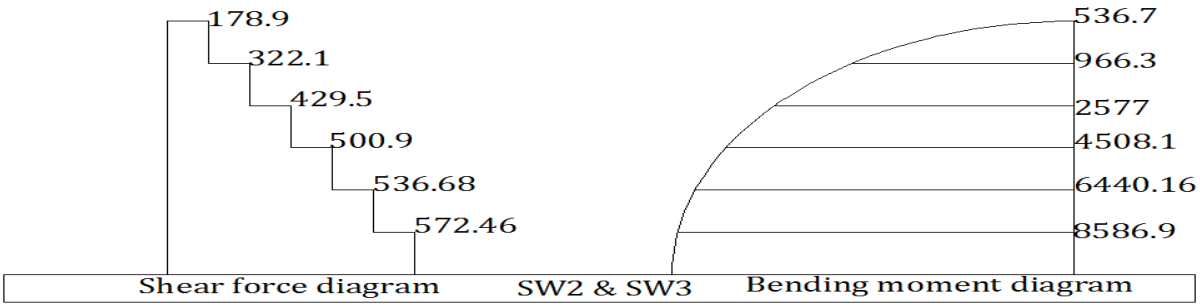



Figure 10. 4: Shear force and bending moment diagram for SW2 & SW3

## 10.6. Reinforcement for shear wall

Table 10. 6: Reinforcement for shear wall

| | level | M | K | Z | As cal | As min | As max | Aprov | remark |
|---|---|---|---|---|---|---|---|---|---|
| sw1 | basment | 4294.35 | 0.001443 | 3096.047 | 3190.218 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | ground | 3220.8 | 0.001082 | 3097.036 | 2391.927 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | first | 2254.59 | 0.000758 | 3097.926 | 1673.89 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | second | 1288.38 | 0.000433 | 3098.815 | 956.2661 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | third | 483.12 | 0.000162 | 3099.556 | 358.4974 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | forth | 268.41 | 9.02E-05 | 3099.753 | 199.16 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| SW2 & SW3 | basment | 8586.9 | 0.002885 | 3092.086 | 6387.27 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | ground | 6440.16 | 0.002164 | 3094.068 | 4787.372 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | first | 4508.1 | 0.001515 | 3095.85 | 3349.223 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | second | 2577 | 0.000866 | 3097.629 | 1913.443 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | third | 966.3 | 0.000325 | 3099.111 | 717.1421 | 806 | 2480 | 2480 | Ø 13 c/c 250 |
| | forth | 536.7 | 0.00018 | 3099.507 | 398.2626 | 806 | 2480 | 2480 | Ø 13 c/c 250 |

## 10.7. Design shear reinforcement

- Check Diagonal compression failure
  - ✓ Vrd = 0.25 * fcd * bw * d
    = 0.25 *24 * 0.2 * 1800 = **2160> Vd**
- Check the section capacity Vc
  - ✓ Vc = 0.25 * fctd * K1 * K2 * b * d
  - ✓ K1 = 1+50ρ = 1.0625
  - ✓ K2 = 1.6 –d = 1.4
  - ✓ Vc = 0.25 * 1.06 * 2.4* 1.4 *1800 * 0.2 = **310.544> Vd**
  - ✓ S = bas/As and Smax = **250mm**

Table 10. 7:Spacing of shear reinforcement

| Notation | level | vsd | vc | spacing |
|---|---|---|---|---|
| SW1 | basment | 286.29 | 310.5 | 250 |
| | ground | 268.4 | 310.5 | 250 |
| | first | 250.5 | 310.5 | 250 |
| | second | 214.7 | 310.5 | 250 |
| | third | 161.04 | 310.5 | 250 |
| | forth | 89.47 | 310.5 | 250 |
| SW2 & SW3 | basment | 178.9 | 310.5 | 250 |
| | ground | 322.1 | 310.5 | 250 |
| | first | 429.5 | 310.5 | 250 |

| | | | | |
|---|---|---|---|---|
| | second | 500.9 | 310.5 | 250 |
| | third | 536.68 | 310.5 | 250 |
| | forth | 572.46 | 310.5 | 250 |

# CHAPTER-ELEVEN
# CONCLUSION AND RECOMMENDATION

## 11.1. CONCLUSION

In this final simister project of structural design of B+G+4 with one basement building, there were a lot of obstacles and try to take these in order to come up with the most realistic and well organized final document. Each part of the building had been analyzed and designed.

In design of this building, the three basic questions of design were being tried to address. These structural members are economical, safe and workable with good aesthetics as per the standard of our country building code. But me haven't done much as we expected we tried our best

Generally, this final project is drawn the following conclusion:

- Isolated footing type has been selected for the foundation because of it have Good bearing capacity of soil in Gamebela town.
- The intended slab type in this project is solid slab. Thesis type of slab has been used because span length of all panels are less than five meter.
- The Frame analysis is done by ETABS (2016) Software and the output is obtained by using design manual method to design beams and columns.
- Check Lateral load including wind load analysis by using manual method calculation or work compared with ETABS (2016) Software out put our result is stable.
- Generally, this building is designed to answer most economical, safe and good aesthetics values.

## 11.2. RECOMMENDATION

- It is better to know the title of the project at the end of first semester, accordingly, the necessary preparation can be handle in the most proper way.
- To make the students rich in information, there should be internet access in the computer room.
- There is no truss for roof design in this building so, it was better to do that to be knowledgeable.
- It is recommended that, it is better to come up with the design data which have the necessary information.
- It is better if the project incorporating all types of slab like ribbed and flat slab design. In order to take and understand all the actual design phenomena.
- In order to have general understanding about the procedures and preparation of the project, the school should give orientation for the students.
- It is better to incorporate this type of project since it helps the student to develop the quality of working in teams, understanding with each other and develop good interaction with those who has better knowledge and experience than us.
- We have taken deferent kinds of assumptions which was unclear for as.

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# Appendix

## Appendex A structural analysis and design of roof floor

Table A. 1: Types of slab and Span types on the Roof floor

| Panel | Lx(m) | Ly(m) | Ly/Lx | Type of slab | Span type |
|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-2 | 5 | 5 | 1 | Two way | Interior Span |
| S-3 | 5 | 5 | 1 | Two way | Interior Span |
| S-4 | 5 | 5 | 1 | Two way | End Span |
| S-5 | 5 | 5 | 1 | Two way | End Span |
| S-6 | 5 | 5 | 1 | Two way | Interior Span |
| S-7 | 5 | 5 | 1 | Two way | Interior Span |
| S-8 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-9 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-10 | 5 | 5 | 1 | Two way | Interior Span |
| S-11 | 5 | 5 | 1 | Two way | Interior Span |
| S-12 | 5 | 5 | 1 | Two way | Interior Span |
| S-13 | 5 | 5 | 1 | Two way | Interior Span |
| S-14 | 5 | 5 | 1 | Two way | Interior Span |
| S-15 | 5 | 5 | 1 | Two way | Interior Span |
| S-16 | 5 | 5 | 1 | Two way | Interior Span |
| S-17 | 4.43 | 4.43 | 1 | Two way | End Span |
| C-1 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-2 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-3 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-4 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-5 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-6 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-7 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-8 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-9 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-10 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-11 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-12 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-13 | 1.6 | 5 | 3.125 | One way | Cantiliver |

Table A. 2: Minimum concrete cover for roof floor

**ROOF FLOOR GOVERING CONCRETE COVER DESIGN**

| Panel | Bond/Durability Minimum cover required | | | Allowance in Design for Variation | | Standred Fire | Cover | Govering Cover |
|---|---|---|---|---|---|---|---|---|
| | $Cmin,B$ | $Cmin,Dur$ | $Cmin$ | Δcdev(mm) | $Cnom$ | Resistance | Design | Design (mm) |
| S-1 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-2 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-3 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-4 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-5 | 12 | 10 | 12 | 10 | 22 | 10 | 30 | |
| S-6 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-7 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-8 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-9 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-10 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-11 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-12 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-13 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | **22mm** |
| S-14 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-15 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-16 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-17 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| C-1 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-2 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-3 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-4 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-5 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-6 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-7 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-8 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-9 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-10 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-11 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-12 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-13 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |

Table A. 3: Effective depth of Roof floor slab

| Panel | Lx(m) | Ly(m) | Ly/Lx | Type of slab | span type | F1 | K | N | Lx/d | Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.78 | 153.93 |
| S-2 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-3 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-4 | 5 | 5 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.78 | 173.74 |
| S-5 | 5 | 5 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.78 | 173.74 |
| S-6 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-7 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-8 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.78 | 153.93 |
| S-9 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.78 | 153.93 |
| S-10 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-11 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-12 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-13 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-14 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-15 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-16 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.21 | 150.57 |
| S-17 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.78 | 153.93 |
| C-1 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-2 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-3 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-4 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-5 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-6 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-7 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-8 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-9 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-10 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C-11 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-12 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| C-13 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.86 | 180.69 |
| | | | | | | | | | dmax = | 180.69 |
| | | | | | | | | | Cover = | 22.00 |
| | | | | | | | | | Φ= | 12.00 |
| | | | | | | | | | D= | 200.00 |

Table A. 4: Calculation of moment for all cantilever on the roof floor

| Panel | Types of slab | Pd | Lx | M |
|---|---|---|---|---|
| C-1 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-2 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-3 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-4 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-5 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-6 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-7 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-8 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-9 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-10 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-11 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-12 | Cantilever | 10.231 | 1.6 | 13.0957 |
| C-13 | Cantilever | 10.231 | 1.6 | 13.0957 |

Table A. 5:Moment coefficients according to ES EN for the roof slab of the build

| Panel | Ly | Lx | $l_y/l_x$ | $\beta_{xs}$ | $\beta_{xf}$ | $\beta_{ys}$ | $\beta_{yf}$ |
|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-2 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-3 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-7 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-8 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-9 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-10 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-11 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-12 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S-13 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-14 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-15 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-16 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-17 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-18 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |

Table A. 6: Computation of moments for all panel

| **Panel** | **Support condition** | **lx** | **$lx^2$** | **Pd** | **Moment Coeficient** | | **Moment location** | **bending moment Mi= $\beta_i P_d L^2 x$** |
|---|---|---|---|---|---|---|---|---|
| | | | | | **location** | **value** | | |
| S-1 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 10.231 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 9.44 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 7.23 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 9.04 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 6.83 |
| S-2 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-3 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-7 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-8 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-9 | Two adjacent | 4.43 | 19.6249 | 10.231 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 9.44 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | edges discontinuous | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 7.23 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 9.04 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 6.83 |
| S-10 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 10.231 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 9.44 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 7.23 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 9.04 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 6.83 |
| S-11 | One short edge discontinuous | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-12 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-13 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-14 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-15 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-16 | Interior panel | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S-17 | One short edge discontinuous | 5 | 25 | 10.231 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 7.93 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 6.14 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 8.18 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 6.14 |
| S-18 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 10.231 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 9.44 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 7.23 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 9.04 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 6.83 |

Table A. 7:Adjusted moment for the roof floor

| Panel | Moment notation | Unadjusted moment for support moment | | ΔM/Mlarge*100 | Method of Adjustment | Adjusted moment |
|---|---|---|---|---|---|---|
| | | Ms | Ms | | | |
| S-1 & S-2 | Mys | 9.040 | 8.180 | 9.51 | Average method | 8.61 |
| S-1 & S-9 | Mxs | 9.440 | 9.44 | 0.00 | No adjustment | 9.44 |
| S-2 & S-3 | Mys | 8.180 | 8.18 | 0.00 | No adjustment | 8.18 |
| S-2 & S-10 | Mxs | 7.930 | 7.93 | 0.00 | No adjustment | 7.93 |
| S-3 & S-4 | Mys | 85.259 | 8.18 | 90.41 | Moment distribution | 46.72 |
| S-3 & S-11 | Mxs | 7.930 | 7.93 | 0.00 | No adjustment | 7.93 |
| S-4 & S-12 | Mxs | 42.629 | 7.93 | 81.40 | Moment distribution | 25.28 |
| S-5 & S-6 | Mys | 85.259 | 8.18 | 90.41 | Moment distribution | 46.72 |
| S-5 & S-14 | Mxs | 42.629 | 7.93 | 81.40 | Moment distribution | 28.28 |
| S-6 & S-7 | Mys | 8.180 | 8.18 | 0.00 | No adjustment | 8.18 |
| S-6 & S-15 | Mxs | 7.930 | 7.93 | 0.00 | No adjustment | 7.93 |
| S-7 & S-8 | Mys | 9.040 | 8.180 | 9.51 | Average method | 8.61 |
| S-7 & S-16 | Mxs | 12.560 | 7.93 | 36.86 | Moment distribution | 10.25 |
| S-8 & S-17 | Mxs | 9.440 | 9.44 | 0.00 | No adjustment | 9.44 |
| S-9 & S-10 | Mys | 9.040 | 8.180 | 9.51 | Average method | 8.61 |
| S-10 & S-11 | Mys | 8.180 | 8.18 | 0.00 | No adjustment | 8.18 |
| S-11 & S-12 | Mys | 8.180 | 8.18 | 0.00 | No adjustment | 8.18 |
| S-12 & S-13 | Mys | 8.180 | 8.18 | 0.00 | No adjustment | 8.18 |
| S-13 & S-14 | Mys | 8.180 | 8.18 | 0.00 | No adjustment | 8.18 |
| S-14 & S-15 | Mys | 8.180 | 8.18 | 0.00 | No adjustment | 8.18 |

| | | | | | | |
|---|---|---|---|---|---|---|
| S-15 & S-16 | Mys | 8.180 | 8.18 | 0.00 | No adjustment | 8.18 |
| S-16 & S-17 | Mys | 9.040 | 8.180 | 9.51 | Average method | 8.61 |
| C-1 & S-2 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-2 & S-3 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-3 & S-4 | Mxs | 42.629 | 13.0957 | 69.28 | Moment distribution | 18.31 |
| C-4 & S-5 | Mxs | 42.629 | 13.0957 | 69.28 | Moment distribution | 18.31 |
| C-5 & S-6 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-6 & S-7 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-7 & S-10 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-8 & S-11 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-9 & S-12 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-10 & S-13 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-11 & S-14 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-12 & S-15 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |
| C-13 & S-16 | Mxs | 13.096 | 7.93 | 39.45 | Moment distribution | 9.47 |

Table A. 8: Span moment adjustment for the roof floor

| Panel | moment notation | Un adjusted moment | Adjusted support moment | ΔM | | Ly/Lx | Span moment notation | Factor for Adju. | | adjusted span moment |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ΔMxs | ΔMys | | | | | |
| S-1 | Mxs | 9.44 | 9.44 | 0.00 | 0.43 | 1 | Mxf Adj | cx | 0.38 | 7.35 |
| | Mxf | 7.23 | | | | | | cy | 0.28 | |
| | Mys | 9.04 | 8.61 | | | | Myf adj | cx | 0.28 | 6.99 |
| | Myf | 6.83 | | | | | | cy | 0.38 | |
| S-2 | Mxs | 7.93 | 7.93 | 0.00 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 6.14 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 8.18 | | | | Myf adj | cx | 0.28 | 6.14 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-3 | Mxs | 7.93 | 7.93 | 0.00 | -38.54 | 1 | Mxf Adj | cx | 0.38 | -4.65 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 46.72 | | | | Myf adj | cx | 0.28 | -8.51 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-4 | Mxs | 42.63 | 25.28 | 17.35 | 38.54 | 1 | Mxf Adj | cx | 0.38 | 38.70 |
| | Mxf | 21.32 | | | | | | cy | 0.28 | |
| | Mys | 85.26 | 46.72 | | | | Myf adj | cx | 0.28 | 62.13 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Myf | 42.63 | | | | | | cy | 0.38 | |
| S-5 | Mxs | 42.63 | 28.28 | 14.35 | 38.54 | 1 | Mxf Adj | cx | 0.38 | 37.56 |
| | Mxf | 21.32 | | | | | | cy | 0.28 | |
| | Mys | 85.26 | 46.72 | | | | Myf adj | cx | 0.28 | 61.29 |
| | Myf | 42.63 | | | | | | cy | 0.38 | |
| S-6 | Mxs | 7.93 | 7.93 | 0.00 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 6.14 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 8.18 | | | | Myf adj | cx | 0.28 | 6.14 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-7 | Mxs | 7.93 | 10.25 | -2.32 | 2.36 | 1 | Mxf Adj | cx | 0.38 | 5.92 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 5.82 | | | | Myf adj | cx | 0.28 | 6.39 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-8 | Mxs | 9.44 | 9.44 | 0.00 | 0.43 | 1 | Mxf Adj | cx | 0.38 | 7.35 |
| | Mxf | 7.23 | | | | | | cy | 0.28 | |
| | Mys | 9.04 | 8.61 | | | | Myf adj | cx | 0.28 | 6.99 |
| | Myf | 6.83 | | | | | | cy | 0.38 | |
| S-9 | Mxs | 9.44 | 9.44 | 0.00 | 0.43 | 1 | Mxf Adj | cx | 0.38 | 7.35 |
| | Mxf | 7.23 | | | | | | cy | 0.28 | |
| | Mys | 9.04 | 8.61 | | | | Myf adj | cx | 0.28 | 6.99 |
| | Myf | 6.83 | | | | | | cy | 0.38 | |
| S-10 | Mxs | 13.10 | 12.83 | 0.27 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 6.24 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 8.18 | | | | Myf adj | cx | 0.28 | 6.21 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-11 | Mxs | 13.10 | 13.28 | -0.18 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 6.07 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 8.18 | | | | Myf adj | cx | 0.28 | 6.09 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-12 | Mxs | 13.10 | 12.63 | 0.47 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 6.32 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 8.18 | | | | Myf adj | cx | 0.28 | 6.27 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-13 | Mxs | 13.10 | 13 | 0.10 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 6.18 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 8.18 | | | | Myf adj | cx | 0.28 | 6.17 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| | Mxs | 13.10 | 13.13 | | | | Mxf Adj | cx | 0.38 | 6.13 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S-14 | Mxf | 6.14 | | -0.03 | 0.00 | 1 | | cy | 0.28 | |
| | Mys | 8.18 | 8.18 | | | | Myf adj | cx | 0.28 | 6.13 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-15 | Mxs | 13.10 | 12.8 | 0.30 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 6.25 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 8.18 | | | | Myf adj | cx | 0.28 | 6.22 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-16 | Mxs | 13.10 | 12.83 | 0.27 | 2.36 | 1 | Mxf Adj | cx | 0.38 | 6.90 |
| | Mxf | 6.14 | | | | | | cy | 0.28 | |
| | Mys | 8.18 | 5.82 | | | | Myf adj | cx | 0.28 | 7.11 |
| | Myf | 6.14 | | | | | | cy | 0.38 | |
| S-17 | Mxs | 9.44 | 9.44 | 0.00 | 0.43 | 1 | Mxf Adj | cx | 0.38 | 7.35 |
| | Mxf | 7.23 | | | | | | cy | 0.28 | |
| | Mys | 9.04 | 8.61 | | | | Myf adj | cx | 0.28 | 6.99 |
| | Myf | 6.83 | | | | | | cy | 0.38 | |

Table A. 9: Flexural Reinforcement calculation for the roof

| Panel | moment notation | adjusted moment | d (mm) | As, min | As, max | µsd | Z | As | NO. of bar | Spacing | Spacing provied | AS Provide |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | Mxs | 9.44 | 172 | 197.7 | 8000 | 0.016 | 169.55 | 147.20 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 7.35 | 172 | 197.7 | 8000 | 0.010 | 170.48 | 113.98 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.61 | 160 | 183.9 | 8000 | 0.013 | 158.08 | 143.99 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.99 | 160 | 183.9 | 8000 | 0.011 | 158.44 | 116.63 | 12 | 614.66 | 450 | 251.20 |
| S-2 | Mxs | 7.93 | 172 | 197.7 | 8000 | 0.011 | 170.36 | 123.06 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 6.14 | 172 | 197.7 | 8000 | 0.008 | 170.73 | 95.07 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.18 | 160 | 183.9 | 8000 | 0.013 | 158.18 | 136.72 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.14 | 160 | 183.9 | 8000 | 0.010 | 158.63 | 102.32 | 12 | 614.66 | 450 | 251.20 |
| S-3 | Mxs | 7.93 | 172 | 197.7 | 8000 | 0.011 | 170.36 | 123.06 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 4.65 | 172 | 197.7 | 8000 | 0.006 | 171.04 | 71.87 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 46.72 | 160 | 183.9 | 8000 | 0.073 | 148.93 | 829.31 | 12 | 156.75 | 130 | 869.54 |
| | Myf | 8.51 | 160 | 183.9 | 8000 | 0.013 | 158.10 | 142.30 | 12 | 614.66 | 450 | 251.20 |
| S-4 | Mxs | 25.28 | 172 | 197.7 | 8000 | 0.034 | 166.65 | 401.04 | 12 | 324.15 | 280 | 403.71 |
| | Mxf | 38.70 | 172 | 197.7 | 8000 | 0.052 | 163.66 | 625.15 | 12 | 207.95 | 180 | 628.00 |
| | Mys | 46.72 | 160 | 183.9 | 8000 | 0.073 | 148.93 | 829.31 | 12 | 156.75 | 130 | 869.54 |
| | Myf | 62.13 | 160 | 183.9 | 8000 | 0.097 | 144.87 | 1133.77 | 12 | 114.66 | 90 | 1256.00 |
| | Mxs | 28.28 | 172 | 197.7 | 8000 | 0.038 | 165.99 | 450.41 | 12 | 288.62 | 250 | 452.16 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5 | Mxf | 37.56 | 172 | 197.7 | 8000 | 0.051 | 163.92 | 605.78 | 12 | 214.60 | 180 | 628.00 |
| | Mys | 46.72 | 160 | 183.9 | 8000 | 0.073 | 148.93 | 829.31 | 12 | 156.75 | 130 | 869.54 |
| | Myf | 61.29 | 160 | 183.9 | 8000 | 0.096 | 145.10 | 1116.69 | 12 | 116.41 | 100 | 1130.40 |
| S-6 | Mxs | 7.93 | 172 | 197.7 | 8000 | 0.011 | 170.36 | 123.06 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 6.14 | 172 | 197.7 | 8000 | 0.008 | 170.73 | 95.07 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.18 | 160 | 183.9 | 8000 | 0.013 | 158.18 | 136.72 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.14 | 160 | 183.9 | 8000 | 0.010 | 158.63 | 102.32 | 12 | 614.66 | 450 | 251.20 |
| S-7 | Mxs | 10.25 | 172 | 197.7 | 8000 | 0.014 | 169.87 | 159.52 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 5.92 | 172 | 197.7 | 8000 | 0.008 | 170.78 | 91.64 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 5.82 | 160 | 183.9 | 8000 | 0.009 | 158.71 | 96.95 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.39 | 160 | 183.9 | 8000 | 0.010 | 158.58 | 106.53 | 12 | 614.66 | 450 | 251.20 |
| S-8 | Mxs | 9.44 | 172 | 197.7 | 8000 | 0.013 | 170.04 | 146.77 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 7.35 | 172 | 197.7 | 8000 | 0.010 | 170.48 | 113.98 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.61 | 160 | 183.9 | 8000 | 0.013 | 158.08 | 143.99 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.99 | 160 | 183.9 | 8000 | 0.011 | 158.44 | 116.63 | 12 | 614.66 | 450 | 251.20 |
| S-9 | Mxs | 9.44 | 172 | 197.7 | 8000 | 0.013 | 170.04 | 146.77 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 7.35 | 172 | 197.7 | 8000 | 0.010 | 170.48 | 113.98 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.61 | 160 | 183.9 | 8000 | 0.013 | 158.08 | 143.99 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.99 | 160 | 183.9 | 8000 | 0.011 | 158.44 | 116.63 | 12 | 614.66 | 450 | 251.20 |
| S-10 | Mxs | 12.83 | 172 | 197.7 | 8000 | 0.017 | 169.33 | 200.31 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 8.18 | 172 | 197.7 | 8000 | 0.011 | 170.31 | 126.98 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 6.24 | 160 | 183.9 | 8000 | 0.010 | 158.61 | 104.01 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.21 | 160 | 183.9 | 8000 | 0.010 | 158.62 | 103.50 | 12 | 614.66 | 450 | 251.20 |
| S-11 | Mxs | 13.28 | 172 | 197.7 | 8000 | 0.018 | 169.23 | 207.46 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 6.07 | 172 | 197.7 | 8000 | 0.008 | 170.75 | 93.98 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.18 | 160 | 183.9 | 8000 | 0.013 | 158.18 | 136.72 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.09 | 160 | 183.9 | 8000 | 0.010 | 158.65 | 101.48 | 12 | 614.66 | 450 | 251.20 |
| S-12 | Mxs | 12.63 | 172 | 197.7 | 8000 | 0.017 | 169.37 | 197.14 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 6.32 | 172 | 197.7 | 8000 | 0.009 | 170.69 | 97.88 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.18 | 160 | 183.9 | 8000 | 0.013 | 158.18 | 136.72 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.27 | 160 | 183.9 | 8000 | 0.010 | 158.61 | 104.51 | 12 | 614.66 | 450 | 251.20 |
| S-13 | Mxs | 13.00 | 172 | 197.7 | 8000 | 0.018 | 169.29 | 203.01 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 6.18 | 172 | 197.7 | 8000 | 0.008 | 170.72 | 95.70 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.18 | 160 | 183.9 | 8000 | 0.013 | 158.18 | 136.72 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.17 | 160 | 183.9 | 8000 | 0.010 | 158.63 | 102.83 | 12 | 614.66 | 450 | 251.20 |
| | Mxs | 13.13 | 172 | 197.7 | 8000 | 0.018 | 169.26 | 205.07 | 12 | 571.78 | 450 | 251.20 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-14 | Mxf | 6.13 | 172 | 197.7 | 8000 | 0.008 | 170.73 | 94.92 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.18 | 160 | 183.9 | 8000 | 0.013 | 158.18 | 136.72 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.13 | 160 | 183.9 | 8000 | 0.010 | 158.64 | 102.16 | 12 | 614.66 | 450 | 251.20 |
| S-15 | Mxs | 12.80 | 172 | 197.7 | 8000 | 0.017 | 169.33 | 199.84 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 6.25 | 172 | 197.7 | 8000 | 0.008 | 170.71 | 96.79 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.18 | 160 | 183.9 | 8000 | 0.013 | 158.18 | 136.72 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.22 | 160 | 183.9 | 8000 | 0.010 | 158.62 | 103.67 | 12 | 614.66 | 450 | 251.20 |
| S-16 | Mxs | 12.83 | 172 | 197.7 | 8000 | 0.017 | 169.33 | 200.31 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 6.90 | 172 | 197.7 | 8000 | 0.009 | 170.57 | 106.94 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 5.82 | 160 | 183.9 | 8000 | 0.009 | 158.71 | 96.95 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 7.11 | 160 | 183.9 | 8000 | 0.011 | 158.42 | 118.65 | 12 | 614.66 | 450 | 251.20 |
| S-17 | Mxs | 9.44 | 172 | 197.7 | 8000 | 0.013 | 170.04 | 146.77 | 12 | 571.78 | 450 | 251.20 |
| | Mxf | 7.35 | 172 | 197.7 | 8000 | 0.010 | 170.48 | 113.98 | 12 | 571.78 | 450 | 251.20 |
| | Mys | 8.61 | 160 | 183.9 | 8000 | 0.013 | 158.08 | 143.99 | 12 | 614.66 | 450 | 251.20 |
| | Myf | 6.99 | 160 | 183.9 | 8000 | 0.011 | 158.44 | 116.63 | 12 | 614.66 | 450 | 251.20 |

Table A. 10: Check for defelection and Serviceability Requirement for roof floor

| Panel | d | Ascalc | AS required | ρo | P | F1 | K | N | LX/D | LX | D | depth check |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 31.0 | 72.2 | 4430 | 61.333 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 42.0 | 97.9 | 4430 | 45.239 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 36.9 | 85.9 | 4430 | 51.584 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 36.9 | 85.9 | 4430 | 51.584 | SAFE |
| S-2 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 42.0 | 113.0 | 5000 | 44.252 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 42.0 | 113.0 | 5000 | 44.252 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |
| S-3 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 42.0 | 113.0 | 5000 | 44.252 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 42.0 | 113.0 | 5000 | 44.252 | SAFE |
| | 160 | 869.5 | 130.0 | 0.0045 | 0.0008 | 0.150 | 1.5 | 184.7 | 41.4 | 5000 | 120.704 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |
| S-4 | 172 | 403.7 | 280.0 | 0.0045 | 0.0016 | 0.694 | 1.5 | 62.5 | 65.0 | 5000 | 76.928 | SAFE |
| | 172 | 628.0 | 180.0 | 0.0045 | 0.0010 | 0.287 | 1.5 | 124.4 | 53.5 | 5000 | 93.475 | SAFE |
| | 160 | 869.5 | 130.0 | 0.0045 | 0.0008 | 0.150 | 1.5 | 184.7 | 41.4 | 5000 | 120.704 | SAFE |
| | 160 | 1256.0 | 90.0 | 0.0045 | 0.0006 | 0.072 | 1.5 | 326.6 | 35.1 | 5000 | 142.454 | SAFE |
| S-5 | 172 | 452.2 | 450.0 | 0.0045 | 0.0026 | 0.995 | 1.5 | 36.9 | 55.1 | 5000 | 90.824 | SAFE |
| | 172 | 628.0 | 450.0 | 0.0045 | 0.0026 | 0.717 | 1.5 | 1976.4 | 2124.3 | 5000 | 2.354 | SAFE |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 160 | 869.5 | 450.0 | 0.0045 | 0.0028 | 0.518 | 1.5 | 39.1 | 30.3 | 5000 | 164.871 | SAFE |
| | 160 | 1130.4 | 450.0 | 0.0045 | 0.0028 | 0.398 | 1.5 | 24.9 | 14.9 | 5000 | 336.334 | SAFE |
| S-6 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 16.5 | 38.5 | 5000 | 129.821 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 42.0 | 97.9 | 5000 | 51.060 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 42.0 | 97.9 | 5000 | 51.060 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 36.9 | 85.9 | 5000 | 58.221 | SAFE |
| S-7 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 31.0 | 83.3 | 5000 | 59.995 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 1976.4 | 5310.8 | 5000 | 0.941 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 39.1 | 105.0 | 5000 | 47.629 | SAFE |
| S-8 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 24.9 | 66.9 | 4430 | 66.220 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 16.5 | 44.4 | 4430 | 99.685 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 42.0 | 113.0 | 4430 | 39.207 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 42.0 | 113.0 | 4430 | 39.207 | SAFE |
| S-9 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 36.9 | 99.1 | 4430 | 44.706 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 36.9 | 99.1 | 4430 | 44.706 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 42.0 | 113.0 | 4430 | 39.207 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 42.0 | 113.0 | 4430 | 39.207 | SAFE |
| S-10 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 31.0 | 72.2 | 5000 | 69.224 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 36.9 | 85.9 | 5000 | 58.221 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 1976.4 | 4602.7 | 5000 | 1.086 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 39.1 | 91.0 | 5000 | 54.957 | SAFE |
| S-11 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 31.0 | 72.2 | 5000 | 69.224 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 36.9 | 85.9 | 5000 | 58.221 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 1976.4 | 4602.7 | 5000 | 1.086 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 39.1 | 91.0 | 5000 | 54.957 | SAFE |
| S-12 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 31.0 | 83.3 | 5000 | 59.995 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 1976.4 | 5310.8 | 5000 | 0.941 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 39.1 | 105.0 | 5000 | 47.629 | SAFE |
| S-13 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 31.0 | 83.3 | 5000 | 59.995 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 1976.4 | 5310.8 | 5000 | 0.941 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 39.1 | 105.0 | 5000 | 47.629 | SAFE |
| S-14 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 31.0 | 83.3 | 5000 | 59.995 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 1976.4 | 5310.8 | 5000 | 0.941 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 39.1 | 105.0 | 5000 | 47.629 | SAFE |
| S-15 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 31.0 | 83.3 | 5000 | 59.995 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 1976.4 | 5310.8 | 5000 | 0.941 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 39.1 | 105.0 | 5000 | 47.629 | SAFE |
| S-16 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 31.0 | 83.3 | 5000 | 59.995 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.5 | 36.9 | 99.1 | 5000 | 50.458 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 1976.4 | 5310.8 | 5000 | 0.941 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.5 | 39.1 | 105.0 | 5000 | 47.629 | SAFE |
| S-17 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 24.9 | 58.0 | 4430 | 76.408 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.791 | 1.3 | 16.5 | 38.5 | 4430 | 115.021 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 42.0 | 97.9 | 4430 | 45.239 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.791 | 1.3 | 42.0 | 97.9 | 4430 | 45.239 | SAFE |

Table A. 11: Loads on Supporting Beams for the roof floor

| Panel | Ly | Lx | Ly/lx | Shear coefficent | | Pd | Loads transferred | |
|---|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 10.231 | Vxc | 18.13 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 10.231 | Vxd | 11.78 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 10.231 | Vyc | 18.13 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 10.231 | Vyd | 11.78 |
| S-2 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-3 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-4 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-6 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-7 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-8 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 10.231 | Vxc | 18.13 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 10.231 | Vxd | 11.78 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 10.231 | Vyc | 18.13 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 10.231 | Vyd | 11.78 |
| S-9 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 10.231 | Vxc | 18.13 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 10.231 | Vxd | 11.78 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 10.231 | Vyc | 18.13 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 10.231 | Vyd | 11.78 |
| S-10 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-11 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-12 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-13 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-14 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-15 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-16 | 5 | 5 | 1 | Bvxc | 0.36 | 10.231 | Vxc | 18.42 |
| | 5 | 5 | 1 | Bvxd | 0 | 10.231 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 10.231 | Vyc | 18.42 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 10.231 | Vyd | 12.28 |
| S-17 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 10.231 | Vxc | 18.13 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 10.231 | Vxd | 11.78 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 10.231 | Vyc | 18.13 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 10.231 | Vyd | 11.78 |

Table A. 12: Dead load on the beam for the roof floor

| Panel | H parafit | T HCB | ϒ HCB | T Plaster | ϒ Plaster | Total DL |
|---|---|---|---|---|---|---|
| S-1 | | | | | | |
| Axis(A, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(B, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, A&B) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(3, A&B) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-2 | | | | | | |
| Axis(B, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(C, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, B&C) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(3, B&C) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-3 | | | | | | |
| Axis(C, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(D, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, C&D) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(3, C&D) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-4 | | | | | | |
| Axis(D, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(E, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, D&E) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(3, D&E) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-5 | | | | | | |
| Axis(F, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(G, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(2, F&G) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(3, F&G) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-6 | | | | | | |
| Axis(G, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(H, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, G&H) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(3, G&H) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-7 | | | | | | |
| Axis(H, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(I, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, H&I) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(3, H&I) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-8 | | | | | | |
| Axis(I, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(J, 2&3) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, I&J) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(3, I&J) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-9 | | | | | | |
| Axis(A, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(B, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, A&B) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, A&B) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-10 | | | | | | |
| Axis(B, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(C, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, B&C) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, B&C) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-11 | | | | | | |
| Axis(C, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(D, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, C&D) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, C&D) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-12 | | | | | | |
| Axis(D, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(E, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, D&E) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(2, D&E) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-13 | | | | | | |
| Axis(E, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(F, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, E&F) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, E&F) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-14 | | | | | | |
| Axis(F, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(G, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, F&G) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, F&G) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-15 | | | | | | |
| Axis(G, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(H, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, G&H) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, G&H) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-16 | | | | | | |
| Axis(H, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(I, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, H&I) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, H&I) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| S-17 | | | | | | |
| Axis(I, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(J, 1&2) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(1, I&J) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |
| Axis(2, I&J) | 0.8 | 0.2 | 14 | 0.04 | 23.00 | 2.976 |

Table A. 13: Shear transfer on the beam

| Panel | shear | dead load | Total pd including parafit (KN/M) | Beam self weight(250*300) | shear load | total load |
|---|---|---|---|---|---|---|
| S-1 | | | | | | |
| Axis(A, 2&3) | Vxc | 2.976 | 13.206 | 1.87 | 18.13 | 31.57 |
| Axis(B, 2&3) | Vxd | 2.976 | 13.206 | 1.87 | 11.78 | 25.80 |
| Axis(2, A&B) | Vyc | 2.976 | 13.206 | 1.87 | 18.13 | 31.57 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(3, A&B) | Vyd | 2.976 | 13.206 | 1.87 | 11.78 | 25.80 |
| S-2 | | | | | | |
| Axis(B, 2&3) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(C, 2&3) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(2, B&C) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(3, B&C) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-3 | | | | | | |
| Axis(C, 2&3) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(D, 2&3) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(2, C&D) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(3, C&D) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-4 | | | | | | |
| Axis(D, 2&3) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(E, 2&3) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(2, D&E) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(3, D&E) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-5 | | | | | | |
| Axis(F, 2&3) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(G, 2&3) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(2, F&G) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(3, F&G) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-6 | | | | | | |
| Axis(G, 2&3) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(H, 2&3) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(2, G&H) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(3, G&H) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-7 | | | | | | |
| Axis(H, 2&3) | Vxc | 2.976 | 13.206 | 1.87 | 18.13 | 31.57 |
| Axis(I, 2&3) | Vxd | 2.976 | 13.206 | 1.87 | 11.78 | 25.80 |
| Axis(2, H&I) | Vyc | 2.976 | 13.206 | 1.87 | 18.13 | 31.57 |
| Axis(3, H&I) | Vyd | 2.976 | 13.206 | 1.87 | 11.78 | 25.80 |
| S-8 | | | | | | |
| Axis(I, 2&3) | Vxc | 2.976 | 13.206 | 1.87 | 18.13 | 31.57 |
| Axis(J, 2&3) | Vxd | 2.976 | 13.206 | 1.87 | 11.78 | 25.80 |
| Axis(2, I&J) | Vyc | 2.976 | 13.206 | 1.87 | 18.13 | 31.57 |
| Axis(3, I&J) | Vyd | 2.976 | 13.206 | 1.87 | 11.78 | 25.80 |

| | | | | | | |
|---|---|---|---|---|---|---|
| S-9 | | | | | | |
| Axis(A, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(B, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(1, A&B) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(2, A&B) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-10 | | | | 1.87 | | |
| Axis(B, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(C, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(1, B&C) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(2, B&C) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-11 | | | | | | |
| Axis(C, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(D, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(1, C&D) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(2, C&D) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-12 | | | | | | |
| Axis(D, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(E, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(1, D&E) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(2, D&E) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-13 | | | | | | |
| Axis(E, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(F, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(1, E&F) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(2, E&F) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-14 | | | | | | |
| Axis(F, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(G, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(1, F&G) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(2, F&G) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-15 | | | | | | |
| Axis(G, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(H, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(1, G&H) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(2, G&H) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-16 | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(H, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(I, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 0.00 | 15.08 |
| Axis(1, H&I) | Vyc | 2.976 | 13.206 | 1.87 | 18.42 | 31.83 |
| Axis(2, H&I) | Vyd | 2.976 | 13.206 | 1.87 | 12.28 | 26.25 |
| S-17 | | | | | | |
| Axis(I, 1&2) | Vxc | 2.976 | 13.206 | 1.87 | 18.13 | 31.57 |
| Axis(J, 1&2) | Vxd | 2.976 | 13.206 | 1.87 | 11.78 | 25.80 |
| Axis(1, I&J) | Vyc | 2.976 | 13.206 | 1.87 | 18.13 | 31.57 |
| Axis(2, I&J) | Vyd | 2.976 | 13.206 | 1.87 | 11.78 | 25.80 |

Table A. 14: Check for shear reinforcement on the roof floor

| Panel | d | K | CRd,c | Vmin | ρshear | As provide | VRd,c | VEd | check for shear |
|---|---|---|---|---|---|---|---|---|---|
| S-1 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-2 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-3 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.005434615 | 869.54 | 85.1 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-4 | 172 | 2 | 0.12 | 76.1 | 0.002347176 | 403.71 | 69.1 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.003651163 | 628.00 | 80.1 | 22.5389 | SAEE |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 160 | 2 | 0.12 | 70.8 | 0.005434615 | 869.54 | 85.1 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00785 | 1256.00 | 96.2 | 22.6617 | SAEE |
| S-5 | 172 | 2 | 0.12 | 76.1 | 0.002628837 | 452.16 | 71.8 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.003651163 | 628.00 | 80.1 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.005434615 | 869.54 | 85.1 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.007065 | 1130.40 | 92.8 | 22.6617 | SAEE |
| S-6 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-7 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-8 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-9 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S-10 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-11 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-12 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-13 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-14 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-15 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-16 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| S-17 | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 172 | 2 | 0.12 | 76.1 | 0.001460465 | 251.20 | 59.0 | 22.5389 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |
| | 160 | 2 | 0.12 | 70.8 | 0.00157 | 251.20 | 56.2 | 22.6617 | SAEE |

## Appendex B structural analysis and design of Ground floor slab

Table B. 1:Types of slab and Span types on the Ground floor

| Panel | Lx(m) | Ly(m) | Ly/Lx | Type of slab | Span type |
|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-2 | 5 | 5 | 1 | Two way | Interior Span |
| S-3 | 5 | 5 | 1 | Two way | Interior Span |
| S-4 | 5 | 5 | 1 | Two way | Interior Span |
| S-4 | 5 | 5 | 1 | Two way | End Span |
| S-5 | 1.6 | 5 | 3.125 | One way | Interior Span |
| S-6 | 5 | 5 | 1 | Two way | End Span |
| S-6 | 5 | 5 | 1 | Two way | Interior Span |
| S-7 | 5 | 5 | 1 | Two way | Interior Span |
| S-8 | 5 | 5 | 1 | Two way | Interior Span |
| S-9 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-10 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-11 | 5 | 5 | 1 | Two way | Interior Span |
| S-12 | 5 | 5 | 1 | Two way | Interior Span |
| S-13 | 5 | 5 | 1 | Two way | Interior Span |
| S-14 | 5 | 5 | 1 | Two way | Interior Span |
| S-15 | 5 | 5 | 1 | Two way | Interior Span |
| S-16 | 5 | 5 | 1 | Two way | Interior Span |
| S-17 | 5 | 5 | 1 | Two way | Interior Span |
| S-18 | 4.43 | 4.43 | 1 | Two way | End Span |

Table B. 2: Minimum concrete cover for Ground floor

**GROUND FLOOR GOVERING CONCRETE COVER DESIGN**

| Panel | Bond/Durability Minimum cover required | | | Allowance in Design for Variation | | Standred Fire | Cover | GOVERNING Cover Design |
|---|---|---|---|---|---|---|---|---|
| | $Cmin,B$ | $Cmin,Dur$ | $Cmin$(mm) | Δcdev(mm) | $Cnom$ | Resistance | Design | (mm) |
| S-1 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | 22mm |
| S-2 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-3 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-4 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-5 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| S-6 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-7 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-8 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-9 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-10 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-11 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-12 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-13 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-14 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-15 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-16 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-17 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-18 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |

Table B. 3: Effective depth of Ground floor slab

| Panel | Lx(m) | Ly(m) | Ly/Lx | Type of slab | span type | F1 | K | N | Lx/d | Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.779 | 153.933 |
| S-2 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-3 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-4 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-4 | 5 | 5 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.779 | 173.739 |
| S-5 | 1.6 | 5 | 3.125 | One way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 48.1837 |
| S-6 | 5 | 5 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.779 | 173.739 |
| S-6 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-7 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-8 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S-9 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.779 | 153.933 |
| S-10 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.779 | 153.933 |
| S-11 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-12 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-13 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-14 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-15 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-16 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-17 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.206 | 150.574 |
| S-18 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.779 | 153.933 |

| | |
|---|---|
| dmax= | 173 |
| Cover = | 22 |
| Φ= | 12 |
| D= | 200 |

Table B. 4: Partition wall load on the ground floor slab

| **Panel** | **L HCB** | **T HCB** | **H HCB** | **ϒ HCB** | **Ly** | **Lx** | **Area of floor** | **Tplaster** | **ϒ plaster** | **T DL** | **Pd=TDL/A** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S-2 | 5.00 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 45.300 | 1.812 |
| S-3 | 5.00 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 45.300 | 1.812 |
| S-4 | 10.65 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 96.489 | 3.860 |
| S-6 | 10.65 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 96.489 | 3.860 |
| S-7 | 5.00 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 75.651 | 3.026 |
| S-8 | 5.00 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 75.651 | 3.026 |
| S-11 | 2.55 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 75.651 | 3.026 |
| S-12 | 2.55 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 75.651 | 3.026 |
| S-13 | 2.55 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 75.651 | 3.026 |
| S-15 | 2.55 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 75.651 | 3.026 |
| S-16 | 2.55 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 75.651 | 3.026 |
| S-17 | 2.55 | 0.15 | 3.0 | 14 | 5 | 5 | 25 | 0.04 | 23.00 | 75.651 | 3.026 |

Table B. 5: Self-weight of the ground floor based on panel function

| Function | Material | Thickness(m) | Unit weight(KN/$m^3$ ) | Dead Load(KN/ $m^2$ ) |
|---|---|---|---|---|
| | Ceramic | 0.007 | 24 | 0.168 |
| **Shop** | Cement Screed | 0.043 | 23 | 0.989 |
| | RC Slab | 0.2 | 25 | 5 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/$m^2$ )** | **6.617** |
| | | | | |
| **Corrider** | Marble | 0.02 | 27 | 0.54 |
| | Cement Screed | 0.03 | 23 | 0.69 |
| | RC Slab | 0.2 | 25 | 5 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/ $m^2$ )** | **6.69** |
| | | | | |
| **Toilet** | Ceramic | 0.007 | 24 | 0.168 |
| | Cement Screed | 0.043 | 23 | 0.989 |
| | RC Slab | 0.2 | 25 | 5 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/ $m^2$ )** | **6.617** |

Table B. 6: Design factored load on the ground floor

| Panel | Slab self-weight | Partition wall load | Total self-weight | live load | Pd=1.35DL+1.5LL |
|---|---|---|---|---|---|
| S-1 | 6.69 | 0.000 | 6.690 | 5 | 16.53 |
| S-2 | 6.69 | 1.812 | 8.502 | 5 | 18.98 |
| S-3 | 6.69 | 1.812 | 8.502 | 5 | 18.98 |
| S-4 | 6.69 | 3.860 | 10.550 | 5 | 21.74 |
| S-5 | 6.69 | 0.000 | 6.690 | 5 | 16.53 |
| S-6 | 6.69 | 3.860 | 10.550 | 5 | 21.74 |

| | | | | | |
|---|---|---|---|---|---|
| S-7 | 6.69 | 3.026 | 9.716 | 5 | 20.62 |
| S-8 | 6.69 | 3.026 | 9.716 | 5 | 20.62 |
| S-9 | 6.69 | 0.000 | 6.690 | 5 | 16.53 |
| S-10 | 6.69 | 0.000 | 6.690 | 5 | 16.53 |
| S-11 | 6.69 | 3.026 | 9.716 | 5 | 20.62 |
| S-12 | 6.69 | 3.026 | 9.716 | 5 | 20.62 |
| S-13 | 6.69 | 3.026 | 9.716 | 5 | 20.62 |
| S-14 | 6.69 | 0.000 | 6.690 | 5 | 16.53 |
| S-15 | 6.69 | 3.026 | 9.716 | 5 | 20.62 |
| S-16 | 6.69 | 3.026 | 9.716 | 5 | 20.62 |
| S-17 | 6.69 | 3.026 | 9.716 | 5 | 20.62 |
| S-18 | 6.69 | 0.000 | 6.690 | 5 | 16.53 |

Table B. 7: Moment coefficients according to ES EN for the roof slab of the build

| **Panel** | **Ly** | **Lx** | $l_y/l_x$ | $\beta_{xs}$ | $\beta_{xf}$ | $\beta_{ys}$ | $\beta_{yf}$ |
|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-2 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-3 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-7 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-8 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-9 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-10 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-11 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-12 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-13 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-14 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-15 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-16 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-17 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-18 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |

Table B. 8: Computation of moments for all panel

| Panel | Support condition | lx | $lx^2$ | Pd | Moment Coeficient | | Moment location | bending moment $Mi= \beta_i P_d L^2 x$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | location | value | | |
| S-1 | Two adjacent edges discontinuous | 4.43 | 19.62 | 16.5 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 15.25 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 11.68 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 14.60 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 11.03 |
| S-2 | One short edge discontinuous | 5 | 25 | 19 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 18.51 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 13.76 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 17.56 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 13.29 |
| S-3 | One short edge discontinuous | 5 | 25 | 19 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 18.51 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 13.76 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 17.56 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 13.29 |
| S-5 | Interior panel | 1.6 | 2.56 | 16.5 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 1.31 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 1.02 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 1.35 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 1.02 |
| S-7 | One short edge discontinuous | 5 | 25 | 20.6 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 20.10 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 14.95 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.07 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.43 |
| S-8 | One short edge discontinuous | 5 | 25 | 20.6 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 20.10 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 14.95 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.07 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.43 |
| S-9 | Two adjacent edges discontinuous | 4.43 | 19.62 | 16.5 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 15.25 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 11.68 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 14.60 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 11.03 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S-10 | Two adjacent edges discontinuous | 4.43 | 19.62 | 16.5 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 15.25 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 11.68 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 14.60 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 11.03 |
| S-11 | One short edge discontinuous | 5 | 25 | 20.6 | $\beta_{xf}$ | 0.039 | $M_{xs}$ = | 20.10 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 14.95 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.07 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.43 |
| S-12 | One short edge discontinuous | 5 | 25 | 20.6 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 20.10 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 14.95 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.07 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.43 |
| S-13 | One short edge discontinuous | 5 | 25 | 20.6 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 20.10 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 14.95 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.07 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.43 |
| S-14 | One short edge discontinuous | 5 | 25 | 16.5 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 16.12 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 11.98 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 15.29 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 11.57 |
| S-15 | One short edge discontinuous | 5 | 25 | 20.6 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 20.10 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 14.95 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.07 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.43 |
| S-16 | One short edge discontinuous | 5 | 25 | 20.6 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 20.10 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 14.95 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.07 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.43 |
| S-17 | One short edge discontinuous | 5 | 25 | 20.6 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 20.10 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 14.95 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.07 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.43 |
| S-18 | Two adjacent edges discontinuous | 4.43 | 19.62 | 16.5 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 15.25 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 11.68 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 14.60 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 11.03 |

Table B. 9: Adjusted moment for the ground floor

| **Panel** | **Moment notation** | **Unadjusted moment for support moment** | | **ΔM/Mlarge*100** | **Method of Adjustment** | **Adjusted moment** |
|---|---|---|---|---|---|---|
| | | **Ms** | **Ms** | | | |
| S1&S2 | Mys | 17.56 | 14.6 | 16.86 | Take average | 16.08 |
| S1&S10 | Mxs | 15.25 | 15.25 | 0.00 | No adjustment | 15.25 |
| S2&S3 | Mys | 17.56 | 17.56 | 0.00 | No adjustment | 17.56 |
| S2&S11 | Mxs | 20.1 | 18.51 | 7.91 | Take average | 19.31 |
| S3&S4 | Mys | 181.17 | 17.53 | 90.32 | Moment distribution | 99.35 |
| S3&S12 | Mxs | 20.1 | 18.51 | 7.91 | Take average | 19.31 |
| S4&S5 | Mys | 181.17 | 1.35 | 99.25 | Moment distribution | 137.58 |
| S4&S13 | Mxs | 90.58 | 20.11 | 77.80 | Moment distribution | 60.38 |
| S5&S6 | Mys | 181.17 | 1.35 | 99.25 | Moment distribution | 137.58 |
| S5&S14 | Mxs | 16.12 | 1.31 | 91.87 | Moment distribution | 11.69 |
| S6&S7 | Mys | 181.17 | 19.07 | 89.47 | Moment distribution | 100.12 |
| S6&S15 | Mxs | 90.58 | 20.1 | 77.81 | Moment distribution | 60.38 |
| S7&S8 | Mys | 19.07 | 19.07 | 0.00 | No adjustment | 19.07 |
| S7&S16 | Mxs | 20.1 | 20.1 | 0.00 | No adjustment | 20.10 |
| S8&S9 | Mys | 19.07 | 14.6 | 23.44 | Moment distribution | 16.52 |
| S8&S17 | Mxs | 20.1 | 20.1 | 0.00 | No adjustment | 20.10 |
| S9&S18 | Mxs | 15.25 | 15.25 | 0.00 | No adjustment | 15.25 |
| S10&S11 | Mys | 19.07 | 14.6 | 23.44 | Moment distribution | 16.52 |
| S11&S12 | Mys | 19.07 | 19.07 | 0.00 | No adjustment | 19.07 |
| S12&S13 | Mys | 19.07 | 19.07 | 0.00 | No adjustment | 19.07 |
| S13&S14 | Mys | 19.07 | 15.29 | 19.82 | Take average | 17.18 |
| S14&S15 | Mys | 19.07 | 15.29 | 19.82 | Take average | 17.18 |
| S15&S16 | Mys | 19.07 | 19.07 | 0.00 | No adjustment | 19.07 |
| S16&S17 | Mys | 19.07 | 19.07 | 0.00 | No adjustment | 19.07 |

| | | | | | | |
|---|---|---|---|---|---|---|
| S17&S18 | Mys | 19.07 | 14.6 | 23.44 | Moment distribution | 16.52 |

Table B. 10: Span moment adjustment for the Ground floor

| Panel | moment notation | Un adjusted moment | Adjusted support moment | ΔM | | Ly/Lx | Span moment notation | Factor for Adju. | | adjusted span moment |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ΔMxs | ΔMys | | | | | |
| S-1 | Mxs | 15.25 | 15.25 | 0.00 | -1.48 | 1 | Mxf Adj | cx | 0.38 | 11.26 |
| | Mxf | 11.68 | | | | | | cy | 0.28 | |
| | Mys | 14.60 | 16.08 | | | | Myf adj | cx | 0.28 | 10.47 |
| | Myf | 11.03 | | | | | | cy | 0.38 | |
| S-2 | Mxs | 18.51 | 19.31 | -0.80 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 13.45 |
| | Mxf | 13.76 | | | | | | cy | 0.28 | |
| | Mys | 17.56 | 17.56 | | | | Myf adj | cx | 0.28 | 13.06 |
| | Myf | 13.29 | | | | | | cy | 0.38 | |
| S-3 | Mxs | 18.51 | 19.31 | -0.80 | -81.79 | 1 | Mxf Adj | cx | 0.38 | -9.45 |
| | Mxf | 13.76 | | | | | | cy | 0.28 | |
| | Mys | 17.56 | 99.35 | | | | Myf adj | cx | 0.28 | -18.02 |
| | Myf | 13.29 | | | | | | cy | 0.38 | |
| S-4 | Mxs | 90.58 | 60.38 | 30.20 | 43.59 | 1 | Mxf Adj | cx | 0.38 | 68.97 |
| | Mxf | 45.29 | | | | | | cy | 0.28 | |
| | Mys | 181.17 | 137.58 | | | | Myf adj | cx | 0.28 | 115.60 |
| | Myf | 90.58 | | | | | | cy | 0.38 | |
| S-5 | Mxs | 1.31 | 11.69 | -10.38 | -136.23 | 1 | Mxf Adj | cx | 0.38 | -41.07 |
| | Mxf | 1.02 | | | | | | cy | 0.28 | |
| | Mys | 1.35 | 137.58 | | | | Myf adj | cx | 0.28 | -53.66 |
| | Myf | 1.02 | | | | | | cy | 0.38 | |
| S-6 | Mxs | 90.58 | 60.38 | 30.20 | 81.05 | 1 | Mxf Adj | cx | 0.38 | 79.46 |
| | Mxf | 45.29 | | | | | | cy | 0.28 | |
| | Mys | 181.17 | 100.12 | | | | Myf adj | cx | 0.28 | 129.84 |
| | Myf | 90.58 | | | | | | cy | 0.38 | |
| S-7 | Mxs | 20.10 | 20.1 | 0.00 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 14.95 |
| | Mxf | 14.95 | | | | | | cy | 0.28 | |
| | Mys | 19.07 | 19.07 | | | | Myf adj | cx | 0.28 | 14.44 |
| | Myf | 14.43 | | | | | | cy | 0.38 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S-8 | Mxs | 20.10 | 20.1 | 0.00 | 2.55 | 1 | Mxf Adj | cx | 0.38 | 15.67 |
| | Mxf | 14.95 | | | | | | cy | 0.28 | |
| | Mys | 19.07 | 16.52 | | | | Myf adj | cx | 0.28 | 15.41 |
| | Myf | 14.43 | | | | | | cy | 0.38 | |
| S-9 | Mxs | 15.25 | 15.25 | 0.00 | -1.92 | 1 | Mxf Adj | cx | 0.38 | 11.14 |
| | Mxf | 11.68 | | | | | | cy | 0.28 | |
| | Mys | 14.60 | 16.52 | | | | Myf adj | cx | 0.28 | 10.30 |
| | Myf | 11.03 | | | | | | cy | 0.38 | |
| S-10 | Mxs | 15.25 | 15.25 | 0.00 | -1.92 | 1 | Mxf Adj | cx | 0.38 | 11.14 |
| | Mxf | 11.68 | | | | | | cy | 0.28 | |
| | Mys | 14.60 | 16.52 | | | | Myf adj | cx | 0.28 | 10.30 |
| | Myf | 11.03 | | | | | | cy | 0.38 | |
| S-11 | Mxs | 20.10 | 19.31 | 0.79 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 15.25 |
| | Mxf | 14.95 | | | | | | cy | 0.28 | |
| | Mys | 19.07 | 19.07 | | | | Myf adj | cx | 0.28 | 14.66 |
| | Myf | 14.43 | | | | | | cy | 0.38 | |
| S-12 | Mxs | 20.10 | 19.31 | 0.79 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 15.25 |
| | Mxf | 14.95 | | | | | | cy | 0.28 | |
| | Mys | 19.07 | 19.07 | | | | Myf adj | cx | 0.28 | 14.66 |
| | Myf | 14.43 | | | | | | cy | 0.38 | |
| S-13 | Mxs | 20.10 | 60.38 | -40.28 | 1.89 | 1 | Mxf Adj | cx | 0.38 | 0.17 |
| | Mxf | 14.95 | | | | | | cy | 0.28 | |
| | Mys | 19.07 | 17.18 | | | | Myf adj | cx | 0.28 | 3.88 |
| | Myf | 14.43 | | | | | | cy | 0.38 | |
| S-14 | Mxs | 16.12 | 11.69 | 4.43 | -1.89 | 1 | Mxf Adj | cx | 0.38 | 13.14 |
| | Mxf | 11.98 | | | | | | cy | 0.28 | |
| | Mys | 15.29 | 17.18 | | | | Myf adj | cx | 0.28 | 12.09 |
| | Myf | 11.57 | | | | | | cy | 0.38 | |
| S-15 | Mxs | 20.10 | 60.38 | -40.28 | 0.00 | 1 | Mxf Adj | cx | 0.38 | -0.35 |
| | Mxf | 14.95 | | | | | | cy | 0.28 | |
| | Mys | 19.07 | 19.07 | | | | Myf adj | cx | 0.28 | 3.16 |
| | Myf | 14.43 | | | | | | cy | 0.38 | |
| S-16 | Mxs | 20.10 | 20.1 | 0.00 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 14.95 |
| | Mxf | 14.95 | | | | | | cy | 0.28 | |
| | Mys | 19.07 | 19.07 | | | | Myf adj | cx | 0.28 | 14.44 |
| | Myf | 14.43 | | | | | | cy | 0.38 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S-17 | Mxs | 20.10 | 20.1 | 0.00 | 2.55 | 1 | Mxf Adj | cx | 0.38 | 15.67 |
| | Mxf | 14.95 | | | | | | cy | 0.28 | |
| | Mys | 19.07 | 16.52 | | | | Myf adj | cx | 0.28 | 15.41 |
| | Myf | 14.43 | | | | | | cy | 0.38 | |
| S-18 | Mxs | 15.25 | 15.25 | 0.00 | -1.92 | 1 | Mxf Adj | cx | 0.38 | 11.14 |
| | Mxf | 11.68 | | | | | | cy | 0.28 | |
| | Mys | 14.60 | 16.52 | | | | Myf adj | cx | 0.28 | 10.30 |
| | Myf | 11.03 | | | | | | cy | 0.38 | |

Table B. 11: Flexural Reinforcement calculation for the Ground floor

| Panel | moment notation | adjusted moment | d(mm) | As min | As max | μsd | Z | As | NO. of bar | Spacing | Spacing provied | AS Provide |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | Mxs | 15.25 | 172 | 247.1 | 8000 | 0.021 | 168.814 | 207.625 | 12 | 457.421 | 450 | 251.2 |
| | Mxf | 11.26 | 172 | 247.1 | 8000 | 0.015 | 169.659 | 190.714 | 12 | 457.421 | 450 | 251.2 |
| | Mys | 16.08 | 160 | 229.9 | 8000 | 0.025 | 156.373 | 295.492 | 12 | 382.549 | 380 | 297.5 |
| | Myf | 10.47 | 160 | 229.9 | 8000 | 0.016 | 157.658 | 190.833 | 12 | 491.728 | 450 | 251.2 |
| S-2 | Mxs | 19.31 | 172 | 247.1 | 8000 | 0.026 | 167.944 | 330.398 | 12 | 342.133 | 340 | 332.5 |
| | Mxf | 13.45 | 172 | 247.1 | 8000 | 0.018 | 169.196 | 228.430 | 12 | 457.421 | 450 | 251.2 |
| | Mys | 17.56 | 160 | 229.9 | 8000 | 0.027 | 156.030 | 323.397 | 12 | 349.539 | 340 | 332.5 |
| | Myf | 13.06 | 160 | 229.9 | 8000 | 0.020 | 157.067 | 238.934 | 12 | 473.100 | 450 | 251.2 |
| S-3 | Mxs | 19.31 | 172 | 247.1 | 8000 | 0.026 | 167.944 | 330.398 | 12 | 342.133 | 340 | 332.5 |
| | Mxf | 9.45 | 172 | 247.1 | 8000 | 0.013 | 170.040 | 159.699 | 12 | 457.421 | 450 | 251.2 |
| | Mys | 99.35 | 160 | 229.9 | 8000 | 0.155 | 133.811 | 2133.525 | 12 | 52.983 | 50 | 2260.8 |
| | Myf | 18.02 | 160 | 229.9 | 8000 | 0.028 | 155.923 | 332.096 | 12 | 340.383 | 340 | 332.5 |
| S-4 | Mxs | 60.38 | 172 | 247.1 | 8000 | 0.082 | 158.569 | 1094.200 | 12 | 103.308 | 100 | 1130.4 |
| | Mxf | 68.97 | 172 | 247.1 | 8000 | 0.093 | 156.450 | 1266.793 | 12 | 89.233 | 80 | 1413.0 |
| | Mys | 137.58 | 160 | 229.9 | 8000 | 0.215 | 119.333 | 3312.953 | 12 | 34.121 | 30 | 3768.0 |
| | Myf | 115.60 | 160 | 229.9 | 8000 | 0.181 | 128.191 | 2591.315 | 12 | 43.623 | 40 | 2826.0 |
| S-5 | Mxs | 11.69 | 172 | 247.1 | 8000 | 0.016 | 169.568 | 198.103 | 12 | 457.421 | 450 | 251.2 |
| | Mxf | 41.07 | 172 | 247.1 | 8000 | 0.056 | 163.119 | 723.504 | 12 | 156.240 | 150 | 753.6 |
| | Mys | 137.58 | 160 | 229.9 | 8000 | 0.215 | 119.333 | 3312.953 | 12 | 34.121 | 30 | 3768.0 |
| | Myf | 53.66 | 160 | 229.9 | 8000 | 0.084 | 147.136 | 1047.979 | 12 | 491.728 | 450 | 251.2 |
| S-6 | Mxs | 60.38 | 172 | 247.1 | 8000 | 0.082 | 158.569 | 1094.200 | 12 | 103.308 | 100 | 1130.4 |
| | Mxf | 79.46 | 172 | 247.1 | 8000 | 0.107 | 153.773 | 1484.873 | 12 | 76.128 | 70 | 1614.9 |
| | Mys | 100.12 | 160 | 229.9 | 8000 | 0.156 | 133.558 | 2154.133 | 12 | 52.476 | 50 | 2260.8 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Myf | 129.84 | 160 | 229.9 | 8000 | 0.203 | 122.663 | 3041.703 | 12 | 37.163 | 30 | 3768.0 |
| S-7 | Mxs | 20.10 | 172 | 247.1 | 8000 | 0.027 | 167.774 | 344.264 | 12 | 328.352 | 320 | 353.3 |
| | Mxf | 14.95 | 172 | 247.1 | 8000 | 0.020 | 168.877 | 254.384 | 12 | 444.367 | 440 | 256.9 |
| | Mys | 19.07 | 160 | 229.9 | 8000 | 0.030 | 155.679 | 351.999 | 12 | 321.138 | 320 | 353.3 |
| | Myf | 14.44 | 160 | 229.9 | 8000 | 0.023 | 156.751 | 264.715 | 12 | 427.025 | 420 | 269.1 |
| S-8 | Mxs | 20.10 | 172 | 247.1 | 8000 | 0.027 | 167.774 | 344.264 | 12 | 328.352 | 320 | 353.3 |
| | Mxf | 15.67 | 172 | 247.1 | 8000 | 0.021 | 168.724 | 266.878 | 12 | 423.564 | 420 | 269.1 |
| | Mys | 16.52 | 160 | 229.9 | 8000 | 0.026 | 156.271 | 303.775 | 12 | 372.117 | 370 | 305.5 |
| | Myf | 15.41 | 160 | 229.9 | 8000 | 0.024 | 156.527 | 282.900 | 12 | 399.576 | 390 | 289.8 |
| S-9 | Mxs | 15.25 | 172 | 247.1 | 8000 | 0.021 | 168.814 | 259.531 | 12 | 435.554 | 430 | 262.9 |
| | Mxf | 11.14 | 172 | 247.1 | 8000 | 0.015 | 169.684 | 188.653 | 12 | 457.421 | 450 | 251.2 |
| | Mys | 16.52 | 160 | 229.9 | 8000 | 0.026 | 156.271 | 303.775 | 12 | 372.117 | 370 | 305.5 |
| | Myf | 10.30 | 160 | 229.9 | 8000 | 0.016 | 157.696 | 187.688 | 12 | 602.275 | 450 | 251.2 |
| S-10 | Mxs | 15.25 | 172 | 247.1 | 8000 | 0.021 | 168.814 | 259.531 | 12 | 435.554 | 430 | 262.9 |
| | Mxf | 11.14 | 172 | 247.1 | 8000 | 0.015 | 169.684 | 188.653 | 12 | 457.421 | 450 | 251.2 |
| | Mys | 16.52 | 160 | 229.9 | 8000 | 0.026 | 156.271 | 303.775 | 12 | 372.117 | 370 | 305.5 |
| | Myf | 10.30 | 160 | 229.9 | 8000 | 0.016 | 157.696 | 187.688 | 12 | 602.275 | 450 | 251.2 |
| S-11 | Mxs | 19.31 | 172 | 247.1 | 8000 | 0.026 | 167.944 | 330.398 | 12 | 342.133 | 340 | 332.5 |
| | Mxf | 15.25 | 172 | 247.1 | 8000 | 0.021 | 168.814 | 259.587 | 12 | 435.461 | 430 | 262.9 |
| | Mys | 19.07 | 160 | 229.9 | 8000 | 0.030 | 155.679 | 351.999 | 12 | 321.138 | 320 | 353.3 |
| | Myf | 14.66 | 160 | 229.9 | 8000 | 0.023 | 156.700 | 268.835 | 12 | 420.481 | 420 | 269.1 |
| S-12 | Mxs | 19.31 | 172 | 247.1 | 8000 | 0.026 | 167.944 | 330.398 | 12 | 342.133 | 340 | 332.5 |
| | Mxf | 15.25 | 172 | 247.1 | 8000 | 0.021 | 168.814 | 259.587 | 12 | 435.461 | 430 | 262.9 |
| | Mys | 19.07 | 160 | 229.9 | 8000 | 0.030 | 155.679 | 351.999 | 12 | 321.138 | 320 | 353.3 |
| | Myf | 14.66 | 160 | 229.9 | 8000 | 0.023 | 156.700 | 268.835 | 12 | 420.481 | 420 | 269.1 |
| S-13 | Mxs | 60.38 | 172 | 247.1 | 8000 | 0.082 | 158.569 | 1094.200 | 12 | 103.308 | 100 | 1130.4 |
| | Mxf | 0.17 | 172 | 247.1 | 8000 | 0.000 | 171.965 | 2.841 | 12 | 39792.650 | 450 | 251.2 |
| | Mys | 17.18 | 160 | 229.9 | 8000 | 0.027 | 156.118 | 316.220 | 12 | 357.472 | 350 | 323.0 |
| | Myf | 3.88 | 160 | 229.9 | 8000 | 0.006 | 159.140 | 70.060 | 12 | 1613.463 | 450 | 251.2 |
| S-14 | Mxs | 11.69 | 172 | 247.1 | 8000 | 0.016 | 169.568 | 198.103 | 12 | 570.613 | 450 | 251.2 |
| | Mxf | 13.14 | 172 | 247.1 | 8000 | 0.018 | 169.262 | 223.078 | 12 | 506.728 | 450 | 251.2 |
| | Mys | 17.18 | 160 | 229.9 | 8000 | 0.027 | 156.118 | 316.220 | 12 | 357.472 | 350 | 323.0 |
| | Myf | 12.09 | 160 | 229.9 | 8000 | 0.019 | 157.289 | 220.876 | 12 | 511.779 | 450 | 251.2 |
| S-15 | Mxs | 60.38 | 172 | 247.1 | 8000 | 0.082 | 158.569 | 1094.200 | 12 | 103.308 | 100 | 1130.4 |
| | Mxf | 0.35 | 172 | 247.1 | 8000 | 0.000 | 171.928 | 5.850 | 12 | 19323.707 | 450 | 251.2 |
| | Mys | 19.07 | 160 | 229.9 | 8000 | 0.030 | 155.679 | 351.999 | 12 | 321.138 | 320 | 353.3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Myf | 3.16 | 160 | 229.9 | 8000 | 0.005 | 159.300 | 57.002 | 12 | 1983.083 | 450 | 251.2 |
| S-16 | Mxs | 20.10 | 172 | 247.1 | 8000 | 0.027 | 167.774 | 344.264 | 12 | 328.352 | 320 | 353.3 |
| | Mxf | 14.95 | 172 | 247.1 | 8000 | 0.020 | 168.877 | 254.384 | 12 | 444.367 | 440 | 256.9 |
| | Mys | 19.07 | 160 | 229.9 | 8000 | 0.030 | 155.679 | 351.999 | 12 | 321.138 | 320 | 353.3 |
| | Myf | 14.44 | 160 | 229.9 | 8000 | 0.023 | 156.751 | 264.715 | 12 | 427.025 | 420 | 269.1 |
| S-17 | Mxs | 20.10 | 172 | 247.1 | 8000 | 0.027 | 167.774 | 344.264 | 12 | 328.352 | 320 | 353.3 |
| | Mxf | 15.67 | 172 | 247.1 | 8000 | 0.021 | 168.724 | 266.878 | 12 | 423.564 | 420 | 269.1 |
| | Mys | 16.52 | 160 | 229.9 | 8000 | 0.026 | 156.271 | 303.775 | 12 | 372.117 | 370 | 305.5 |
| | Myf | 15.41 | 160 | 229.9 | 8000 | 0.024 | 156.527 | 282.900 | 12 | 399.576 | 390 | 289.8 |
| S-18 | Mxs | 15.25 | 172 | 247.1 | 8000 | 0.021 | 168.814 | 259.587 | 12 | 435.461 | 430 | 262.9 |
| | Mxf | 11.14 | 172 | 247.1 | 8000 | 0.015 | 169.684 | 188.653 | 12 | 457.421 | 450 | 251.2 |
| | Mys | 16.52 | 160 | 229.9 | 8000 | 0.026 | 156.271 | 303.775 | 12 | 372.117 | 370 | 305.5 |
| | Myf | 10.30 | 160 | 229.9 | 8000 | 0.016 | 157.696 | 187.688 | 12 | 602.275 | 450 | 251.2 |

Table B. 12: Check for defelection and Serviceability Requirement for Ground floor

| **Panel** | **d** | **Ascalc** | **AS required** | **ρo** | **P** | **F1** | **K** | **N** | **LX/D** | **LX** | **D** | **depth check** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.3 | 31.0 | 72.2 | 4430 | 61.33 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.3 | 31.0 | 72.2 | 4430 | 61.33 | SAFE |
| | 160 | 297.5 | 380.0 | 0.0045 | 0.0024 | 1.28 | 1.3 | 35.5 | 59.0 | 4430 | 75.14 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.79 | 1.3 | 28.2 | 65.6 | 4430 | 67.57 | SAFE |
| S-2 | 172 | 332.5 | 340.0 | 0.0045 | 0.0020 | 1.02 | 1.5 | 46.5 | 71.3 | 5000 | 70.14 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.5 | 31.0 | 83.3 | 5000 | 59.99 | SAFE |
| | 160 | 332.5 | 340.0 | 0.0045 | 0.0021 | 1.02 | 1.5 | 41.7 | 64.0 | 5000 | 78.11 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.79 | 1.5 | 28.2 | 75.6 | 5000 | 66.09 | SAFE |
| S-3 | 172 | 332.5 | 340.0 | 0.0045 | 0.0020 | 1.02 | 1.5 | 46.5 | 71.3 | 5000 | 70.14 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.5 | 31.0 | 83.3 | 5000 | 59.99 | SAFE |
| | 160 | 2260.8 | 50.0 | 0.0045 | 0.0003 | 0.02 | 1.5 | 801.9 | 26.6 | 5000 | 187.9 | SAFE |
| | 160 | 332.5 | 340.0 | 0.0045 | 0.0021 | 1.02 | 1.5 | 41.7 | 64.0 | 5000 | 78.11 | SAFE |
| S-4 | 172 | 1130.4 | 100.0 | 0.0045 | 0.0006 | 0.09 | 1.5 | 310.3 | 41.2 | 5000 | 121.4 | SAFE |
| | 172 | 1413.0 | 80.0 | 0.0045 | 0.0005 | 0.06 | 1.5 | 437.4 | 37.1 | 5000 | 134.6 | SAFE |
| | 160 | 3768.0 | 30.0 | 0.0045 | 0.0002 | 0.01 | 1.5 | 1734.2 | 20.7 | 5000 | 241.4 | SAFE |
| | 160 | 2826.0 | 40.0 | 0.0045 | 0.0003 | 0.01 | 1.5 | 1124.2 | 23.9 | 5000 | 209.5 | SAFE |
| S-5 | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.5 | 31.0 | 83.3 | 5000 | 59.99 | SAFE |
| | 172 | 753.6 | 150.0 | 0.0045 | 0.0009 | 0.2 | 1.5 | 165.4 | 49.4 | 5000 | 101.2 | SAFE |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 160 | 3768.0 | 30.0 | 0.0045 | 0.0002 | 0.01 | 1.5 | 1734.2 | 20.7 | 5000 | 241.4 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.79 | 1.5 | 28.2 | 75.6 | 5000 | 66.09 | SAFE |
| S-6 | 172 | 1130.4 | 320.0 | 0.0045 | 0.0019 | 0.28 | 1.5 | 50.9 | 21.6 | 5000 | 231.2 | SAFE |
| | 172 | 1614.9 | 440.0 | 0.0045 | 0.0026 | 0.27 | 1.5 | 32.0 | 13.1 | 5000 | 382.5 | SAFE |
| | 160 | 2260.8 | 320.0 | 0.0045 | 0.0020 | 0.14 | 1.5 | 45.7 | 9.7 | 5000 | 515.7 | SAFE |
| | 160 | 3768.0 | 420.0 | 0.0045 | 0.0026 | 0.11 | 1.5 | 30.9 | 5.2 | 5000 | 968.6 | SAFE |
| S-7 | 172 | 353.3 | 320.0 | 0.0045 | 0.0019 | 0.91 | 1.3 | 50.9 | 60.0 | 5000 | 83.37 | SAFE |
| | 172 | 256.9 | 420.0 | 0.0045 | 0.0026 | 1.63 | 1.3 | 32.0 | 68.0 | 5000 | 73.55 | SAFE |
| | 160 | 353.3 | 370.0 | 0.0045 | 0.0020 | 1.05 | 1.3 | 45.7 | 62.2 | 5000 | 80.41 | SAFE |
| | 160 | 269.1 | 390.0 | 0.0045 | 0.0026 | 1.45 | 1.3 | 30.9 | 58.2 | 5000 | 85.97 | SAFE |
| S-8 | 172 | 353.3 | 430.0 | 0.0045 | 0.0019 | 1.22 | 1.5 | 50.9 | 93.0 | 5000 | 53.77 | SAFE |
| | 172 | 269.1 | 450.0 | 0.0045 | 0.0024 | 1.67 | 1.5 | 34.1 | 85.6 | 5000 | 58.41 | SAFE |
| | 160 | 305.5 | 370.0 | 0.0045 | 0.0023 | 1.21 | 1.5 | 36.9 | 67.0 | 5000 | 74.62 | SAFE |
| | 160 | 289.8 | 450.0 | 0.0045 | 0.0024 | 1.55 | 1.5 | 34.2 | 79.7 | 5000 | 62.74 | SAFE |
| S-9 | 172 | 262.9 | 430.0 | 0.0045 | 0.0025 | 1.64 | 1.5 | 33.0 | 81.0 | 4430 | 54.67 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.5 | 31.0 | 83.3 | 4430 | 53.16 | SAFE |
| | 160 | 305.5 | 370.0 | 0.0045 | 0.0023 | 1.21 | 1.5 | 36.9 | 67.0 | 4430 | 66.11 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.79 | 1.5 | 28.2 | 75.6 | 4430 | 58.56 | SAFE |
| S-10 | 172 | 262.9 | 340.0 | 0.0045 | 0.0025 | 1.29 | 1.5 | 33.0 | 64.1 | 4430 | 69.14 | SAFE |
| | 172 | 251.2 | 430.0 | 0.0045 | 0.0026 | 1.71 | 1.5 | 31.0 | 79.6 | 4430 | 55.63 | SAFE |
| | 160 | 305.5 | 320.0 | 0.0045 | 0.0023 | 1.05 | 1.5 | 36.9 | 58.0 | 4430 | 76.44 | SAFE |
| | 160 | 251.2 | 420.0 | 0.0045 | 0.0028 | 1.67 | 1.5 | 28.2 | 70.6 | 4430 | 62.74 | SAFE |
| S-11 | 172 | 332.5 | 340.0 | 0.0045 | 0.0020 | 1.02 | 1.3 | 46.5 | 61.8 | 5000 | 80.93 | SAFE |
| | 172 | 262.9 | 430.0 | 0.0045 | 0.0025 | 1.64 | 1.3 | 33.0 | 70.2 | 5000 | 71.2 | SAFE |
| | 160 | 353.3 | 320.0 | 0.0045 | 0.0020 | 0.91 | 1.3 | 45.7 | 53.8 | 5000 | 92.98 | SAFE |
| | 160 | 269.1 | 420.0 | 0.0045 | 0.0026 | 1.56 | 1.3 | 30.9 | 62.6 | 5000 | 79.83 | SAFE |
| S-12 | 172 | 332.5 | 100.0 | 0.0045 | 0.0020 | 0.3 | 1.3 | 46.5 | 18.2 | 5000 | 275.2 | SAFE |
| | 172 | 262.9 | 450.0 | 0.0045 | 0.0025 | 1.71 | 1.3 | 33.0 | 73.5 | 5000 | 68.03 | SAFE |
| | 160 | 353.3 | 350.0 | 0.0045 | 0.0020 | 0.99 | 1.3 | 45.7 | 58.8 | 5000 | 85.01 | SAFE |
| | 160 | 269.1 | 450.0 | 0.0045 | 0.0026 | 1.67 | 1.3 | 30.9 | 67.1 | 5000 | 74.51 | SAFE |
| S-13 | 172 | 1130.4 | 450.0 | 0.0045 | 0.0006 | 0.4 | 1.5 | 310.3 | 185.3 | 5000 | 26.98 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.5 | 31.0 | 83.3 | 5000 | 59.99 | SAFE |
| | 160 | 323.0 | 350.0 | 0.0045 | 0.0022 | 1.08 | 1.5 | 40.0 | 65.0 | 5000 | 76.92 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.79 | 1.5 | 28.2 | 75.6 | 5000 | 66.09 | SAFE |
| S-14 | 172 | 251.2 | 100.0 | 0.0045 | 0.0026 | 0.4 | 1.5 | 31.0 | 18.5 | 5000 | 270 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.5 | 31.0 | 83.3 | 5000 | 59.99 | SAFE |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 160 | 323.0 | 320.0 | 0.0045 | 0.0022 | 0.99 | 1.5 | 40.0 | 59.4 | 5000 | 84.13 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.79 | 1.5 | 28.2 | 75.6 | 5000 | 66.09 | SAFE |
| S-15 | 172 | 1130.4 | 320.0 | 0.0045 | 0.0006 | 0.28 | 1.5 | 310.3 | 131.8 | 5000 | 37.94 | SAFE |
| | 172 | 251.2 | 440.0 | 0.0045 | 0.0026 | 1.75 | 1.5 | 31.0 | 81.5 | 5000 | 61.36 | SAFE |
| | 160 | 353.3 | 320.0 | 0.0045 | 0.0020 | 0.91 | 1.5 | 45.7 | 62.0 | 5000 | 80.58 | SAFE |
| | 160 | 251.2 | 420.0 | 0.0045 | 0.0028 | 1.67 | 1.5 | 28.2 | 70.6 | 5000 | 70.82 | SAFE |
| S-16 | 172 | 353.3 | 320.0 | 0.0045 | 0.0019 | 0.91 | 1.5 | 50.9 | 69.2 | 5000 | 72.26 | SAFE |
| | 172 | 256.9 | 420.0 | 0.0045 | 0.0026 | 1.63 | 1.5 | 32.0 | 78.4 | 5000 | 63.74 | SAFE |
| | 160 | 353.3 | 370.0 | 0.0045 | 0.0020 | 1.05 | 1.5 | 45.7 | 71.7 | 5000 | 69.69 | SAFE |
| | 160 | 269.1 | 390.0 | 0.0045 | 0.0026 | 1.45 | 1.5 | 30.9 | 67.1 | 5000 | 74.51 | SAFE |
| S-17 | 172 | 353.3 | 430.0 | 0.0045 | 0.0019 | 1.22 | 1.5 | 50.9 | 93.0 | 5000 | 53.77 | SAFE |
| | 172 | 269.1 | 450.0 | 0.0045 | 0.0024 | 1.67 | 1.5 | 34.1 | 85.6 | 5000 | 58.41 | SAFE |
| | 160 | 305.5 | 370.0 | 0.0045 | 0.0023 | 1.21 | 1.5 | 36.9 | 67.0 | 5000 | 74.62 | SAFE |
| | 160 | 289.8 | 450.0 | 0.0045 | 0.0024 | 1.55 | 1.5 | 34.2 | 79.7 | 5000 | 62.74 | SAFE |
| S-18 | 172 | 262.9 | 430.0 | 0.0045 | 0.0025 | 1.64 | 1.3 | 33.0 | 70.2 | 4430 | 63.08 | SAFE |
| | 172 | 251.2 | 450.0 | 0.0045 | 0.0026 | 1.79 | 1.3 | 31.0 | 72.2 | 4430 | 61.33 | SAFE |
| | 160 | 305.5 | 370.0 | 0.0045 | 0.0023 | 1.21 | 1.3 | 36.9 | 58.1 | 4430 | 76.28 | SAFE |
| | 160 | 251.2 | 450.0 | 0.0045 | 0.0028 | 1.79 | 1.3 | 28.2 | 65.6 | 4430 | 67.57 | SAFE |

Table B. 13: Loads on Supporting Beams for the roof floor

| Panel | Ly | Lx | Ly/lx | Shear coefficent | | Pd | Loads transferred | |
|---|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 16.53 | Vxc | 29.29 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 16.53 | Vxd | 19.04 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 16.53 | Vyc | 29.29 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 16.53 | Vyd | 19.04 |
| S-2 | 5 | 5 | 1 | Bvxc | 0.36 | 18.98 | Vxc | 34.16 |
| | 5 | 5 | 1 | Bvxd | 0 | 18.98 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 18.98 | Vyc | 34.16 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 18.98 | Vyd | 22.78 |
| S-3 | 5 | 5 | 1 | Bvxc | 0.36 | 18.98 | Vxc | 34.16 |
| | 5 | 5 | 1 | Bvxd | 0 | 18.98 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 18.98 | Vyc | 34.16 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 18.98 | Vyd | 22.78 |
| S-4 | 5 | 5 | 1 | Bvxc | 0.36 | 21.74 | Vxc | 39.13 |
| | 5 | 5 | 1 | Bvxd | 0 | 21.74 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 21.74 | Vyc | 39.13 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 5 | 1 | Bvyd | 0.24 | 21.74 | Vyd | 26.09 |
| S-5 | 5 | 1.6 | 3.125 | Bvxc | 0.36 | 16.53 | Vxc | 9.52 |
| | 5 | 1.6 | 3.125 | Bvxd | 0 | 16.53 | Vxd | 0.00 |
| | 5 | 1.6 | 3.125 | Bvyc | 0.36 | 16.53 | Vyc | 9.52 |
| | 5 | 1.6 | 3.125 | Bvyd | 0.24 | 16.53 | Vyd | 6.35 |
| S-6 | 5 | 5 | 1 | Bvxc | 0.36 | 21.74 | Vxc | 39.13 |
| | 5 | 5 | 1 | Bvxd | 0 | 21.74 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 21.74 | Vyc | 39.13 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 21.74 | Vyd | 26.09 |
| S-7 | 5 | 5 | 1 | Bvxc | 0.36 | 20.62 | Vxc | 37.12 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.62 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.62 | Vyc | 37.12 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.62 | Vyd | 24.74 |
| S-8 | 5 | 5 | 1 | Bvxc | 0.36 | 20.62 | Vxc | 37.12 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.62 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.62 | Vyc | 37.12 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.62 | Vyd | 24.74 |
| S-9 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 16.53 | Vxc | 29.29 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 16.53 | Vxd | 19.04 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 16.53 | Vyc | 29.29 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 16.53 | Vyd | 19.04 |
| S-10 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 16.53 | Vxc | 29.29 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 16.53 | Vxd | 19.04 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 16.53 | Vyc | 29.29 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 16.53 | Vyd | 19.04 |
| S-11 | 5 | 5 | 1 | Bvxc | 0.36 | 20.62 | Vxc | 37.12 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.62 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.62 | Vyc | 37.12 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.62 | Vyd | 24.74 |
| S-12 | 5 | 5 | 1 | Bvxc | 0.36 | 20.62 | Vxc | 37.12 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.62 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.62 | Vyc | 37.12 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.62 | Vyd | 24.74 |
| S-13 | 5 | 5 | 1 | Bvxc | 0.36 | 20.62 | Vxc | 37.12 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.62 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.62 | Vyc | 37.12 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.62 | Vyd | 24.74 |
| S-14 | 5 | 5 | 1 | Bvxc | 0.36 | 16.53 | Vxc | 29.75 |
| | 5 | 5 | 1 | Bvxd | 0 | 16.53 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 16.53 | Vyc | 29.75 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 16.53 | Vyd | 19.84 |
| S-15 | 5 | 5 | 1 | Bvxc | 0.36 | 20.62 | Vxc | 37.12 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.62 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.62 | Vyc | 37.12 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.62 | Vyd | 24.74 |
| S-16 | 5 | 5 | 1 | Bvxc | 0.36 | 20.62 | Vxc | 37.12 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.62 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.62 | Vyc | 37.12 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.62 | Vyd | 24.74 |
| S-17 | 5 | 5 | 1 | Bvxc | 0.36 | 20.62 | Vxc | 37.12 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.62 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.62 | Vyc | 37.12 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.62 | Vyd | 24.74 |
| S-18 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 16.53 | Vxc | 29.29 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 16.53 | Vxd | 19.04 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 16.53 | Vyc | 29.29 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 16.53 | Vyd | 19.04 |

Table B. 14: Dead load on the beam for the Ground floor

| **Panel** | **H Wall** | **T HCB** | **ϒ HCB** | **T Plaster** | **ϒ Plaster** | **Total DL** |
|---|---|---|---|---|---|---|
| S-1 | | | | | | |
| Axis(A, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(B, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| S-2 | | | | | | |
| Axis(B, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(C, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, B&C) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, B&C) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| S-3 | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(C, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(D, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, C&D) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, C&D) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| S-4 | | | | | | |
| Axis(D, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(E, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| S-5 | | | | | | |
| Axis(E, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(F, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, E&F) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, E&F) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-6 | | | | | | |
| Axis(F, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(G, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, F&G) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, F&G) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| S-7 | | | | | | |
| Axis(G, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(H, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, G&H) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, G&H) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| S-8 | | | | | | |
| Axis(H, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(I, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, H&I) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, H&I) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| S-9 | | | | | | |
| Axis(I, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(J, 2&3) | 3 | 0.2 | 14 | 0 | 23.00 | 8.775 |
| Axis(2, I&J) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, I&J) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| S-10 | | | | | | |
| Axis(A, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(B, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, A&B) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-11 | | | | | | |
| Axis(B, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(C, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, B&C) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, B&C) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-12 | | | | | | |
| Axis(C, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(D, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, C&D) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, C&D) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-13 | | | | | | |
| Axis(D, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(E, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, D&E) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-14 | | | | | | |
| Axis(E, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(F, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, E&F) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, E&F) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-15 | | | | | | |
| Axis(F, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(G, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, F&G) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, F&G) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-16 | | | | | | |
| Axis(G, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(H, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, G&H) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, G&H) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-17 | | | | | | |
| Axis(H, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(I, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(1, H&I) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, H&I) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-18 | | | | | | |
| Axis(I, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(J, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(1, I&J) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.535 |
| Axis(2, I&J) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |

Table B. 15: Shear transfer on the beam

| **Panel** | **shear** | **Total pd including plaster (KN/M)** | **Beam self weight(250*400)** | **shear load** | **total load** |
|---|---|---|---|---|---|
| S-1 | | | | | |
| Axis(A, 2&3) | Vxc | 11.535 | 2.5 | 29.29 | 40.69 |
| Axis(B, 2&3) | Vxd | 9.06 | 2.5 | 19.04 | 28.89 |
| Axis(2, A&B) | Vyc | 9.06 | 2.5 | 29.29 | 38.21 |
| Axis(3, A&B) | Vyd | 11.535 | 2.5 | 19.04 | 31.36 |
| S-2 | | | | | |
| Axis(B, 2&3) | Vxc | 9.06 | 2.5 | 34.16 | 42.65 |
| Axis(C, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, B&C) | Vyc | 9.06 | 2.5 | 34.16 | 42.65 |
| Axis(3, B&C) | Vyd | 11.535 | 2.5 | 22.78 | 34.76 |
| S-3 | | | | | |
| Axis(C, 2&3) | Vxc | 9.06 | 2.5 | 34.16 | 42.65 |
| Axis(D, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, C&D) | Vyc | 9.06 | 2.5 | 34.16 | 42.65 |
| Axis(3, C&D) | Vyd | 11.535 | 2.5 | 22.78 | 34.76 |
| S-4 | | | | | |
| Axis(D, 2&3) | Vxc | 9.06 | 2.5 | 39.13 | 47.17 |
| Axis(E, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, D&E) | Vyc | 9.06 | 2.5 | 39.13 | 47.17 |
| Axis(3, D&E) | Vyd | 11.535 | 2.5 | 26.09 | 37.78 |
| S-5 | | | | | |
| Axis(E, 2&3) | Vxc | 9.06 | 2.5 | 9.52 | 20.22 |

| | | | | | |
|---|---|---|---|---|---|
| Axis(F, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, E&F) | Vyc | 9.06 | 2.5 | 9.52 | 20.22 |
| Axis(3, E&F) | Vyd | 11.535 | 2.5 | 6.35 | 19.81 |
| S-6 | | | | | |
| Axis(F, 2&3) | Vxc | 9.06 | 2.5 | 39.13 | 47.17 |
| Axis(G, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, F&G) | Vyc | 9.06 | 2.5 | 39.13 | 47.17 |
| Axis(3, F&G) | Vyd | 11.16 | 2.5 | 26.09 | 37.40 |
| S-7 | | | | | |
| Axis(G, 2&3) | Vxc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(H, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, G&H) | Vyc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(3, G&H) | Vyd | 11.535 | 2.5 | 24.74 | 36.55 |
| S-8 | | | | | |
| Axis(H, 2&3) | Vxc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(I, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(2, H&I) | Vyc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(3, H&I) | Vyd | 11.535 | 2.5 | 24.74 | 36.55 |
| S-9 | | | | | |
| Axis(I, 2&3) | Vxc | 11.16 | 2.5 | 29.29 | 40.31 |
| Axis(J, 2&3) | Vxd | 0.375 | 2.5 | 19.04 | 20.20 |
| Axis(2, I&J) | Vyc | 9.06 | 2.5 | 29.29 | 38.21 |
| Axis(3, I&J) | Vyd | 11.535 | 2.5 | 19.04 | 31.36 |
| S-10 | | | | | |
| Axis(A, 1&2) | Vxc | 11.535 | 2.5 | 29.29 | 40.69 |
| Axis(B, 1&2) | Vxd | 9.06 | 2.5 | 19.04 | 28.89 |
| Axis(1, A&B) | Vyc | 9.435 | 2.5 | 29.29 | 38.59 |
| Axis(2, A&B) | Vyd | 9.06 | 2.5 | 19.04 | 28.89 |
| S-11 | | | | | |
| Axis(B, 1&2) | Vxc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(C, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, B&C) | Vyc | 11.535 | 2.5 | 37.12 | 47.81 |
| Axis(2, B&C) | Vyd | 9.06 | 2.5 | 24.74 | 34.08 |
| S-12 | | | | | |
| Axis(C, 1&2) | Vxc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(D, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |

| | | | | | |
|---|---|---|---|---|---|
| Axis(1, C&D) | Vyc | 11.535 | 2.5 | 37.12 | 47.81 |
| Axis(2, C&D) | Vyd | 9.06 | 2.5 | 24.74 | 34.08 |
| S-13 | | | | | |
| Axis(D, 1&2) | Vxc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(E, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, D&E) | Vyc | 11.535 | 2.5 | 37.12 | 47.81 |
| Axis(2, D&E) | Vyd | 9.06 | 2.5 | 24.74 | 34.08 |
| S-14 | | | | | |
| Axis(E, 1&2) | Vxc | 9.06 | 2.5 | 29.75 | 38.64 |
| Axis(F, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, E&F) | Vyc | 11.535 | 2.5 | 29.75 | 41.11 |
| Axis(2, E&F) | Vyd | 9.06 | 2.5 | 19.84 | 29.61 |
| S-15 | | | | | |
| Axis(F, 1&2) | Vxc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(G, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, F&G) | Vyc | 11.535 | 2.5 | 37.12 | 47.81 |
| Axis(2, F&G) | Vyd | 9.06 | 2.5 | 24.74 | 34.08 |
| S-16 | | | | | |
| Axis(G, 1&2) | Vxc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(H, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, G&H) | Vyc | 11.535 | 2.5 | 37.12 | 47.81 |
| Axis(2, G&H) | Vyd | 9.06 | 2.5 | 24.74 | 34.08 |
| S-17 | | | | | |
| Axis(H, 1&2) | Vxc | 9.06 | 2.5 | 37.12 | 45.34 |
| Axis(I, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(1, H&I) | Vyc | 11.535 | 2.5 | 37.12 | 47.81 |
| Axis(2, H&I) | Vyd | 9.06 | 2.5 | 24.74 | 34.08 |
| S-18 | | | | | |
| Axis(I, 1&2) | Vxc | 9.06 | 2.5 | 29.29 | 38.21 |
| Axis(J, 1&2) | Vxd | 11.535 | 2.5 | 19.04 | 31.36 |
| Axis(1, I&J) | Vyc | 11.535 | 2.5 | 29.29 | 40.69 |
| Axis(2, I&J) | Vyd | 9.06 | 2.5 | 19.04 | 28.89 |

Table B. 16: Check for shear reinforcement on the Ground floor

| Panel | d | K | crdc | Vmin | Vrdc | check for shear | ρshear | As provide |
|---|---|---|---|---|---|---|---|---|
| S-1 | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 64.1 | SAEE | 0.00186 | 297.5 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |
| S-2 | 172 | 2 | 0.12 | 85.1 | 69.8 | SAEE | 0.00193 | 332.5 |
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 66.5 | SAEE | 0.00208 | 332.5 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |
| S-3 | 172 | 2 | 0.12 | 85.1 | 69.8 | SAEE | 0.00193 | 332.5 |
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 125.8 | SAEE | 0.01413 | 2260.8 |
| | 160 | 2 | 0.12 | 79.2 | 66.5 | SAEE | 0.00208 | 332.5 |
| S-4 | 172 | 2 | 0.12 | 85.1 | 104.8 | SAEE | 0.00657 | 1130.4 |
| | 172 | 2 | 0.12 | 85.1 | 112.9 | SAEE | 0.00822 | 1413.0 |
| | 160 | 2 | 0.12 | 79.2 | 149.2 | SAEE | 0.02355 | 3768.0 |
| | 160 | 2 | 0.12 | 79.2 | 135.6 | SAEE | 0.01766 | 2826.0 |
| S-5 | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 172 | 2 | 0.12 | 85.1 | 91.6 | SAEE | 0.00438 | 753.6 |
| | 160 | 2 | 0.12 | 79.2 | 149.2 | SAEE | 0.02355 | 3768.0 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |
| S-6 | 172 | 2 | 0.12 | 85.1 | 104.8 | SAEE | 0.00657 | 1130.4 |
| | 172 | 2 | 0.12 | 85.1 | 118.1 | SAEE | 0.00939 | 1614.9 |
| | 160 | 2 | 0.12 | 79.2 | 125.8 | SAEE | 0.01413 | 2260.8 |
| | 160 | 2 | 0.12 | 79.2 | 149.2 | SAEE | 0.02355 | 3768.0 |
| S-7 | 172 | 2 | 0.12 | 85.1 | 71.2 | SAEE | 0.00205 | 353.3 |
| | 172 | 2 | 0.12 | 85.1 | 64.0 | SAEE | 0.00149 | 256.9 |
| | 160 | 2 | 0.12 | 79.2 | 67.8 | SAEE | 0.00221 | 353.3 |
| | 160 | 2 | 0.12 | 79.2 | 62.0 | SAEE | 0.00168 | 269.1 |
| S-8 | 172 | 2 | 0.12 | 85.1 | 71.2 | SAEE | 0.00205 | 353.3 |
| | 172 | 2 | 0.12 | 85.1 | 65.0 | SAEE | 0.00156 | 269.1 |
| | 160 | 2 | 0.12 | 79.2 | 64.6 | SAEE | 0.00191 | 305.5 |
| | 160 | 2 | 0.12 | 79.2 | 63.5 | SAEE | 0.00181 | 289.8 |
| S-9 | 172 | 2 | 0.12 | 85.1 | 64.5 | SAEE | 0.00153 | 262.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 64.6 | SAEE | 0.00191 | 305.5 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |
| S-10 | 172 | 2 | 0.12 | 85.1 | 64.5 | SAEE | 0.00153 | 262.9 |
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 64.6 | SAEE | 0.00191 | 305.5 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |
| S-11 | 172 | 2 | 0.12 | 85.1 | 69.8 | SAEE | 0.00193 | 332.5 |
| | 172 | 2 | 0.12 | 85.1 | 64.5 | SAEE | 0.00153 | 262.9 |
| | 160 | 2 | 0.12 | 79.2 | 67.8 | SAEE | 0.00221 | 353.3 |
| | 160 | 2 | 0.12 | 79.2 | 62.0 | SAEE | 0.00168 | 269.1 |
| S-12 | 172 | 2 | 0.12 | 85.1 | 69.8 | SAEE | 0.00193 | 332.5 |
| | 172 | 2 | 0.12 | 85.1 | 64.5 | SAEE | 0.00153 | 262.9 |
| | 160 | 2 | 0.12 | 79.2 | 67.8 | SAEE | 0.00221 | 353.3 |
| | 160 | 2 | 0.12 | 79.2 | 62.0 | SAEE | 0.00168 | 269.1 |
| S-13 | 172 | 2 | 0.12 | 85.1 | 104.8 | SAEE | 0.00657 | 1130.4 |
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 65.8 | SAEE | 0.00202 | 323.0 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |
| S-14 | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 65.8 | SAEE | 0.00202 | 323.0 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |
| S-15 | 172 | 2 | 0.12 | 85.1 | 104.8 | SAEE | 0.00657 | 1130.4 |
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 67.8 | SAEE | 0.00221 | 353.3 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |
| S-16 | 172 | 2 | 0.12 | 85.1 | 71.2 | SAEE | 0.00205 | 353.3 |
| | 172 | 2 | 0.12 | 85.1 | 64.0 | SAEE | 0.00149 | 256.9 |
| | 160 | 2 | 0.12 | 79.2 | 67.8 | SAEE | 0.00221 | 353.3 |
| | 160 | 2 | 0.12 | 79.2 | 62.0 | SAEE | 0.00168 | 269.1 |
| S-17 | 172 | 2 | 0.12 | 85.1 | 71.2 | SAEE | 0.00205 | 353.3 |
| | 172 | 2 | 0.12 | 85.1 | 65.0 | SAEE | 0.00156 | 269.1 |
| | 160 | 2 | 0.12 | 79.2 | 64.6 | SAEE | 0.00191 | 305.5 |
| | 160 | 2 | 0.12 | 79.2 | 63.5 | SAEE | 0.00181 | 289.8 |
| S-18 | 172 | 2 | 0.12 | 85.1 | 64.5 | SAEE | 0.00153 | 262.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 172 | 2 | 0.12 | 85.1 | 63.5 | SAEE | 0.00146 | 251.2 |
| | 160 | 2 | 0.12 | 79.2 | 64.6 | SAEE | 0.00191 | 305.5 |
| | 160 | 2 | 0.12 | 79.2 | 60.5 | SAEE | 0.00157 | 251.2 |

## Appendex C Structural analaysis and design of 1st & 2nd Floor slab

Table C. 1: Types of slab and Span types on the 1st and 2nd floor

| Panel | Lx(m) | Ly(m) | Ly/Lx | Type of slab | Span type |
|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-2 | 5 | 5 | 1 | Two way | Interior Span |
| S-3 | 5 | 5 | 1 | Two way | Interior Span |
| S-4 | 5 | 5 | 1 | Two way | Interior Span |
| S-4 | 5 | 5 | 1 | Two way | End Span |
| S-5 | 1.6 | 5 | 3.125 | One way | Interior Span |
| S-6 | 5 | 5 | 1 | Two way | End Span |
| S-6 | 5 | 5 | 1 | Two way | Interior Span |
| S-7 | 5 | 5 | 1 | Two way | Interior Span |
| S-8 | 5 | 5 | 1 | Two way | Interior Span |
| S-9 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-10 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-11 | 5 | 5 | 1 | Two way | Interior Span |
| S-12 | 5 | 5 | 1 | Two way | Interior Span |
| S-13 | 5 | 5 | 1 | Two way | Interior Span |
| S-14 | 5 | 5 | 1 | Two way | Interior Span |
| S-15 | 5 | 5 | 1 | Two way | Interior Span |
| S-16 | 5 | 5 | 1 | Two way | Interior Span |
| S-17 | 5 | 5 | 1 | Two way | Interior Span |
| S-18 | 4.43 | 4.43 | 1 | Two way | End Span |
| C-1 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-2 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-3 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-4 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-5 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-6 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-7 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-8 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-9 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-10 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-11 | 1.6 | 5 | 3.125 | One way | Cantiliver |

Table C. 2: Minimum concrete cover for 1st and 2nd floor

| Panel | Bond/Durability Minimum cover required | | | Allowance in Design for Variation | | Standred Fire | Cover | GOVERNING Cover Design |
|---|---|---|---|---|---|---|---|---|
| | $Cmin,B$ | $Cmin,Dur$ | $Cmin$(mm) | Δcdev(mm) | $Cnom$ | Resistance | Design | (mm) |
| S-1 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-2 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-3 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-4 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-5 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| S-6 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-7 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-8 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-9 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-10 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-11 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-12 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-13 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-14 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | **22mm** |
| S-15 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-16 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-17 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-18 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| C-1 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-2 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-3 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-4 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-5 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-6 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-7 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-8 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-9 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-10 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-11 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |

Table C. 3: Effective depth of 1st and 2nd floor slab

| Panel | Lx(m) | Ly(m) | Ly/Lx | Type of slab | span type | F1 | K | N | Lx/d | Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 153.933 |
| S-2 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-3 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-4 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-4 | 5 | 5 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 173.7393 |
| S-5 | 1.6 | 5 | 3.125 | One way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 48.1837 |
| S-6 | 5 | 5 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 173.7393 |
| S-6 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-7 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-8 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-9 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 153.933 |
| S-10 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 153.933 |
| S-11 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-12 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-13 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-14 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-15 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-16 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-17 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-18 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 153.933 |
| C-1 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-2 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-3 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-4 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-5 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-6 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-7 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-8 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-9 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-10 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-11 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |

| | |
|---|---|
| dmax= | 180.689 |
| Cover= | 22 |
| Φ= | 12 |
| D= | 230 |

Table C. 4: Design load for Partition wall load on the 1st and 2nd floor slab

| Panel | L HCB | T HCB | H HCB | ϒ HCB | Ly | Lx | Area of floor | Tplaster | ϒ plaster | T DL | Pd=TDL/A |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S2 | 5 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 45.300 | 1.812 |
| S3 | 5 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 45.300 | 1.812 |
| S-4 | 10.65 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 96.489 | 3.860 |
| S-6 | 10.65 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 96.489 | 3.860 |
| S-7 | 5 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 45.300 | 1.812 |
| S-8 | 5 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 45.300 | 1.812 |
| S-11 | 6.769 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 61.327 | 2.453 |
| S-12 | 5 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 45.300 | 1.812 |
| S-13 | 5.433 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 49.223 | 1.969 |
| S-14 | 4.6 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 41.676 | 1.667 |
| S-15 | 5.433 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 49.223 | 1.969 |
| S-16 | 5 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 45.300 | 1.812 |
| S-17 | 6.769 | 0.15 | 3 | 14 | 5 | 5 | 25 | 0.04 | 23 | 61.327 | 2.453 |

Table C. 5: Self-weight of the 1st and 2nd floor based on panel function

| Function | Material | Thickness(m) | Unit weight(KN/ $m^3$ ) | Dead Load(KN/ $m^2$ ) |
|---|---|---|---|---|
| Shop | Ceramic | 0.007 | 24 | 0.168 |
| | Cement Screed | 0.043 | 23 | 0.989 |
| | RC Slab | 0.23 | 25 | 5.75 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/ $m^2$)** | **7.367** |

| Function | Material | Thickness(m) | Unit weight(KN/ $m^3$ ) | Dead Load(KN/ $m^2$ ) |
|---|---|---|---|---|
| | Marble | 0.02 | 27 | 0.54 |

| | | | | |
|---|---|---|---|---|
| **Corrider** | Cement Screed | 0.03 | 23 | 0.69 |
| | RC Slab | 0.23 | 25 | 5.75 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/ $m^2$ )** | **7.44** |
| | | | | |
| **Function** | **Material** | **Thickness(m)** | **Unit weight(KN/ $m^3$ )** | **Dead Load(KN/ $m^2$)** |
| | Ceramic | 0.007 | 24 | 0.168 |
| **Toilet** | Cement Screed | 0.043 | 23 | 0.989 |
| | RC Slab | 0.23 | 25 | 5.75 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/ $m^2$ )** | **7.367** |
| | | | | |
| **Function** | **Material** | **Thickness(m)** | **Unit weight(KN/ $m^3$ )** | **Dead Load(KN/ $m^2$ )** |
| | Ceramic | 0.007 | 24 | 0.168 |
| **Caffee** | Cement Screed | 0.043 | 23 | 0.989 |
| | RC Slab | 0.23 | 25 | 5.75 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/ $m^2$)** | **7.367** |

Table C. 6: Design factored load on the 1st and 2nd floor

| **Panel** | **Slab self-weight** | **Partition wall load** | **Total self-weight** | **Live load** | **Pd=1.35DL+1.5LL** |
|---|---|---|---|---|---|
| S-1 | 7.44 | 0.00 | 7.44 | 5.000 | 17.54 |
| S-2 | 7.44 | 1.812 | 9.25 | 5.000 | 19.99 |
| S-3 | 7.44 | 1.812 | 9.25 | 5.000 | 19.99 |
| S-4 | 7.44 | 3.860 | 11.30 | 5.000 | 22.75 |
| S-5 | 7.44 | 0.00 | 7.44 | 5.000 | 17.54 |
| S-6 | 7.44 | 3.860 | 11.30 | 5.000 | 22.75 |
| S-7 | 7.44 | 1.812 | 9.25 | 5.000 | 19.99 |
| S-8 | 7.44 | 1.812 | 9.25 | 5.000 | 19.99 |

| | | | | | |
|---|---|---|---|---|---|
| S-9 | 7.44 | 0.00 | 7.44 | 5.000 | 17.54 |
| S-10 | 7.44 | 0.00 | 7.44 | 5.000 | 17.54 |
| S-11 | 7.44 | 2.453 | 9.89 | 5.000 | 20.86 |
| S-12 | 7.44 | 1.812 | 9.25 | 5.000 | 19.99 |
| S-13 | 7.44 | 1.969 | 9.41 | 5.000 | 20.20 |
| S-14 | 7.44 | 1.667 | 9.11 | 5.000 | 19.79 |
| S-15 | 7.44 | 1.969 | 9.41 | 5.000 | 20.20 |
| S-16 | 7.44 | 1.812 | 9.25 | 5.000 | 19.99 |
| S-17 | 7.44 | 2.453 | 9.89 | 5.000 | 20.86 |
| S-18 | 7.44 | 0.00 | 7.44 | 5.000 | 17.54 |

Table C. 7: Partition wall load on the cantilever part 1st and 2nd floor slab

| Panel | T HCB | H WALL | ϒ HCB | T plaster | ϒ plaster | P (KN) |
|---|---|---|---|---|---|---|
| C-1 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-2 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-3 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-4 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-5 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-6 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-7 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-8 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-9 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-10 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-11 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |

Table C. 8: Partition wall load in side the panel on the cantilever part 1st and 2nd floor slab

| Panel | L HCB | T HCB | H Wall | ϒ HCB | Ly | Lx | Area of floor | T plaster | ϒ plaster | T DL | Pd'=TDL/A |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C-3 | 2.8 | 0.15 | 3 | 14 | 5 | 1.6 | 8 | 0.04 | 23 | 25.368 | 3.171 |
| C-4 | 2.8 | 0.15 | 3 | 14 | 5 | 1.6 | 8 | 0.04 | 23 | 25.368 | 3.171 |
| C-7 | 1.6 | 0.2 | 1.15 | 14 | 5 | 1.6 | 8 | 0.04 | 23 | 6.845 | 0.856 |

Table C. 9: Design factored load of cantilever slab on the 1st and 2nd floor

| Panel | P(KN) | Dead Load | Live Load | Pd(KN/m2 ) | Pd'(KN/m2 ) | Total Pd(KN/m2 ) |
|---|---|---|---|---|---|---|
| C-1 | 11.160 | 7.44 | 5 | 17.544 | 0.000 | 17.544 |
| C-2 | 11.160 | 7.44 | 5 | 17.544 | 0.000 | 17.544 |
| C-3 | 11.160 | 7.44 | 5 | 17.544 | 3.171 | 20.715 |
| C-4 | 11.160 | 7.44 | 5 | 17.544 | 3.171 | 20.715 |
| C-5 | 11.160 | 7.44 | 5 | 17.544 | 0.000 | 17.544 |
| C-6 | 11.160 | 7.44 | 5 | 17.544 | 0.000 | 17.544 |
| C-7 | 11.160 | 7.44 | 5 | 17.544 | 0.856 | 18.3996 |
| C-8 | 11.160 | 7.44 | 5 | 17.544 | 0.000 | 17.544 |
| C-9 | 11.160 | 7.44 | 5 | 17.544 | 0.000 | 17.544 |
| C-10 | 11.160 | 7.44 | 5 | 17.544 | 0.000 | 17.544 |
| C-11 | 11.160 | 7.44 | 5 | 17.544 | 0.000 | 17.544 |

Table C. 10: Calculation of moment for all cantilever on the 1st and 2nd floor

| Panel | Types of slab | Pd | P | Lx | M |
|---|---|---|---|---|---|
| C-1 | Cantilever | 17.544 | 11.16 | 1.6 | 40.3123 |
| C-2 | Cantilever | 17.544 | 11.16 | 1.6 | 40.3123 |
| C-3 | Cantilever | 20.715 | 11.16 | 1.6 | 44.3712 |
| C-4 | Cantilever | 20.715 | 11.16 | 1.6 | 44.3712 |
| C-5 | Cantilever | 17.544 | 11.16 | 1.6 | 40.3123 |
| C-6 | Cantilever | 17.544 | 11.16 | 1.6 | 40.3123 |
| C-7 | Cantilever | 18.3996 | 11.16 | 1.6 | 41.4075 |
| C-8 | Cantilever | 17.544 | 11.16 | 1.6 | 40.3123 |
| C-9 | Cantilever | 17.544 | 11.16 | 1.6 | 40.3123 |
| C-10 | Cantilever | 17.544 | 11.16 | 1.6 | 40.3123 |
| C-11 | Cantilever | 17.544 | 11.16 | 1.6 | 40.3123 |

Table C. 11: Moment coefficients according to ES EN for the 1st and 2nd floor slab of the build

| Panel | Ly | Lx | $l_y/l_x$ | $\beta_{xs}$ | $\beta_{xf}$ | $\beta_{ys}$ | $\beta_{yf}$ |
|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-2 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-3 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-5 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-7 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-8 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S-9 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-10 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-11 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-12 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-13 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-14 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-15 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-16 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-17 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-18 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |

Table C. 12: Computation of moments for all panel for the 1st and 2nd floor

| **Panel** | **Support condition** | **lx** | **lx²** | **Pd** | **Moment Coeficient** | | **Moment location** | **bending moment Mi= $\beta_i P_d L^2 x$** |
|---|---|---|---|---|---|---|---|---|
| | | | | | **location** | **value** | | |
| S-1 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 17.54 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 16.18 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 12.39 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 15.49 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 11.70 |
| S-2 | Interior panel | 5 | 25 | 19.99 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 15.49 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 11.99 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 15.99 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 11.99 |
| S-3 | Interior panel | 5 | 25 | 19.99 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 15.49 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 11.99 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 15.99 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 11.99 |
| S-5 | Interior panel | 1.6 | 2.56 | 17.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 1.39 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 1.08 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 1.44 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 1.08 |
| S-7 | Interior panel | 5 | 25 | 19.99 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 15.49 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 11.99 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 15.99 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 11.99 |
| S-8 | Interior panel | 5 | 25 | 19.99 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 15.49 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 11.99 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 15.99 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 11.99 |
| S-9 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 17.54 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 16.18 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 12.39 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 15.49 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 11.70 |
| S-10 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 17.54 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 16.18 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 12.39 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 15.49 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 11.70 |
| S-11 | One short edge discontinuous | 5 | 25 | 20.86 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 20.34 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 15.12 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 19.30 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 14.60 |
| S-12 | Interior panel | 5 | 25 | 19.99 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 15.49 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 11.99 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 15.99 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 11.99 |
| S-13 | Interior panel | 5 | 25 | 20.2 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 15.66 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 12.12 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 16.16 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 12.12 |
| S-14 | Interior panel | 5 | 25 | 19.79 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 15.34 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 11.87 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 15.83 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 11.87 |
| S-15 | | 5 | 25 | 20.2 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 15.66 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Interior panel | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 12.12 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 16.16 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 12.12 |
| S-16 | Interior panel | 5 | 25 | 20.86 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 16.17 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 12.52 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 16.69 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 12.52 |
| S-17 | One short edge discontinuous | 5 | 25 | 20.85 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 16.16 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 12.51 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 16.68 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 12.51 |
| S-18 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 17.54 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 16.18 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 12.39 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 15.49 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 11.70 |

Table C. 13: Adjusted moment for the 1st and 2nd floor

| **Panel** | **Moment notation** | **Unadjusted moment for support moment** | | **ΔM/Mlarge*100** | **Method of Adjustment** | **Adjusted moment** |
|---|---|---|---|---|---|---|
| | | **Ms** | **Ms** | | | |
| S1&S2 | Mys | 15.99 | 15.49 | 3.13 | Take average | 15.74 |
| S1&S10 | Mxs | 16.18 | 16.18 | 0.00 | No adjustment | 16.18 |
| S2&S3 | Mys | 15.99 | 15.49 | 3.13 | Take average | 15.74 |
| S2&S11 | Mxs | 20.34 | 15.49 | 23.84 | Moment distribution | 17.92 |
| S3&S4 | Mys | 189.58 | 15.99 | 91.57 | Moment distribution | 102.79 |
| S3&S12 | Mxs | 15.49 | 15.49 | 0.00 | No adjustment | 15.49 |
| S4&S5 | Mys | 189.58 | 1.44 | 99.24 | Moment distribution | 143.97 |
| S4&S13 | Mxs | 94.79 | 15.66 | 83.48 | Moment distribution | 55.23 |
| S5&S6 | Mys | 189.58 | 1.44 | 99.24 | Moment distribution | 143.97 |
| S5&S14 | Mxs | 15.34 | 1.39 | 90.94 | Moment distribution | 8.37 |
| S6&S7 | Mys | 189.58 | 15.99 | 91.57 | Moment distribution | 102.79 |
| S6&S15 | Mxs | 94.79 | 15.66 | 83.48 | Moment distribution | 55.23 |

| | | | | | | |
|---|---|---|---|---|---|---|
| S7&S8 | Mys | 15.99 | 15.99 | 0.00 | No adjustment | 15.99 |
| S7&S16 | Mxs | 16.17 | 15.49 | 4.21 | Take average | 15.83 |
| S8&S9 | Mys | 15.99 | 15.49 | 3.13 | Take average | 15.74 |
| S8&S17 | Mxs | 16.16 | 15.49 | 4.15 | Take average | 15.83 |
| S9&S18 | Mxs | 16.18 | 16.18 | 0.00 | No adjustment | 16.18 |
| S10&S11 | Mys | 19.3 | 15.49 | 19.74 | Take average | 17.40 |
| S11&S12 | Mys | 19.3 | 15.99 | 17.15 | Take average | 17.65 |
| S12&S13 | Mys | 16.16 | 15.99 | 1.05 | Take average | 16.08 |
| S13&S14 | Mys | 16.16 | 15.83 | 2.04 | Take average | 16.00 |
| S14&S15 | Mys | 16.16 | 15.83 | 2.04 | Take average | 16.00 |
| S15&S16 | Mys | 16.69 | 16.16 | 3.18 | Take average | 16.43 |
| S16&S17 | Mys | 16.69 | 16.68 | 0.06 | Take average | 16.69 |
| S17&S18 | Mys | 16.68 | 15.49 | 7.13 | Take average | 16.09 |
| C-1 & S-2 | Mxs | 40.312 | 15.49 | 61.58 | Moment distribution | 22.91 |
| C-2 & S-3 | Mxs | 40.312 | 15.49 | 61.58 | Moment distribution | 22.91 |
| C-3 & S-4 | Mxs | 94.780 | 44.3712 | 53.19 | Moment distribution | 79.70 |
| C-4 & S-6 | Mxs | 94.780 | 44.3712 | 53.19 | Moment distribution | 79.70 |
| C-5 & S-7 | Mxs | 40.312 | 15.49 | 61.58 | Moment distribution | 22.91 |
| C-6 & S-8 | Mxs | 40.312 | 15.49 | 61.58 | Moment distribution | 22.91 |
| C-7 & S-12 | Mxs | 41.407 | 15.49 | 62.59 | Moment distribution | 23.24 |
| C-8 & S-13 | Mxs | 40.312 | 15.66 | 61.15 | Moment distribution | 23.03 |
| C-9 & S-14 | Mxs | 40.312 | 15.34 | 61.95 | Moment distribution | 22.81 |
| C-10 & S-15 | Mxs | 40.312 | 15.66 | 61.15 | Moment distribution | 23.03 |
| C-11 & S-16 | Mxs | 40.312 | 16.17 | 59.89 | Moment distribution | 23.39 |

Table C. 14: Span moment adjustment for the 1st and 2nd floor

| **Panel** | **moment notation** | **Un adjusted moment** | **Adjusted support moment** | **ΔM** | | **Ly/Lx** | **Span moment notation** | **Factor for Adju.** | | **adjusted span moment** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **ΔMxs** | **ΔMys** | | | | | |
| S-1 | Mxs | 16.18 | 16.18 | 0.00 | -0.25 | 1 | Mxf Adj | cx | 0.38 | 12.32 |
| | Mxf | 12.39 | | | | | | cy | 0.28 | |
| | Mys | 15.49 | 15.74 | | | | Myf adj | cx | 0.28 | 11.61 |
| | Myf | 11.70 | | | | | | cy | 0.38 | |
| | Mxs | 15.49 | 17.92 | | | | Mxf Adj | cx | 0.38 | 11.14 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S-2 | Mxf | 11.99 | | -2.43 | 0.25 | 1 | | cy | 0.28 | |
| | Mys | 15.99 | 15.74 | | | | Myf adj | cx | 0.28 | 11.41 |
| | Myf | 11.99 | | | | | | cy | 0.38 | |
| S-3 | Mxs | 15.49 | 15.49 | 0.00 | -86.80 | 1 | Mxf Adj | cx | 0.38 | -12.31 |
| | Mxf | 11.99 | | | | | | cy | 0.28 | |
| | Mys | 15.99 | 102.79 | | | | Myf adj | cx | 0.28 | -20.99 |
| | Myf | 11.99 | | | | | | cy | 0.38 | |
| S-4 | Mxs | 94.79 | 55.23 | 39.56 | 45.61 | 1 | Mxf Adj | cx | 0.38 | 75.19 |
| | Mxf | 47.39 | | | | | | cy | 0.28 | |
| | Mys | 189.58 | 143.97 | | | | Myf adj | cx | 0.28 | 123.20 |
| | Myf | 94.79 | | | | | | cy | 0.38 | |
| S-5 | Mxs | 1.39 | 8.37 | -6.98 | -142.53 | 1 | Mxf Adj | cx | 0.38 | -41.48 |
| | Mxf | 1.08 | | | | | | cy | 0.28 | |
| | Mys | 1.44 | 143.97 | | | | Myf adj | cx | 0.28 | -55.04 |
| | Myf | 1.08 | | | | | | cy | 0.38 | |
| S-6 | Mxs | 94.79 | 55.23 | 39.56 | 86.79 | 1 | Mxf Adj | cx | 0.38 | 86.72 |
| | Mxf | 47.39 | | | | | | cy | 0.28 | |
| | Mys | 189.58 | 102.79 | | | | Myf adj | cx | 0.28 | 138.85 |
| | Myf | 94.79 | | | | | | cy | 0.38 | |
| S-7 | Mxs | 15.49 | 15.83 | -0.34 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 11.87 |
| | Mxf | 11.99 | | | | | | cy | 0.28 | |
| | Mys | 15.99 | 15.99 | | | | Myf adj | cx | 0.28 | 11.90 |
| | Myf | 11.99 | | | | | | cy | 0.38 | |
| S-8 | Mxs | 15.49 | 15.83 | -0.34 | 0.25 | 1 | Mxf Adj | cx | 0.38 | 11.94 |
| | Mxf | 11.99 | | | | | | cy | 0.28 | |
| | Mys | 15.99 | 15.74 | | | | Myf adj | cx | 0.28 | 12.00 |
| | Myf | 11.99 | | | | | | cy | 0.38 | |
| S-9 | Mxs | 16.18 | 16.18 | 0.00 | -0.25 | 1 | Mxf Adj | cx | 0.38 | 12.32 |
| | Mxf | 12.39 | | | | | | cy | 0.28 | |
| | Mys | 15.49 | 15.74 | | | | Myf adj | cx | 0.28 | 11.61 |
| | Myf | 11.70 | | | | | | cy | 0.38 | |
| S-10 | Mxs | 16.18 | 16.18 | 0.00 | -1.91 | 1 | Mxf Adj | cx | 0.38 | 11.86 |
| | Mxf | 12.39 | | | | | | cy | 0.28 | |
| | Mys | 15.49 | 17.4 | | | | Myf adj | cx | 0.28 | 10.98 |
| | Myf | 11.70 | | | | | | cy | 0.38 | |
| | Mxs | 20.34 | 17.92 | | | | Mxf Adj | cx | 0.38 | 16.50 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S-11 | Mxf | 15.12 | | 2.42 | 1.65 | 1 | | cy | 0.28 | |
| | Mys | 19.30 | 17.65 | | | | Myf adj | cx | 0.28 | 15.90 |
| | Myf | 14.60 | | | | | | cy | 0.38 | |
| S-12 | Mxs | 15.49 | 23.24 | -7.75 | -0.09 | 1 | Mxf Adj | cx | 0.38 | 9.03 |
| | Mxf | 11.99 | | | | | | cy | 0.28 | |
| | Mys | 15.99 | 16.08 | | | | Myf adj | cx | 0.28 | 9.79 |
| | Myf | 11.99 | | | | | | cy | 0.38 | |
| S-13 | Mxs | 15.66 | 23.03 | -7.38 | 0.16 | 1 | Mxf Adj | cx | 0.38 | 9.36 |
| | Mxf | 12.12 | | | | | | cy | 0.28 | |
| | Mys | 16.16 | 16 | | | | Myf adj | cx | 0.28 | 10.12 |
| | Myf | 12.12 | | | | | | cy | 0.38 | |
| S-14 | Mxs | 15.34 | 22.81 | -7.47 | -0.17 | 1 | Mxf Adj | cx | 0.38 | 8.99 |
| | Mxf | 11.87 | | | | | | cy | 0.28 | |
| | Mys | 15.83 | 16 | | | | Myf adj | cx | 0.28 | 9.72 |
| | Myf | 11.87 | | | | | | cy | 0.38 | |
| S-15 | Mxs | 15.66 | 23.03 | -7.38 | -0.30 | 1 | Mxf Adj | cx | 0.38 | 9.23 |
| | Mxf | 12.12 | | | | | | cy | 0.28 | |
| | Mys | 16.16 | 16.46 | | | | Myf adj | cx | 0.28 | 9.94 |
| | Myf | 12.12 | | | | | | cy | 0.38 | |
| S-16 | Mxs | 16.17 | 23.39 | -7.22 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 9.77 |
| | Mxf | 12.52 | | | | | | cy | 0.28 | |
| | Mys | 16.69 | 16.69 | | | | Myf adj | cx | 0.28 | 10.49 |
| | Myf | 12.52 | | | | | | cy | 0.38 | |
| S-17 | Mxs | 16.16 | 15.83 | 0.33 | 0.59 | 1 | Mxf Adj | cx | 0.38 | 12.80 |
| | Mxf | 12.51 | | | | | | cy | 0.28 | |
| | Mys | 16.68 | 16.09 | | | | Myf adj | cx | 0.28 | 12.83 |
| | Myf | 12.51 | | | | | | cy | 0.38 | |
| S-18 | Mxs | 16.18 | 16.18 | 0.00 | -0.60 | 1 | Mxf Adj | cx | 0.38 | 12.22 |
| | Mxf | 12.39 | | | | | | cy | 0.28 | |
| | Mys | 15.49 | 16.09 | | | | Myf adj | cx | 0.28 | 11.48 |
| | Myf | 11.70 | | | | | | cy | 0.38 | |

Table C. 15: Flexural Reinforcement calculation for the 1st and 2nd floor

| Panel | moment notation | adjusted moment | d (mm) | As min | As max | μsd | Z | As | NO. of bar | Spacing | Spacing provied | AS Provide |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | Mxs | 16.18 | 202 | 290.2 | 8000 | 0.016 | 199.134 | 233.482 | 10 | 389.488 | 380 | 297.5 |
| | Mxf | 12.32 | 202 | 290.2 | 8000 | 0.012 | 199.825 | 177.166 | 10 | 389.488 | 380 | 297.5 |
| | Mys | 15.74 | 190 | 273.0 | 8000 | 0.017 | 187.032 | 241.830 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 11.61 | 190 | 273.0 | 8000 | 0.013 | 187.820 | 177.628 | 12 | 414.087 | 410 | 275.7 |
| S-2 | Mxs | 17.92 | 202 | 290.2 | 8000 | 0.018 | 198.821 | 258.998 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 11.14 | 202 | 290.2 | 8000 | 0.011 | 200.036 | 160.029 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 15.74 | 190 | 273.0 | 8000 | 0.017 | 187.032 | 241.830 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 11.41 | 190 | 273.0 | 8000 | 0.013 | 187.858 | 174.533 | 12 | 414.087 | 410 | 275.7 |
| S-3 | Mxs | 15.49 | 202 | 290.2 | 8000 | 0.015 | 199.258 | 223.386 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 12.31 | 202 | 290.2 | 8000 | 0.012 | 199.827 | 177.021 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 102.79 | 190 | 273.0 | 8000 | 0.114 | 168.480 | 1753.171 | 12 | 64.477 | 60 | 1884.0 |
| | Myf | 20.99 | 190 | 273.0 | 8000 | 0.023 | 186.020 | 324.245 | 12 | 348.625 | 340 | 332.5 |
| S-4 | Mxs | 55.23 | 202 | 290.2 | 8000 | 0.054 | 191.845 | 827.265 | 12 | 136.643 | 130 | 869.5 |
| | Mxf | 75.19 | 202 | 290.2 | 8000 | 0.074 | 187.884 | 1149.983 | 12 | 98.297 | 90 | 1256.0 |
| | Mys | 143.97 | 190 | 273.0 | 8000 | 0.160 | 157.823 | 2621.339 | 12 | 43.123 | 40 | 2826.0 |
| | Myf | 123.20 | 190 | 273.0 | 8000 | 0.137 | 163.406 | 2166.530 | 12 | 52.176 | 50 | 2260.8 |
| S-5 | Mxs | 8.37 | 202 | 290.2 | 8000 | 0.008 | 200.528 | 119.942 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 41.48 | 202 | 290.2 | 8000 | 0.041 | 194.477 | 612.904 | 12 | 184.434 | 180 | 628.0 |
| | Mys | 143.97 | 190 | 273.0 | 8000 | 0.160 | 157.823 | 2621.339 | 12 | 43.123 | 40 | 2826.0 |
| | Myf | 55.04 | 190 | 273.0 | 8000 | 0.061 | 179.164 | 882.772 | 12 | 128.051 | 120 | 942.0 |
| S-6 | Mxs | 55.23 | 202 | 290.2 | 8000 | 0.054 | 191.845 | 827.265 | 12 | 136.643 | 130 | 869.5 |
| | Mxf | 86.72 | 202 | 290.2 | 8000 | 0.085 | 185.511 | 1343.292 | 12 | 84.151 | 80 | 1413.0 |
| | Mys | 102.79 | 190 | 273.0 | 8000 | 0.114 | 168.480 | 1753.171 | 12 | 64.477 | 60 | 1884.0 |
| | Myf | 138.85 | 190 | 273.0 | 8000 | 0.154 | 159.244 | 2505.553 | 12 | 45.116 | 40 | 2826.0 |
| S-7 | Mxs | 15.83 | 202 | 290.2 | 8000 | 0.016 | 199.197 | 228.360 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 11.87 | 202 | 290.2 | 8000 | 0.012 | 199.906 | 170.627 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 15.99 | 190 | 273.0 | 8000 | 0.018 | 186.984 | 245.734 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 11.90 | 190 | 273.0 | 8000 | 0.013 | 187.764 | 182.119 | 12 | 414.087 | 410 | 275.7 |
| S-8 | Mxs | 15.83 | 202 | 290.2 | 8000 | 0.016 | 199.197 | 228.360 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 11.94 | 202 | 290.2 | 8000 | 0.012 | 199.893 | 171.644 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 15.74 | 190 | 273.0 | 8000 | 0.017 | 187.032 | 241.830 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 12.00 | 190 | 273.0 | 8000 | 0.013 | 187.745 | 183.668 | 12 | 414.087 | 410 | 275.7 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-9 | Mxs | 16.18 | 202 | 290.2 | 8000 | 0.016 | 199.134 | 233.482 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 12.32 | 202 | 290.2 | 8000 | 0.012 | 199.825 | 177.166 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 15.74 | 190 | 273.0 | 8000 | 0.017 | 187.032 | 241.830 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 11.61 | 190 | 273.0 | 8000 | 0.013 | 187.820 | 177.628 | 12 | 414.087 | 410 | 275.7 |
| S-10 | Mxs | 16.18 | 202 | 290.2 | 8000 | 0.016 | 199.134 | 233.482 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 11.86 | 202 | 290.2 | 8000 | 0.012 | 199.907 | 170.481 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 17.40 | 190 | 273.0 | 8000 | 0.019 | 186.713 | 267.791 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 10.98 | 190 | 273.0 | 8000 | 0.012 | 187.939 | 167.883 | 12 | 414.087 | 410 | 275.7 |
| S-11 | Mxs | 17.92 | 202 | 290.2 | 8000 | 0.018 | 198.821 | 258.998 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 16.05 | 202 | 290.2 | 8000 | 0.016 | 199.157 | 231.579 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 17.65 | 190 | 273.0 | 8000 | 0.020 | 186.665 | 271.708 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 15.90 | 190 | 273.0 | 8000 | 0.018 | 187.001 | 244.329 | 12 | 414.087 | 410 | 275.7 |
| S-12 | Mxs | 23.24 | 202 | 290.2 | 8000 | 0.023 | 197.857 | 337.525 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 9.03 | 202 | 290.2 | 8000 | 0.009 | 200.411 | 129.476 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 16.08 | 190 | 273.0 | 8000 | 0.018 | 186.966 | 247.140 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 9.79 | 190 | 273.0 | 8000 | 0.011 | 188.165 | 149.508 | 12 | 414.087 | 410 | 275.7 |
| S-13 | Mxs | 23.03 | 202 | 290.2 | 8000 | 0.023 | 197.895 | 334.410 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 9.36 | 202 | 290.2 | 8000 | 0.009 | 200.352 | 134.246 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 16.00 | 190 | 273.0 | 8000 | 0.018 | 186.982 | 245.890 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 10.12 | 190 | 273.0 | 8000 | 0.011 | 188.102 | 154.599 | 12 | 414.087 | 410 | 275.7 |
| S-14 | Mxs | 22.81 | 202 | 290.2 | 8000 | 0.022 | 197.935 | 331.149 | 12 | 341.357 | 340 | 332.5 |
| | Mxf | 8.99 | 202 | 290.2 | 8000 | 0.009 | 200.418 | 128.897 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 16.00 | 190 | 273.0 | 8000 | 0.018 | 186.982 | 245.890 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 9.72 | 190 | 273.0 | 8000 | 0.011 | 188.178 | 148.429 | 12 | 414.087 | 410 | 275.7 |
| S-15 | Mxs | 23.03 | 202 | 290.2 | 8000 | 0.023 | 197.895 | 334.410 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 9.23 | 202 | 290.2 | 8000 | 0.009 | 200.375 | 132.367 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 16.46 | 190 | 273.0 | 8000 | 0.018 | 186.893 | 253.079 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 9.94 | 190 | 273.0 | 8000 | 0.011 | 188.136 | 151.822 | 12 | 414.087 | 410 | 275.7 |
| S-16 | Mxs | 23.39 | 202 | 290.2 | 8000 | 0.023 | 197.830 | 339.750 | 12 | 332.715 | 330 | 342.5 |
| | Mxf | 9.79 | 202 | 290.2 | 8000 | 0.010 | 200.276 | 140.467 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 16.69 | 190 | 273.0 | 8000 | 0.018 | 186.849 | 256.676 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 10.49 | 190 | 273.0 | 8000 | 0.012 | 188.032 | 160.311 | 12 | 414.087 | 410 | 275.7 |
| S-17 | Mxs | 15.83 | 202 | 290.2 | 8000 | 0.016 | 199.197 | 228.360 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 12.80 | 202 | 290.2 | 8000 | 0.013 | 199.740 | 184.148 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 16.09 | 190 | 273.0 | 8000 | 0.018 | 186.964 | 247.296 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 12.83 | 190 | 273.0 | 8000 | 0.014 | 187.587 | 196.537 | 12 | 414.087 | 410 | 275.7 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-18 | Mxs | 16.18 | 202 | 290.2 | 8000 | 0.016 | 199.134 | 233.482 | 12 | 389.488 | 380 | 297.5 |
| | Mxf | 12.22 | 202 | 290.2 | 8000 | 0.012 | 199.843 | 175.713 | 12 | 389.488 | 380 | 297.5 |
| | Mys | 16.09 | 190 | 273.0 | 8000 | 0.018 | 186.964 | 247.296 | 12 | 414.087 | 410 | 275.7 |
| | Myf | 11.48 | 190 | 273.0 | 8000 | 0.013 | 187.844 | 175.616 | 12 | 414.087 | 410 | 275.7 |

Table C. 16: Check for Shear reinforcement calculation for the 1st and 2nd floor

| Panel | d | K | crdc | Vmin | Vrdc | check for shear | ρshear | As provide |
|---|---|---|---|---|---|---|---|---|
| S-1 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-2 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-3 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 132.8 | SAEE | 0.00992 | 1884.0 |
| | 190 | 2 | 0.12 | 94.0 | 74.5 | SAEE | 0.00175 | 332.5 |
| S-4 | 202 | 1.99 | 0.12 | 99.2 | 106.4 | SAEE | 0.0043 | 869.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 120.3 | SAEE | 0.00622 | 1256.0 |
| | 190 | 2 | 0.12 | 94.0 | 152.0 | SAEE | 0.01487 | 2826.0 |
| | 190 | 2 | 0.12 | 94.0 | 141.1 | SAEE | 0.0119 | 2260.8 |
| S-5 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 95.5 | SAEE | 0.00311 | 628.0 |
| | 190 | 2 | 0.12 | 94.0 | 152.0 | SAEE | 0.01487 | 2826.0 |
| | 190 | 2 | 0.12 | 94.0 | 105.4 | SAEE | 0.00496 | 942.0 |
| S-6 | 202 | 1.99 | 0.12 | 99.2 | 106.4 | SAEE | 0.0043 | 869.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 125.1 | SAEE | 0.007 | 1413.0 |
| | 190 | 2 | 0.12 | 94.0 | 132.8 | SAEE | 0.00992 | 1884.0 |
| | 190 | 2 | 0.12 | 94.0 | 152.0 | SAEE | 0.01487 | 2826.0 |
| S-7 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-8 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-9 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-10 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-11 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-12 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-13 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-14 | 202 | 1.99 | 0.12 | 99.2 | 77.3 | SAEE | 0.00165 | 332.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-15 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-16 | 202 | 1.99 | 0.12 | 99.2 | 78.0 | SAEE | 0.0017 | 342.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-17 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-18 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

Table C. 17: Check for defelection and Serviceability Requirement 1st and 2nd floor

| Panel | d | Ascalc | AS required | ρo | P | F1 | K | N | LX/D | LX | D | depth check |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 4430 | 53.27095 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 4430 | 53.27095 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 4430 | 56.1723 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 4430 | 56.1723 | SAFE |
| S-2 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-3 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 1884.0 | 60.0 | 0.0045 | 0.0003 | 0.03185 | 1.5 | 789.3 | 37.7 | 5000 | 132.6065 | SAFE |
| | 190 | 332.5 | 340.0 | 0.0045 | 0.0018 | 1.02265 | 1.5 | 54.0 | 82.9 | 5000 | 60.32773 | SAFE |
| S-4 | 202 | 869.5 | 130.0 | 0.0045 | 0.0006 | 0.1495 | 1.5 | 265.3 | 59.5 | 5000 | 84.05506 | SAFE |
| | 202 | 1256.0 | 90.0 | 0.0045 | 0.0004 | 0.07166 | 1.5 | 467.1 | 50.2 | 5000 | 99.586 | SAFE |
| | 190 | 2826.0 | 40.0 | 0.0045 | 0.0002 | 0.01415 | 1.5 | 1456.8 | 30.9 | 5000 | 161.6559 | SAFE |
| | 190 | 2260.8 | 50.0 | 0.0045 | 0.0003 | 0.02212 | 1.5 | 1040.3 | 34.5 | 5000 | 144.8756 | SAFE |
| S-5 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 628.0 | 180.0 | 0.0045 | 0.0009 | 0.28662 | 1.5 | 160.0 | 68.8 | 5000 | 72.70752 | SAFE |
| | 190 | 2826.0 | 40.0 | 0.0045 | 0.0002 | 0.01415 | 1.5 | 1456.8 | 30.9 | 5000 | 161.6559 | SAFE |
| | 190 | 942.0 | 120.0 | 0.0045 | 0.0006 | 0.12739 | 1.5 | 273.1 | 52.2 | 5000 | 95.82058 | SAFE |
| S-6 | 202 | 869.5 | 380.0 | 0.0045 | 0.0019 | 0.43701 | 1.5 | 50.1 | 32.8 | 5000 | 152.3172 | SAFE |
| | 202 | 1413.0 | 380.0 | 0.0045 | 0.0019 | 0.26893 | 1.5 | 50.1 | 20.2 | 5000 | 247.5155 | SAFE |
| | 190 | 1884.0 | 410.0 | 0.0045 | 0.0022 | 0.21762 | 1.5 | 40.8 | 13.3 | 5000 | 375.4682 | SAFE |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 190 | 2826.0 | 410.0 | 0.0045 | 0.0022 | 0.14508 | 1.5 | 40.8 | 8.9 | 5000 | 563.2024 | SAFE |
| S-7 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| S-8 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-9 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 4430 | 46.16816 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 4430 | 46.16816 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 4430 | 48.68266 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 4430 | 48.68266 | SAFE |
| S-10 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 4430 | 46.16816 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 4430 | 46.16816 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 4430 | 48.68266 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 4430 | 48.68266 | SAFE |
| S-11 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| S-12 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| S-13 | 202 | 297.5 | 340.0 | 0.0045 | 0.0019 | 1.14296 | 1.5 | 50.1 | 85.9 | 5000 | 58.23894 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-14 | 202 | 332.5 | 380.0 | 0.0045 | 0.0017 | 1.14296 | 1.5 | 59.3 | 101.7 | 5000 | 49.14364 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-15 | 202 | 297.5 | 330.0 | 0.0045 | 0.0019 | 1.10934 | 1.5 | 50.1 | 83.3 | 5000 | 60.00376 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-16 | 202 | 342.5 | 380.0 | 0.0045 | 0.0016 | 1.10934 | 1.5 | 62.1 | 103.4 | 5000 | 48.35809 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-17 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-18 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 4430 | 53.27095 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 4430 | 53.27095 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 4430 | 56.1723 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 4430 | 56.1723 | SAFE |

Table C. 18: Loads on Supporting Beams for the 1st and 2nd floor

| Panel | Ly | Lx | Ly/lx | Shear coefficent | | Pd | Loads transferred | |
|---|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 17.54 | Vxc | 31.08 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 17.54 | Vxd | 20.20 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 17.54 | Vyc | 31.08 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 17.54 | Vyd | 20.20 |
| S-2 | 5 | 5 | 1 | Bvxc | 0.36 | 19.99 | Vxc | 35.98 |
| | 5 | 5 | 1 | Bvxd | 0 | 19.99 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 19.99 | Vyc | 35.98 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 19.99 | Vyd | 23.99 |
| S-3 | 5 | 5 | 1 | Bvxc | 0.36 | 19.99 | Vxc | 35.98 |
| | 5 | 5 | 1 | Bvxd | 0 | 19.99 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 19.99 | Vyc | 35.98 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 19.99 | Vyd | 23.99 |
| S-4 | 5 | 5 | 1 | Bvxc | 0.36 | 22.75 | Vxc | 40.95 |
| | 5 | 5 | 1 | Bvxd | 0 | 22.75 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 22.75 | Vyc | 40.95 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 22.75 | Vyd | 27.30 |
| S-5 | 5 | 1.6 | 3.125 | Bvxc | 0.36 | 17.54 | Vxc | 10.10 |
| | 5 | 1.6 | 3.125 | Bvxd | 0 | 17.54 | Vxd | 0.00 |
| | 5 | 1.6 | 3.125 | Bvyc | 0.36 | 17.54 | Vyc | 10.10 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 1.6 | 3.125 | Bvyd | 0.24 | 17.54 | Vyd | 6.74 |
| S-6 | 5 | 5 | 1 | Bvxc | 0.36 | 22.75 | Vxc | 40.95 |
| | 5 | 5 | 1 | Bvxd | 0 | 22.75 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 22.75 | Vyc | 40.95 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 22.75 | Vyd | 27.30 |
| S-7 | 5 | 5 | 1 | Bvxc | 0.36 | 19.99 | Vxc | 35.98 |
| | 5 | 5 | 1 | Bvxd | 0 | 19.99 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 19.99 | Vyc | 35.98 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 19.99 | Vyd | 23.99 |
| S-8 | 5 | 5 | 1 | Bvxc | 0.36 | 19.99 | Vxc | 35.98 |
| | 5 | 5 | 1 | Bvxd | 0 | 19.99 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 19.99 | Vyc | 35.98 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 19.99 | Vyd | 23.99 |
| S-9 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 17.54 | Vxc | 31.08 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 17.54 | Vxd | 20.20 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 17.54 | Vyc | 31.08 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 17.54 | Vyd | 20.20 |
| S-10 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 17.54 | Vxc | 31.08 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 17.54 | Vxd | 20.20 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 17.54 | Vyc | 31.08 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 17.54 | Vyd | 20.20 |
| S-11 | 5 | 5 | 1 | Bvxc | 0.36 | 20.86 | Vxc | 37.55 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.86 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.86 | Vyc | 37.55 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.86 | Vyd | 25.03 |
| S-12 | 5 | 5 | 1 | Bvxc | 0.36 | 19.99 | Vxc | 35.98 |
| | 5 | 5 | 1 | Bvxd | 0 | 19.99 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 19.99 | Vyc | 35.98 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 19.99 | Vyd | 23.99 |
| S-13 | 5 | 5 | 1 | Bvxc | 0.36 | 20.2 | Vxc | 36.36 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.2 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.2 | Vyc | 36.36 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.2 | Vyd | 24.24 |
| S-14 | 5 | 5 | 1 | Bvxc | 0.36 | 19.79 | Vxc | 35.62 |
| | 5 | 5 | 1 | Bvxd | 0 | 19.79 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 19.79 | Vyc | 35.62 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 5 | 1 | Bvyd | 0.24 | 19.79 | Vyd | 23.75 |
| S-15 | 5 | 5 | 1 | Bvxc | 0.36 | 20.2 | Vxc | 36.36 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.2 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.2 | Vyc | 36.36 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.2 | Vyd | 24.24 |
| S-16 | 5 | 5 | 1 | Bvxc | 0.36 | 19.99 | Vxc | 35.98 |
| | 5 | 5 | 1 | Bvxd | 0 | 19.99 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 19.99 | Vyc | 35.98 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 19.99 | Vyd | 23.99 |
| S-17 | 5 | 5 | 1 | Bvxc | 0.36 | 20.86 | Vxc | 37.55 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.86 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.86 | Vyc | 37.55 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.86 | Vyd | 25.03 |
| S-18 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 17.544 | Vxc | 31.09 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 17.544 | Vxd | 20.21 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 17.544 | Vyc | 31.09 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 17.544 | Vyd | 20.21 |

Table C. 19: Dead load on the beam for the 1st and 2nd floor

| **Panel** | **H Wall** | **T HCB** | **ϒ HCB** | **T Plaster** | **ϒ Plaster** | **Total DL** |
|---|---|---|---|---|---|---|
| S-1 | | | | | | |
| Axis(A, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(B, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-2 | | | | | | |
| Axis(B, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(C, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, B&C) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, B&C) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-3 | | | | | | |
| Axis(C, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(D, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, C&D) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, C&D) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |

| | | | | | | |
|---|---|---|---|---|---|---|
| S-4 | | | | | | |
| Axis(D, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(E, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-5 | | | | | | |
| Axis(E, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(F, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, E&F) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, E&F) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-6 | | | | | | |
| Axis(F, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(G, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, F&G) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, F&G) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-7 | | | | | | |
| Axis(G, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(H, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, G&H) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, G&H) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-8 | | | | | | |
| Axis(H, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(I, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, H&I) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, H&I) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-9 | | | | | | |
| Axis(I, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(J, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, I&J) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, I&J) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-10 | | | | | | |
| Axis(A, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(B, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-11 | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(B, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(C, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, B&C) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, B&C) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-12 | | | | | | |
| Axis(C, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(D, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, C&D) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, C&D) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-13 | | | | | | |
| Axis(D, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(E, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-14 | | | | | | |
| Axis(E, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(F, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, E&F) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, E&F) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-15 | | | | | | |
| Axis(F, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(G, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, F&G) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, F&G) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-16 | | | | | | |
| Axis(G, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(H, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, G&H) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, G&H) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-17 | | | | | | |
| Axis(H, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(I, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, H&I) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, H&I) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-18 | | | | | | |
| Axis(I, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(J, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, I&J) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, I&J) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |

Table C. 20: Shear transfer on the beam on the 1st and 2nd floor

| **Panel** | **shear** | **Total pd including plaster (KN/M)** | **Beam self weight(250*400)** | **shear load** | **total load** |
|---|---|---|---|---|---|
| S-1 | | | | | |
| Axis(A, 2&3) | Vxc | 11.16 | 2.5 | 31.08 | 41.94 |
| Axis(B, 2&3) | Vxd | 11.16 | 2.5 | 20.20 | 32.04 |
| Axis(2, A&B) | Vyc | 11.16 | 2.5 | 31.08 | 41.94 |
| Axis(3, A&B) | Vyd | 11.16 | 2.5 | 20.20 | 32.04 |
| S-2 | | | | | |
| Axis(B, 2&3) | Vxc | 11.16 | 2.5 | 35.98 | 46.40 |
| Axis(C, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(2, B&C) | Vyc | 11.16 | 2.5 | 35.98 | 46.40 |
| Axis(3, B&C) | Vyd | 11.16 | 2.5 | 23.99 | 35.49 |
| S-3 | | | | | |
| Axis(C, 2&3) | Vxc | 11.16 | 2.5 | 35.98 | 46.40 |
| Axis(D, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(2, C&D) | Vyc | 11.16 | 2.5 | 35.98 | 46.40 |
| Axis(3, C&D) | Vyd | 11.16 | 2.5 | 23.99 | 35.49 |
| S-4 | | | | | |
| Axis(D, 2&3) | Vxc | 11.16 | 2.5 | 40.95 | 50.92 |
| Axis(E, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(2, D&E) | Vyc | 11.16 | 2.5 | 40.95 | 50.92 |
| Axis(3, D&E) | Vyd | 11.16 | 2.5 | 27.30 | 38.50 |
| S-5 | | | | | |
| Axis(E, 2&3) | Vxc | 11.16 | 2.5 | 10.10 | 46.40 |
| Axis(F, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(2, E&F) | Vyc | 11.16 | 2.5 | 10.10 | 46.40 |
| Axis(3, E&F) | Vyd | 11.16 | 2.5 | 6.74 | 35.49 |
| S-6 | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Axis(F, 2&3) | Vxc | 11.16 | 2.5 | 40.95 | 46.40 |
| Axis(G, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(2, F&G) | Vyc | 11.16 | 2.5 | 40.95 | 46.40 |
| Axis(3, F&G) | Vyd | 11.16 | 2.5 | 27.30 | 35.49 |
| S-7 | | | | | |
| Axis(G, 2&3) | Vxc | 11.16 | 2.5 | 35.98 | 46.40 |
| Axis(H, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(2, G&H) | Vyc | 11.16 | 2.5 | 35.98 | 46.40 |
| Axis(3, G&H) | Vyd | 11.16 | 2.5 | 23.99 | 35.49 |
| S-8 | | | | | |
| Axis(H, 2&3) | Vxc | 11.16 | 2.5 | 35.98 | 41.94 |
| Axis(I, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 32.04 |
| Axis(2, H&I) | Vyc | 11.16 | 2.5 | 35.98 | 41.94 |
| Axis(3, H&I) | Vyd | 11.16 | 2.5 | 23.99 | 32.04 |
| S-9 | | | | | |
| Axis(I, 2&3) | Vxc | 11.16 | 2.5 | 31.08 | 41.94 |
| Axis(J, 2&3) | Vxd | 11.16 | 2.5 | 20.20 | 32.04 |
| Axis(2, I&J) | Vyc | 11.16 | 2.5 | 31.08 | 41.94 |
| Axis(3, I&J) | Vyd | 11.16 | 2.5 | 20.20 | 32.04 |
| S-10 | | | | | |
| Axis(A, 1&2) | Vxc | 11.16 | 2.5 | 31.08 | 47.83 |
| Axis(B, 1&2) | Vxd | 11.16 | 2.5 | 20.20 | 13.66 |
| Axis(1, A&B) | Vyc | 11.16 | 2.5 | 31.08 | 47.83 |
| Axis(2, A&B) | Vyd | 11.16 | 2.5 | 20.20 | 36.44 |
| S-11 | | | | | |
| Axis(B, 1&2) | Vxc | 11.16 | 2.5 | 37.55 | 46.40 |
| Axis(C, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(1, B&C) | Vyc | 11.16 | 2.5 | 37.55 | 46.40 |
| Axis(2, B&C) | Vyd | 11.16 | 2.5 | 25.03 | 35.49 |
| S-12 | | | | | |
| Axis(C, 1&2) | Vxc | 11.16 | 2.5 | 35.98 | 46.75 |
| Axis(D, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(1, C&D) | Vyc | 11.16 | 2.5 | 35.98 | 46.75 |
| Axis(2, C&D) | Vyd | 11.16 | 2.5 | 23.99 | 35.72 |
| S-13 | | | | | |
| Axis(D, 1&2) | Vxc | 11.16 | 2.5 | 36.36 | 46.08 |

| | | | | | |
|---|---|---|---|---|---|
| Axis(E, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(1, D&E) | Vyc | 11.16 | 2.5 | 36.36 | 46.08 |
| Axis(2, D&E) | Vyd | 11.16 | 2.5 | 24.24 | 35.27 |
| S-14 | | | | | |
| Axis(E, 1&2) | Vxc | 11.16 | 2.5 | 35.62 | 46.75 |
| Axis(F, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(1, E&F) | Vyc | 11.16 | 2.5 | 35.62 | 46.75 |
| Axis(2, E&F) | Vyd | 11.16 | 2.5 | 23.75 | 35.72 |
| S-15 | | | | | |
| Axis(F, 1&2) | Vxc | 11.16 | 2.5 | 36.36 | 46.40 |
| Axis(G, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(1, F&G) | Vyc | 11.16 | 2.5 | 36.36 | 46.40 |
| Axis(2, F&G) | Vyd | 11.16 | 2.5 | 24.24 | 35.49 |
| S-16 | | | | | |
| Axis(G, 1&2) | Vxc | 11.16 | 2.5 | 35.98 | 46.40 |
| Axis(H, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(1, G&H) | Vyc | 11.16 | 2.5 | 35.98 | 47.81 |
| Axis(2, G&H) | Vyd | 11.16 | 2.5 | 23.99 | 36.43 |
| S-17 | | | | | |
| Axis(H, 1&2) | Vxc | 11.16 | 2.5 | 35.98 | 41.95 |
| Axis(I, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 32.05 |
| Axis(1, H&I) | Vyc | 11.16 | 2.5 | 37.53 | 41.95 |
| Axis(2, H&I) | Vyd | 11.16 | 2.5 | 25.02 | 32.05 |
| S-18 | | | | | |
| Axis(I, 1&2) | Vxc | 11.16 | 2.5 | 31.09 | 13.66 |
| Axis(J, 1&2) | Vxd | 11.16 | 2.5 | 20.21 | 13.66 |
| Axis(1, I&J) | Vyc | 11.16 | 2.5 | 31.09 | 13.66 |
| Axis(2, I&J) | Vyd | 11.16 | 2.5 | 20.21 | 13.66 |

Table C. 21: Check for shear on the 1st and 2nd floor

| **Panel** | **d** | **K** | **crdc** | **Vmin** | **Vrdc** | **check for shear** | **ρshear** | **As provide** |
|---|---|---|---|---|---|---|---|---|
| S-1 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-2 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-3 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 132.8 | SAEE | 0.00992 | 1884.0 |
| | 190 | 2 | 0.12 | 94.0 | 74.5 | SAEE | 0.00175 | 332.5 |
| S-4 | 202 | 1.99 | 0.12 | 99.2 | 106.4 | SAEE | 0.0043 | 869.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 120.3 | SAEE | 0.00622 | 1256.0 |
| | 190 | 2 | 0.12 | 94.0 | 152.0 | SAEE | 0.01487 | 2826.0 |
| | 190 | 2 | 0.12 | 94.0 | 141.1 | SAEE | 0.0119 | 2260.8 |
| S-5 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 95.5 | SAEE | 0.00311 | 628.0 |
| | 190 | 2 | 0.12 | 94.0 | 152.0 | SAEE | 0.01487 | 2826.0 |
| | 190 | 2 | 0.12 | 94.0 | 105.4 | SAEE | 0.00496 | 942.0 |
| S-6 | 202 | 1.99 | 0.12 | 99.2 | 106.4 | SAEE | 0.0043 | 869.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 125.1 | SAEE | 0.007 | 1413.0 |
| | 190 | 2 | 0.12 | 94.0 | 132.8 | SAEE | 0.00992 | 1884.0 |
| | 190 | 2 | 0.12 | 94.0 | 152.0 | SAEE | 0.01487 | 2826.0 |
| S-7 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-8 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-9 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-10 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-11 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-12 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-13 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-14 | 202 | 1.99 | 0.12 | 99.2 | 77.3 | SAEE | 0.00165 | 332.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-15 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-16 | 202 | 1.99 | 0.12 | 99.2 | 78.0 | SAEE | 0.0017 | 342.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-17 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-18 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

## Appendex D Structural analysis and design of 2nd , 3rd & 4th floor

Table D. 1:Types of slab and Span types on the 2nd , 3rd & 4th floor

| Panel | Lx(m) | Ly(m) | Ly/Lx | Type of slab | span type |
|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-2 | 5 | 5 | 1 | Two way | Interior Span |
| S-3 | 5 | 5 | 1 | Two way | Interior Span |
| S-4 | 5 | 5 | 1 | Two way | Interior Span |
| S-4 | 5 | 5 | 1 | Two way | End Span |
| S-5 | 1.6 | 5 | 3.125 | One way | Interior Span |
| S-6 | 5 | 5 | 1 | Two way | End Span |
| S-6 | 5 | 5 | 1 | Two way | Interior Span |
| S-7 | 5 | 5 | 1 | Two way | Interior Span |
| S-8 | 5 | 5 | 1 | Two way | Interior Span |
| S-9 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-10 | 4.43 | 4.43 | 1 | Two way | End Span |
| S-11 | 5 | 5 | 1 | Two way | Interior Span |
| S-12 | 5 | 5 | 1 | Two way | Interior Span |
| S-13 | 5 | 5 | 1 | Two way | Interior Span |
| S-14 | 5 | 5 | 1 | Two way | Interior Span |
| S-15 | 5 | 5 | 1 | Two way | Interior Span |
| S-16 | 5 | 5 | 1 | Two way | Interior Span |
| S-17 | 5 | 5 | 1 | Two way | Interior Span |
| S-18 | 4.43 | 4.43 | 1 | Two way | End Span |
| C-1 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-2 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-3 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-4 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-5 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-6 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-7 | 1.6 | 5 | 3.125 | One way | Cantiliver |
| C-8 | 1.6 | 5 | 3.125 | One way | Cantiliver |

Table D. 2: Minimum concrete cover for 2nd , 3rd & 4th floor

| Panel | Bond/Durability Minimum cover required(mm) | | | Allowance in Design for Variation | | Standred Fire | Cover | GOVERNING Cover Design |
|---|---|---|---|---|---|---|---|---|
| | $Cmin,B$ | $Cmin,Dur$ | $Cmin$ | Δcdev(mm) | $Cnom$ | Resistance | Design | (mm) |
| S-1 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-2 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-3 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-4 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-5 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-6 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-7 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-8 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-9 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-10 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-11 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-12 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | **22mm** |
| S-13 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-14 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-15 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-16 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-17 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| S-18 | 12 | 10 | 12 | 10 | 22 | 10 | 22 | |
| C-1 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-2 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-3 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-4 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-5 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-6 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-7 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |
| C-8 | 12 | 10 | 12 | 10 | 22 | 20 | 22 | |

Table D. 3: Effective depth of 2nd , 3rd & 4th floor slab

| Panel | Lx(m) | Ly(m) | Ly/Lx | Type of slab | span type | F1 | K | N | Lx/d | Depth |
|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 153.933 |
| S-2 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-3 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S-4 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-4 | 5 | 5 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 173.7393 |
| S-5 | 1.6 | 5 | 3.125 | One way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 48.1837 |
| S-6 | 5 | 5 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 173.7393 |
| S-6 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-7 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-8 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-9 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 153.933 |
| S-10 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 153.933 |
| S-11 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-12 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-13 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-14 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-15 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-16 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-17 | 5 | 5 | 1 | Two way | Interior Span | 1.25 | 1.5 | 17.71 | 33.20625 | 150.5741 |
| S-18 | 4.43 | 4.43 | 1 | Two way | End Span | 1.25 | 1.3 | 17.71 | 28.77875 | 153.933 |
| C-1 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-2 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-3 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-4 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-5 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-6 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-7 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| C-8 | 1.6 | 5 | 3.125 | One way | Cantiliver | 1.25 | 0.4 | 17.71 | 8.855 | 180.689 |
| | | | | | | | | | dmax= | 180.689 |
| | | | | | | | | | Cover= | 22 |
| | | | | | | | | | Φ= | 12 |
| | | | | | | | | | D= | 230 |

Table D. 4: Partition wall load on the 2nd , 3rd & 4th floor slab

| **Panel** | **L HCB** | **T HCB** | **H WALL** | **ϒ HCB** | **Ly** | **Lx** | **Area of floor** | **T plaster** | **ϒ plaster** | **T DL** | **Pd=TDL/A** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S-2 | 4.075 | 0.15 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 36.920 | 1.477 |
| S-3 | 4.075 | 0.150 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 36.920 | 1.477 |
| S-4 | 12.975 | 0.150 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 117.554 | 4.702 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S-6 | 12.975 | 0.150 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 117.554 | 4.702 |
| S-7 | 4.075 | 0.150 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 36.920 | 1.477 |
| S-8 | 4.075 | 0.150 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 36.920 | 1.477 |
| S-13 | 6.21 | 0.150 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 56.263 | 2.251 |
| S14 | 5 | 0.015 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 16.950 | 0.678 |
| S-15 | 6.21 | 0.150 | 3.000 | 14 | 5 | 5 | 25 | 0.04 | 23 | 56.263 | 2.251 |

Table D. 5: Self-weight of the 2nd , 3rd & 4th floor based on panel function

| **Function** | **Material** | **Thickness(m)** | **Unit weight(KN/ $m^3$ )** | **Dead Load(KN/ $m^2$ )** |
|---|---|---|---|---|
| **Office** | PVC Tile | 0.002 | 16 | 0.032 |
| | Cement Screed | 0.043 | 23 | 0.989 |
| | RC Slab | 0.23 | 25 | 5.75 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/ $m^2$ )** | **7.231** |
| | | | | |
| **Function** | **Material** | **Thickness(m)** | **Unit weight(KN/ $m^3$ )** | **Dead Load(KN/ $m^2$ )** |
| **Corrider** | Marble | 0.02 | 27 | 0.54 |
| | Cement Screed | 0.03 | 23 | 0.69 |
| | RC Slab | 0.23 | 25 | 5.75 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |
| | | | **TOTAL(KN/ $m^2$ )** | **7.44** |
| | | | | |
| **Function** | **Material** | **Thickness(m)** | **Unit weight(KN/ $m^3$ )** | **Dead Load(KN/ $m^2$ )** |
| **Toilet** | Ceramic | 0.007 | 24 | 0.168 |
| | Cement Screed | 0.043 | 23 | 0.989 |
| | RC Slab | 0.23 | 25 | 5.75 |
| | Bottom Plastering & Painting | 0.02 | 23 | 0.46 |

| | | | |
|---|---|---|---|
| | | **TOTAL(KN/ $m^2$ )** | **7.367** |

Table D. 6: Design factored load on the 2nd , 3rd & 4th floor

| Panel | Slab self-weight | Partition wall load | Total self-weight | Live load | Pd=1.35DL+1.5LL |
|---|---|---|---|---|---|
| S-1 | 7.44 | 0.00 | 7.44 | 3.000 | 14.54 |
| S-2 | 7.44 | 1.477 | 8.92 | 3.000 | 16.54 |
| S-3 | 7.44 | 1.477 | 8.92 | 3.000 | 16.54 |
| S-4 | 7.44 | 4.702 | 12.14 | 3.000 | 20.89 |
| S-5 | 7.44 | 0.00 | 7.44 | 3.000 | 14.54 |
| S-6 | 7.44 | 4.702 | 12.14 | 3.000 | 20.89 |
| S-7 | 7.44 | 1.477 | 8.92 | 3.000 | 16.54 |
| S-8 | 7.44 | 1.477 | 8.92 | 3.000 | 16.54 |
| S-9 | 7.44 | 0.00 | 7.44 | 3.000 | 14.54 |
| S-10 | 7.44 | 0.00 | 7.44 | 3.000 | 14.54 |
| S-11 | 7.44 | 0.000 | 7.44 | 3.000 | 14.54 |
| S-12 | 7.44 | 0.000 | 7.44 | 3.000 | 14.54 |
| S-13 | 7.44 | 2.250 | 9.69 | 3.000 | 17.58 |
| S-14 | 7.44 | 0.680 | 8.12 | 3.000 | 15.46 |
| S-15 | 7.44 | 2.250 | 9.69 | 3.000 | 17.58 |
| S-16 | 7.44 | 0.000 | 7.44 | 3.000 | 14.54 |
| S-17 | 7.44 | 0.000 | 7.44 | 3.000 | 14.54 |
| S-18 | 7.44 | 0.00 | 7.44 | 3.000 | 14.54 |

Table D. 7: Partition wall load on the cantilever part 2nd , 3rd & 4th floor slab

| Panel | T HCB | H WALL | ϒ HCB | T plaster | ϒ plaster | P(KN) |
|---|---|---|---|---|---|---|
| C-1 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-2 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-3 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-4 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-5 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-6 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |
| C-7 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |

| | | | | | | |
|---|---|---|---|---|---|---|
| C-8 | 0.2 | 3 | 14 | 0.04 | 23 | 11.160 |

Table D. 8: Partition wall load on the cantilever part 2nd , 3rd & 4th floor slab

| Panel | L HCB | T HCB | H WALL | ϒ HCB | Ly | Lx | Area of floor | T plaster | ϒ plaster | T DL | Pd'=TDL/A |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C-3 | 2.8 | 0.15 | 3 | 14 | 5 | 1.6 | 8 | 0.04 | 23 | 25.368 | 3.171 |
| C-4 | 2.8 | 0.15 | 3 | 14 | 5 | 1.6 | 8 | 0.04 | 23 | 25.368 | 3.171 |

Table D. 9: Design factored load of cantilever slab on the 2nd , 3rd & 4th floor

| Panel | P(KN) | Dead Load | Live Load | Pd(KN/m2 ) | Pd'(KN/m2 ) | Total Pd(KN/m2 ) |
|---|---|---|---|---|---|---|
| C-1 | 11.160 | 7.44 | 3 | 14.544 | 0 | 14.544 |
| C-2 | 11.160 | 7.44 | 3 | 14.544 | 0 | 14.544 |
| C-3 | 11.160 | 7.44 | 3 | 14.544 | 3.171 | 17.715 |
| C-4 | 11.160 | 7.44 | 3 | 14.544 | 3.171 | 17.715 |
| C-5 | 11.160 | 7.44 | 3 | 14.544 | 0 | 14.544 |
| C-6 | 11.160 | 7.44 | 3 | 14.544 | 0 | 14.544 |
| C-7 | 11.160 | 7.44 | 3 | 14.544 | 0 | 14.544 |
| C-8 | 11.160 | 7.44 | 3 | 14.544 | 0 | 14.544 |

Table D. 10: Calculation of moment for all cantilevers on the 2nd , 3rd & 4th floor

| Panel | Types of slab | Pd | P | Lx | M |
|---|---|---|---|---|---|
| C-1 | Cantilever | 14.544 | 11.16 | 1.6 | 36.4723 |
| C-2 | Cantilever | 14.544 | 11.16 | 1.6 | 36.4723 |
| C-3 | Cantilever | 17.715 | 11.16 | 1.6 | 40.5312 |
| C-4 | Cantilever | 17.715 | 11.16 | 1.6 | 40.5312 |
| C-5 | Cantilever | 14.544 | 11.16 | 1.6 | 36.4723 |
| C-6 | Cantilever | 14.544 | 11.16 | 1.6 | 36.4723 |
| C-7 | Cantilever | 14.544 | 11.16 | 1.6 | 36.4723 |
| C-8 | Cantilever | 14.544 | 11.16 | 1.6 | 36.4723 |

Table D. 11: Moment coefficients according to ES EN for 2nd , 3rd & 4th floor slab of the build

| Panel | Ly | Lx | $l_y/l_x$ | $\beta_{xs}$ | $\beta_{xf}$ | $\beta_{ys}$ | $\beta_{yf}$ |
|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-2 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-3 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S-5 | 5 | 1.6 | 3.125 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-7 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-8 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-9 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-10 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |
| S-11 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-12 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-13 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-14 | 5 | 5 | 1 | 0.039 | 0.029 | 0.037 | 0.028 |
| S-15 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-16 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-17 | 5 | 5 | 1 | 0.031 | 0.024 | 0.032 | 0.024 |
| S-18 | 4.43 | 4.43 | 1 | 0.047 | 0.036 | 0.045 | 0.034 |

Table D. 12: Computation of moments for all panel 2nd , 3rd & 4th floor

| **panel** | **support condition** | **lx** | **$lx^2$** | **Pd** | **Moment Coeficient** | | **Moment location** | **bending moment $Mi= \beta_i P_d L^2 x$** |
|---|---|---|---|---|---|---|---|---|
| | | | | | **location** | **value** | | |
| S-1 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 14.54 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 13.41 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 10.27 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 12.84 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 9.70 |
| S-2 | One short edge discontinuous | 5 | 25 | 16.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 12.82 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 9.92 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 13.23 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 9.92 |
| S-3 | One short edge discontinuous | 5 | 25 | 16.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 12.82 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 9.92 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 13.23 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 9.92 |
| S-5 | One short edge discontinuous | 1.6 | 2.56 | 14.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 1.15 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 0.89 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 1.19 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 0.89 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S-7 | One short edge discontinuous | 5 | 25 | 16.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 12.82 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 9.92 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 13.23 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 9.92 |
| S-8 | One short edge discontinuous | 5 | 25 | 16.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 12.82 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 9.92 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 13.23 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 9.92 |
| S-9 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 14.54 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 13.41 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 10.27 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 12.84 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 9.70 |
| S-10 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 14.54 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 13.41 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 10.27 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 12.84 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 9.70 |
| S-11 | One short edge discontinuous | 5 | 25 | 14.54 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 14.18 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 10.54 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 13.45 |
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 10.18 |
| S-12 | One short edge discontinuous | 5 | 25 | 14.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 11.27 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 8.72 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 11.63 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 8.72 |
| S-13 | One short edge discontinuous | 5 | 25 | 17.58 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 13.62 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 10.55 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 14.06 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 10.55 |
| S-14 | One short edge discontinuous | 5 | 25 | 15.46 | $\beta_{xs}$ | 0.039 | $M_{xs}$ = | 15.07 |
| | | | | | $\beta_{xf}$ | 0.029 | $M_{xf}$ = | 11.21 |
| | | | | | $\beta_{ys}$ | 0.037 | $M_{ys}$ = | 14.30 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | $\beta_{yf}$ | 0.028 | $M_{yf}$ = | 10.82 |
| S-15 | One short edge discontinuous | 5 | 25 | 17.58 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 13.62 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 10.55 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 14.06 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 10.55 |
| S-16 | One short edge discontinuous | 5 | 25 | 14.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 11.27 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 8.72 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 11.63 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 8.72 |
| S-17 | One short edge discontinuous | 5 | 25 | 14.54 | $\beta_{xs}$ | 0.031 | $M_{xs}$ = | 11.27 |
| | | | | | $\beta_{xf}$ | 0.024 | $M_{xf}$ = | 8.72 |
| | | | | | $\beta_{ys}$ | 0.032 | $M_{ys}$ = | 11.63 |
| | | | | | $\beta_{yf}$ | 0.024 | $M_{yf}$ = | 8.72 |
| S-18 | Two adjacent edges discontinuous | 4.43 | 19.6249 | 14.54 | $\beta_{xs}$ | 0.047 | $M_{xs}$ = | 13.41 |
| | | | | | $\beta_{xf}$ | 0.036 | $M_{xf}$ = | 10.27 |
| | | | | | $\beta_{ys}$ | 0.045 | $M_{ys}$ = | 12.84 |
| | | | | | $\beta_{yf}$ | 0.034 | $M_{yf}$ = | 9.70 |

Table D. 13: Adjusted moment for the 2nd , 3rd & 4th floor

| **Panel** | **Moment notation** | **Unadjusted moment for support moment** | | **ΔM/Mlarge*100** | **Method of Adjustment** | **Adjusted moment** |
|---|---|---|---|---|---|---|
| | | **Ms** | **Ms** | | | |
| S1&S2 | Mys | 13.23 | 12.84 | 2.95 | Take average | 13.04 |
| S1&S10 | Mxs | 13.41 | 13.41 | 0.00 | No adjustment | 13.41 |
| S2&S3 | Mys | 13.23 | 13.23 | 0.00 | No adjustment | 13.23 |
| S2&S11 | Mxs | 14.18 | 12.82 | 9.59 | Take average | 13.50 |
| S3&S4 | Mys | 174.08 | 13.23 | 92.40 | Moment distribution | 93.66 |
| S3&S12 | Mxs | 12.82 | 11.27 | 12.09 | Take average | 12.05 |
| S4&S5 | Mys | 174.08 | 1.19 | 99.32 | Moment distribution | 87.64 |
| S4&S13 | Mxs | 87.04 | 13.62 | 84.35 | Moment distribution | 50.33 |
| S5&S6 | Mys | 174.08 | 1.19 | 99.32 | Moment distribution | 87.64 |
| S5&S14 | Mxs | 15.07 | 1.15 | 92.37 | Moment distribution | 12.38 |

| | | | | | | |
|---|---|---|---|---|---|---|
| S6&S7 | Mys | 174.08 | 13.23 | 92.40 | Moment distribution | 93.66 |
| S6&S15 | Mxs | 87.04 | 13.62 | 84.35 | Moment distribution | 50.33 |
| S7&S8 | Mys | 13.23 | 13.23 | 0.00 | No adjustment | 13.23 |
| S7&S16 | Mxs | 12.82 | 11.27 | 12.09 | Take average | 12.05 |
| S8&S9 | Mys | 13.23 | 12.84 | 2.95 | Take average | 13.04 |
| S8&S17 | Mxs | 12.82 | 11.27 | 12.09 | Take average | 12.05 |
| S9&S18 | Mxs | 13.41 | 13.41 | 0.00 | No adjustment | 13.41 |
| S10&S11 | Mys | 13.45 | 12.84 | 4.54 | Take average | 13.15 |
| S11&S12 | Mys | 13.45 | 11.63 | 13.53 | Take average | 12.54 |
| S12&S13 | Mys | 14.06 | 11.63 | 17.28 | Take average | 12.85 |
| S13&S14 | Mys | 14.3 | 14.06 | 1.68 | Take average | 14.18 |
| S14&S15 | Mys | 14.3 | 14.06 | 1.68 | Take average | 14.18 |
| S15&S16 | Mys | 14.06 | 11.63 | 17.28 | Take average | 12.85 |
| S16&S17 | Mys | 11.63 | 11.63 | 0.00 | No adjustment | 11.63 |
| S17&S18 | Mys | 12.84 | 11.63 | 9.42 | Take average | 12.24 |
| C-1 & S-2 | Mxs | 36.472 | 12.82 | 64.85 | Moment distribution | 19.89 |
| C-2 & S-3 | Mxs | 36.472 | 12.82 | 64.85 | Moment distribution | 19.89 |
| C-3 & S-4 | Mxs | 87.040 | 44.3712 | 49.02 | Moment distribution | 74.28 |
| C-4 & S-6 | Mxs | 87.040 | 44.3712 | 49.02 | Moment distribution | 74.28 |
| C-5 & S-7 | Mxs | 36.472 | 12.82 | 64.85 | Moment distribution | 19.89 |
| C-6 & S-8 | Mxs | 36.472 | 12.82 | 64.85 | Moment distribution | 19.89 |
| C-7 & S-12 | Mxs | 36.472 | 11.27 | 69.10 | Moment distribution | 18.81 |
| C-7 & S-13 | Mxs | 36.472 | 13.62 | 62.66 | Moment distribution | 20.45 |
| C-8 & S-15 | Mxs | 36.472 | 13.62 | 62.66 | Moment distribution | 20.45 |
| C-8 & S-16 | Mxs | 36.472 | 11.27 | 69.10 | Moment distribution | 18.81 |

Table D. 14: Span moment adjustment for the 2nd , 3rd & 4th floor

| **Panel** | **moment notation** | **Un adjusted moment** | **Adjusted support moment** | **ΔM** | | **Ly/Lx** | **Span moment notation** | **Factor for Adju.** | | **adjusted span moment** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **ΔMxs** | **ΔMys** | | | | | |
| S-1 | Mxs | 13.41 | 13.41 | 0.00 | -0.20 | 1 | Mxf Adj | cx | 0.38 | 10.22 |
| | Mxf | 10.27 | | | | | | cy | 0.28 | |
| | Mys | 12.84 | 13.04 | | | | Myf adj | cx | 0.28 | 9.63 |
| | Myf | 9.70 | | | | | | cy | 0.38 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S-2 | Mxs | 12.82 | 13.5 | -0.68 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 9.67 |
| | Mxf | 9.92 | | | | | | cy | 0.28 | |
| | Mys | 13.23 | 13.23 | | | | Myf adj | cx | 0.28 | 9.73 |
| | Myf | 9.92 | | | | | | cy | 0.38 | |
| S-3 | Mxs | 12.82 | 12.05 | 0.77 | -80.43 | 1 | Mxf Adj | cx | 0.38 | -12.30 |
| | Mxf | 9.92 | | | | | | cy | 0.28 | |
| | Mys | 13.23 | 93.66 | | | | Myf adj | cx | 0.28 | -20.42 |
| | Myf | 9.92 | | | | | | cy | 0.38 | |
| S-4 | Mxs | 87.04 | 50.33 | 36.71 | 86.44 | 1 | Mxf Adj | cx | 0.38 | 81.67 |
| | Mxf | 43.52 | | | | | | cy | 0.28 | |
| | Mys | 174.08 | 87.64 | | | | Myf adj | cx | 0.28 | 130.17 |
| | Myf | 87.04 | | | | | | cy | 0.38 | |
| S-5 | Mxs | 1.15 | 12.38 | -11.23 | -86.45 | 1 | Mxf Adj | cx | 0.38 | -27.58 |
| | Mxf | 0.89 | | | | | | cy | 0.28 | |
| | Mys | 1.19 | 87.64 | | | | Myf adj | cx | 0.28 | -35.10 |
| | Myf | 0.89 | | | | | | cy | 0.38 | |
| S-6 | Mxs | 87.04 | 50.33 | 36.71 | 80.42 | 1 | Mxf Adj | cx | 0.38 | 79.99 |
| | Mxf | 43.52 | | | | | | cy | 0.28 | |
| | Mys | 174.08 | 93.66 | | | | Myf adj | cx | 0.28 | 127.88 |
| | Myf | 87.04 | | | | | | cy | 0.38 | |
| S-7 | Mxs | 12.82 | 12.05 | 0.77 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 10.22 |
| | Mxf | 9.92 | | | | | | cy | 0.28 | |
| | Mys | 13.23 | 13.23 | | | | Myf adj | cx | 0.28 | 10.14 |
| | Myf | 9.92 | | | | | | cy | 0.38 | |
| S-8 | Mxs | 12.82 | 12.05 | 0.77 | 0.19 | 1 | Mxf Adj | cx | 0.38 | 10.27 |
| | Mxf | 9.92 | | | | | | cy | 0.28 | |
| | Mys | 13.23 | 13.04 | | | | Myf adj | cx | 0.28 | 10.21 |
| | Myf | 9.92 | | | | | | cy | 0.38 | |
| S-9 | Mxs | 13.41 | 13.41 | 0.00 | -0.20 | 1 | Mxf Adj | cx | 0.38 | 10.22 |
| | Mxf | 10.27 | | | | | | cy | 0.28 | |
| | Mys | 12.84 | 13.04 | | | | Myf adj | cx | 0.28 | 9.63 |
| | Myf | 9.70 | | | | | | cy | 0.38 | |
| S-10 | Mxs | 13.41 | 13.41 | 0.00 | -0.31 | 1 | Mxf Adj | cx | 0.38 | 10.19 |
| | Mxf | 10.27 | | | | | | cy | 0.28 | |
| | Mys | 12.84 | 13.15 | | | | Myf adj | cx | 0.28 | 9.58 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Myf | 9.70 | | | | | | cy | 0.38 | |
| S-11 | Mxs | 14.18 | 13.5 | 0.68 | 0.91 | 1 | Mxf Adj | cx | 0.38 | 11.05 |
| | Mxf | 10.54 | | | | | | cy | 0.28 | |
| | Mys | 13.45 | 12.54 | | | | Myf adj | cx | 0.28 | 10.71 |
| | Myf | 10.18 | | | | | | cy | 0.38 | |
| S-12 | Mxs | 11.27 | 18.81 | -7.54 | -1.22 | 1 | Mxf Adj | cx | 0.38 | 5.52 |
| | Mxf | 8.72 | | | | | | cy | 0.28 | |
| | Mys | 11.63 | 12.85 | | | | Myf adj | cx | 0.28 | 6.15 |
| | Myf | 8.72 | | | | | | cy | 0.38 | |
| S-13 | Mxs | 13.62 | 20.45 | -6.83 | -0.12 | 1 | Mxf Adj | cx | 0.38 | 7.92 |
| | Mxf | 10.55 | | | | | | cy | 0.28 | |
| | Mys | 14.06 | 14.18 | | | | Myf adj | cx | 0.28 | 8.59 |
| | Myf | 10.55 | | | | | | cy | 0.38 | |
| S-14 | Mxs | 15.07 | 12.38 | 2.69 | 0.12 | 1 | Mxf Adj | cx | 0.38 | 12.27 |
| | Mxf | 11.21 | | | | | | cy | 0.28 | |
| | Mys | 14.30 | 14.18 | | | | Myf adj | cx | 0.28 | 11.62 |
| | Myf | 10.82 | | | | | | cy | 0.38 | |
| S-15 | Mxs | 13.62 | 20.45 | -6.83 | 1.21 | 1 | Mxf Adj | cx | 0.38 | 8.29 |
| | Mxf | 10.55 | | | | | | cy | 0.28 | |
| | Mys | 14.06 | 12.85 | | | | Myf adj | cx | 0.28 | 9.10 |
| | Myf | 10.55 | | | | | | cy | 0.38 | |
| S-16 | Mxs | 11.27 | 18.81 | -7.54 | 0.00 | 1 | Mxf Adj | cx | 0.38 | 5.86 |
| | Mxf | 8.72 | | | | | | cy | 0.28 | |
| | Mys | 11.63 | 11.63 | | | | Myf adj | cx | 0.28 | 6.61 |
| | Myf | 8.72 | | | | | | cy | 0.38 | |
| S-17 | Mxs | 11.27 | 12.05 | -0.78 | -0.61 | 1 | Mxf Adj | cx | 0.38 | 8.26 |
| | Mxf | 8.72 | | | | | | cy | 0.28 | |
| | Mys | 11.63 | 12.24 | | | | Myf adj | cx | 0.28 | 8.27 |
| | Myf | 8.72 | | | | | | cy | 0.38 | |
| S-18 | Mxs | 13.41 | 13.41 | 0.00 | 0.60 | 1 | Mxf Adj | cx | 0.38 | 10.44 |
| | Mxf | 10.27 | | | | | | cy | 0.28 | |
| | Mys | 12.84 | 12.24 | | | | Myf adj | cx | 0.28 | 9.93 |
| | Myf | 9.70 | | | | | | cy | 0.38 | |

Table D. 15: Flexural Reinforcement calculation for the 2nd , 3rd & 4th floor

| Panel | moment notation | adjusted moment | d (mm) | As min | As max | μsd | Z | As | NO. of bar | Spacing | Spacing provied | AS Provide |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | Mxf | 10.22 | 202 | 290.2 | 8000 | 0.010 | 200.200 | 117.321 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 13.41 | 202 | 290.2 | 8000 | 0.013 | 199.631 | 154.423 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 9.63 | 190 | 273.0 | 8000 | 0.011 | 188.196 | 117.588 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 13.04 | 190 | 273.0 | 8000 | 0.014 | 187.547 | 159.837 | 12 | 414.087 | 410 | 275.707 |
| S-2 | Mxf | 9.67 | 202 | 290.2 | 8000 | 0.009 | 200.297 | 110.985 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 13.50 | 202 | 290.2 | 8000 | 0.013 | 199.614 | 155.472 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 9.73 | 190 | 273.0 | 8000 | 0.011 | 188.176 | 118.866 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 13.23 | 190 | 273.0 | 8000 | 0.015 | 187.511 | 162.197 | 12 | 414.087 | 410 | 275.707 |
| S-3 | Mxf | 12.30 | 202 | 290.2 | 8000 | 0.012 | 199.829 | 141.500 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 12.05 | 202 | 290.2 | 8000 | 0.012 | 199.873 | 138.593 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 20.42 | 190 | 273.0 | 8000 | 0.023 | 186.130 | 252.203 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 93.66 | 190 | 273.0 | 8000 | 0.104 | 170.639 | 1261.787 | 12 | 414.087 | 410 | 275.707 |
| S-4 | Mxf | 81.67 | 202 | 290.2 | 8000 | 0.080 | 186.558 | 1006.372 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 50.33 | 202 | 290.2 | 8000 | 0.049 | 192.792 | 600.136 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 130.17 | 190 | 273.0 | 8000 | 0.144 | 161.584 | 1851.921 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 87.64 | 190 | 273.0 | 8000 | 0.097 | 172.030 | 1171.139 | 12 | 414.087 | 410 | 275.707 |
| S-5 | Mxf | 27.58 | 202 | 290.2 | 8000 | 0.027 | 197.063 | 321.736 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 12.38 | 202 | 290.2 | 8000 | 0.012 | 199.815 | 142.431 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 35.10 | 190 | 273.0 | 8000 | 0.039 | 183.243 | 440.341 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 87.64 | 190 | 273.0 | 8000 | 0.097 | 172.030 | 1171.139 | 12 | 414.087 | 410 | 275.707 |
| S-6 | Mxf | 79.99 | 202 | 290.2 | 8000 | 0.078 | 186.904 | 983.848 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 50.33 | 202 | 290.2 | 8000 | 0.049 | 192.792 | 600.136 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 127.88 | 190 | 273.0 | 8000 | 0.142 | 162.188 | 1812.568 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 93.66 | 190 | 273.0 | 8000 | 0.104 | 170.639 | 1261.787 | 12 | 414.087 | 410 | 275.707 |
| S-7 | Mxf | 10.22 | 202 | 290.2 | 8000 | 0.010 | 200.199 | 117.354 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 12.05 | 202 | 290.2 | 8000 | 0.012 | 199.873 | 138.593 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 10.14 | 190 | 273.0 | 8000 | 0.011 | 188.098 | 123.926 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 13.23 | 190 | 273.0 | 8000 | 0.015 | 187.511 | 162.197 | 12 | 414.087 | 410 | 275.707 |
| S-8 | Mxf | 10.27 | 202 | 290.2 | 8000 | 0.010 | 200.190 | 117.934 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 12.05 | 202 | 290.2 | 8000 | 0.012 | 199.873 | 138.593 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 10.21 | 190 | 273.0 | 8000 | 0.011 | 188.085 | 124.791 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 13.04 | 190 | 273.0 | 8000 | 0.014 | 187.547 | 159.837 | 12 | 414.087 | 410 | 275.707 |
| | Mxf | 10.22 | 202 | 290.2 | 8000 | 0.010 | 200.199 | 117.354 | 12 | 389.488 | 380 | 297.474 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-9 | Mxs | 13.41 | 202 | 290.2 | 8000 | 0.013 | 199.631 | 154.423 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 9.63 | 190 | 273.0 | 8000 | 0.011 | 188.195 | 117.633 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 13.04 | 190 | 273.0 | 8000 | 0.014 | 187.547 | 159.837 | 12 | 414.087 | 410 | 275.707 |
| S-10 | Mxf | 10.19 | 202 | 290.2 | 8000 | 0.010 | 200.205 | 117.007 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 13.41 | 202 | 290.2 | 8000 | 0.013 | 199.631 | 154.423 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 9.58 | 190 | 273.0 | 8000 | 0.011 | 188.205 | 117.016 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 13.15 | 190 | 273.0 | 8000 | 0.015 | 187.527 | 161.203 | 12 | 414.087 | 410 | 275.707 |
| S-11 | Mxf | 11.05 | 202 | 290.2 | 8000 | 0.011 | 200.052 | 126.979 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 13.50 | 202 | 290.2 | 8000 | 0.013 | 199.614 | 155.472 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 10.71 | 190 | 273.0 | 8000 | 0.012 | 187.990 | 130.968 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 12.54 | 190 | 273.0 | 8000 | 0.014 | 187.643 | 153.630 | 12 | 414.087 | 410 | 275.707 |
| S-12 | Mxf | 5.52 | 202 | 290.2 | 8000 | 0.005 | 201.031 | 63.123 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 18.81 | 202 | 290.2 | 8000 | 0.018 | 198.660 | 217.665 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 6.15 | 190 | 273.0 | 8000 | 0.007 | 188.851 | 74.863 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 12.85 | 190 | 273.0 | 8000 | 0.014 | 187.584 | 157.478 | 12 | 414.087 | 410 | 275.707 |
| S-13 | Mxf | 7.92 | 202 | 290.2 | 8000 | 0.008 | 200.607 | 90.759 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 20.45 | 202 | 290.2 | 8000 | 0.020 | 198.364 | 236.997 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 8.59 | 190 | 273.0 | 8000 | 0.010 | 188.392 | 104.820 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 14.18 | 190 | 273.0 | 8000 | 0.016 | 187.330 | 174.012 | 12 | 414.087 | 410 | 275.707 |
| S-14 | Mxf | 12.27 | 202 | 290.2 | 8000 | 0.012 | 199.834 | 141.152 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 12.38 | 202 | 290.2 | 8000 | 0.012 | 199.815 | 142.431 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 11.62 | 190 | 273.0 | 8000 | 0.013 | 187.818 | 142.226 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 14.18 | 190 | 273.0 | 8000 | 0.016 | 187.330 | 174.012 | 12 | 414.087 | 410 | 275.707 |
| S-15 | Mxf | 8.29 | 202 | 290.2 | 8000 | 0.008 | 200.542 | 95.030 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 20.45 | 202 | 290.2 | 8000 | 0.020 | 198.364 | 236.997 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 9.10 | 190 | 273.0 | 8000 | 0.010 | 188.295 | 111.100 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 12.85 | 190 | 273.0 | 8000 | 0.014 | 187.584 | 157.478 | 12 | 414.087 | 410 | 275.707 |
| S-16 | Mxf | 5.86 | 202 | 290.2 | 8000 | 0.006 | 200.971 | 67.031 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 18.81 | 202 | 290.2 | 8000 | 0.018 | 198.660 | 217.665 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 6.61 | 190 | 273.0 | 8000 | 0.007 | 188.765 | 80.499 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 11.63 | 190 | 273.0 | 8000 | 0.013 | 187.816 | 142.350 | 12 | 414.087 | 410 | 275.707 |
| S-17 | Mxf | 8.26 | 202 | 290.2 | 8000 | 0.008 | 200.547 | 94.683 | 12 | 389.488 | 380 | 297.474 |
| | Mxs | 12.05 | 202 | 290.2 | 8000 | 0.012 | 199.873 | 138.593 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 8.27 | 190 | 273.0 | 8000 | 0.009 | 188.452 | 100.882 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 12.24 | 190 | 273.0 | 8000 | 0.014 | 187.700 | 149.909 | 12 | 414.087 | 410 | 275.707 |
| | Mxf | 10.44 | 202 | 290.2 | 8000 | 0.010 | 200.160 | 119.904 | 12 | 389.488 | 380 | 297.474 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-18 | Mxs | 13.41 | 202 | 290.2 | 8000 | 0.013 | 199.631 | 154.423 | 12 | 389.488 | 380 | 297.474 |
| | Myf | 9.93 | 190 | 273.0 | 8000 | 0.011 | 188.138 | 121.334 | 12 | 414.087 | 410 | 275.707 |
| | Mys | 12.24 | 190 | 273.0 | 8000 | 0.014 | 187.700 | 149.909 | 12 | 414.087 | 410 | 275.707 |

Table D. 16: Check for defelection and Serviceability Requirement for 2nd , 3rd & 4th floor

| Panel | d | Ascalc | AS required | ρo | P | F1 | K | N | LX/D | LX | D | depth check |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 4430 | 53.27095 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 4430 | 53.27095 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 4430 | 56.1723 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 4430 | 56.1723 | SAFE |
| S-2 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-3 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-4 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-5 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-6 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-7 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| S-8 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-9 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 4430 | 46.16816 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 4430 | 46.16816 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 4430 | 48.68266 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 4430 | 48.68266 | SAFE |
| S-10 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 4430 | 46.16816 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 4430 | 46.16816 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 4430 | 48.68266 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 4430 | 48.68266 | SAFE |
| S-11 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| S-12 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 5000 | 60.12522 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 5000 | 63.39989 | SAFE |
| S-13 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-14 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-15 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-16 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-17 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.5 | 50.1 | 96.0 | 5000 | 52.10853 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.5 | 40.8 | 91.0 | 5000 | 54.94657 | SAFE |
| S-18 | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 4430 | 53.27095 | SAFE |
| | 202 | 297.5 | 380.0 | 0.0045 | 0.0019 | 1.27742 | 1.3 | 50.1 | 83.2 | 4430 | 53.27095 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 4430 | 56.1723 | SAFE |
| | 190 | 275.7 | 410.0 | 0.0045 | 0.0022 | 1.48708 | 1.3 | 40.8 | 78.9 | 4430 | 56.1723 | SAFE |

Table D. 17: Loads on Supporting Beams for the 2nd , 3rd & 4th floor

| Panel | Ly | Lx | Ly/lx | Shear coefficent | | Pd | Loads transferred | |
|---|---|---|---|---|---|---|---|---|
| S-1 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 14.54 | Vxc | 25.76 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 14.54 | Vxd | 16.75 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 14.54 | Vyc | 25.76 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 14.54 | Vyd | 16.75 |
| S-2 | 5 | 5 | 1 | Bvxc | 0.36 | 16.54 | Vxc | 29.77 |
| | 5 | 5 | 1 | Bvxd | 0 | 16.54 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 16.54 | Vyc | 29.77 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 16.54 | Vyd | 19.85 |
| S-3 | 5 | 5 | 1 | Bvxc | 0.36 | 16.54 | Vxc | 29.77 |
| | 5 | 5 | 1 | Bvxd | 0 | 16.54 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 16.54 | Vyc | 29.77 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 16.54 | Vyd | 19.85 |
| S-4 | 5 | 5 | 1 | Bvxc | 0.36 | 20.89 | Vxc | 37.60 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.89 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.89 | Vyc | 37.60 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.89 | Vyd | 25.07 |
| S-5 | 5 | 1.6 | 3.125 | Bvxc | 0.36 | 14.54 | Vxc | 8.38 |
| | 5 | 1.6 | 3.125 | Bvxd | 0 | 14.54 | Vxd | 0.00 |
| | 5 | 1.6 | 3.125 | Bvyc | 0.36 | 14.54 | Vyc | 8.38 |
| | 5 | 1.6 | 3.125 | Bvyd | 0.24 | 14.54 | Vyd | 5.58 |
| S-6 | 5 | 5 | 1 | Bvxc | 0.36 | 20.89 | Vxc | 37.60 |
| | 5 | 5 | 1 | Bvxd | 0 | 20.89 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 20.89 | Vyc | 37.60 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 20.89 | Vyd | 25.07 |
| S-7 | 5 | 5 | 1 | Bvxc | 0.36 | 16.54 | Vxc | 29.77 |
| | 5 | 5 | 1 | Bvxd | 0 | 16.54 | Vxd | 0.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 5 | 1 | Bvyc | 0.36 | 16.54 | Vyc | 29.77 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 16.54 | Vyd | 19.85 |
| S-8 | 5 | 5 | 1 | Bvxc | 0.36 | 16.54 | Vxc | 29.77 |
| | 5 | 5 | 1 | Bvxd | 0 | 16.54 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 16.54 | Vyc | 29.77 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 16.54 | Vyd | 19.85 |
| S-9 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 14.54 | Vxc | 25.76 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 14.54 | Vxd | 16.75 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 14.54 | Vyc | 25.76 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 14.54 | Vyd | 16.75 |
| S-10 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 14.54 | Vxc | 25.76 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 14.54 | Vxd | 16.75 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 14.54 | Vyc | 25.76 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 14.54 | Vyd | 16.75 |
| S-11 | 5 | 5 | 1 | Bvxc | 0.36 | 14.54 | Vxc | 26.17 |
| | 5 | 5 | 1 | Bvxd | 0 | 14.54 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 14.54 | Vyc | 26.17 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 14.54 | Vyd | 17.45 |
| S-12 | 5 | 5 | 1 | Bvxc | 0.36 | 14.54 | Vxc | 26.17 |
| | 5 | 5 | 1 | Bvxd | 0 | 14.54 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 14.54 | Vyc | 26.17 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 14.54 | Vyd | 17.45 |
| S-13 | 5 | 5 | 1 | Bvxc | 0.36 | 17.58 | Vxc | 31.64 |
| | 5 | 5 | 1 | Bvxd | 0 | 17.58 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 17.58 | Vyc | 31.64 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 17.58 | Vyd | 21.10 |
| S-14 | 5 | 5 | 1 | Bvxc | 0.36 | 15.46 | Vxc | 27.83 |
| | 5 | 5 | 1 | Bvxd | 0 | 15.46 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 15.46 | Vyc | 27.83 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 15.46 | Vyd | 18.55 |
| S-15 | 5 | 5 | 1 | Bvxc | 0.36 | 14.54 | Vxc | 26.17 |
| | 5 | 5 | 1 | Bvxd | 0 | 14.54 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 14.54 | Vyc | 26.17 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 14.54 | Vyd | 17.45 |
| S-16 | 5 | 5 | 1 | Bvxc | 0.36 | 14.54 | Vxc | 26.17 |
| | 5 | 5 | 1 | Bvxd | 0 | 14.54 | Vxd | 0.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 5 | 1 | Bvyc | 0.36 | 14.54 | Vyc | 26.17 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 14.54 | Vyd | 17.45 |
| S-17 | 5 | 5 | 1 | Bvxc | 0.36 | 14.54 | Vxc | 26.17 |
| | 5 | 5 | 1 | Bvxd | 0 | 14.54 | Vxd | 0.00 |
| | 5 | 5 | 1 | Bvyc | 0.36 | 14.54 | Vyc | 26.17 |
| | 5 | 5 | 1 | Bvyd | 0.24 | 14.54 | Vyd | 17.45 |
| S-18 | 4.43 | 4.43 | 1 | Bvxc | 0.4 | 14.54 | Vxc | 25.76 |
| | 4.43 | 4.43 | 1 | Bvxd | 0.26 | 14.54 | Vxd | 16.75 |
| | 4.43 | 4.43 | 1 | Bvyc | 0.4 | 14.54 | Vyc | 25.76 |
| | 4.43 | 4.43 | 1 | Bvyd | 0.26 | 14.54 | Vyd | 16.75 |

Table D. 18: Dead load on the beam for the $2^{nd}$ , $3^{rd}$ & $4^{th}$ floor

| **Panel** | **H Wall** | **T HCB** | **ϒ HCB** | **T Plaster** | **ϒ Plaster** | **Total DL** |
|---|---|---|---|---|---|---|
| S-1 | | | | | | |
| Axis(A, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(B, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-2 | | | | | | |
| Axis(B, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(C, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, B&C) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, B&C) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-3 | | | | | | |
| Axis(C, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(D, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, C&D) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, C&D) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-4 | | | | | | |
| Axis(D, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(E, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(3, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-5 | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(E, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(F, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, E&F) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, E&F) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-6 | | | | | | |
| Axis(F, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(G, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, F&G) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, F&G) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-7 | | | | | | |
| Axis(G, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(H, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, G&H) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, G&H) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-8 | | | | | | |
| Axis(H, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(I, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(2, H&I) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, H&I) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-9 | | | | | | |
| Axis(I, 2&3) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(J, 2&3) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, I&J) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(3, I&J) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| S-10 | | | | | | |
| Axis(A, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(B, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, A&B) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, A&B) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-11 | | | | | | |
| Axis(B, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(C, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, B&C) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, B&C) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-12 | | | | | | |
| Axis(C, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Axis(D, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, C&D) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, C&D) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-13 | | | | | | |
| Axis(D, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(E, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, D&E) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, D&E) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-14 | | | | | | |
| Axis(E, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(F, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, E&F) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, E&F) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-15 | | | | | | |
| Axis(F, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(G, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, F&G) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, F&G) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-16 | | | | | | |
| Axis(G, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(H, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, G&H) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, G&H) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-17 | | | | | | |
| Axis(H, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(I, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(1, H&I) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, H&I) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| S-18 | | | | | | |
| Axis(I, 1&2) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |
| Axis(J, 1&2) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(1, I&J) | 3 | 0.2 | 14 | 0.04 | 23.00 | 11.16 |
| Axis(2, I&J) | 3 | 0.15 | 14 | 0.04 | 23.00 | 9.06 |

Table D. 19: Shear transfer on the beam $2^{nd}$ , $3^{rd}$ & $4^{th}$ floor

| Panel | shear | Total pd including plaster (KN/M) | Beam self weight(250*400) | shear load | total load |
|---|---|---|---|---|---|
| S-1 | | | | | |
| Axis(A, 2&3) | Vxc | 0.375 | 2.5 | 25.76 | 26.32 |
| Axis(B, 2&3) | Vxd | 11.16 | 2.5 | 16.75 | 28.90 |
| Axis(2, A&B) | Vyc | 9.06 | 2.5 | 25.76 | 35.01 |
| Axis(3, A&B) | Vyd | 0.375 | 2.5 | 16.75 | 18.11 |
| S-2 | | | | | |
| Axis(B, 2&3) | Vxc | 11.16 | 2.5 | 29.77 | 40.75 |
| Axis(C, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, B&C) | Vyc | 9.06 | 2.5 | 29.77 | 38.65 |
| Axis(3, B&C) | Vyd | 0.375 | 2.5 | 19.85 | 20.94 |
| S-3 | | | | | |
| Axis(C, 2&3) | Vxc | 9.06 | 2.5 | 29.77 | 38.65 |
| Axis(D, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, C&D) | Vyc | 9.06 | 2.5 | 29.77 | 38.65 |
| Axis(3, C&D) | Vyd | 0.375 | 2.5 | 19.85 | 20.94 |
| S-4 | | | | | |
| Axis(D, 2&3) | Vxc | 9.06 | 2.5 | 37.60 | 45.78 |
| Axis(E, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, D&E) | Vyc | 9.06 | 2.5 | 37.60 | 45.78 |
| Axis(3, D&E) | Vyd | 0.375 | 2.5 | 25.07 | 25.69 |
| S-5 | | | | | |
| Axis(E, 2&3) | Vxc | 9.06 | 2.5 | 8.38 | 19.18 |
| Axis(F, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, E&F) | Vyc | 9.06 | 2.5 | 8.38 | 19.18 |
| Axis(3, E&F) | Vyd | 0.375 | 2.5 | 5.58 | 7.96 |
| S-6 | | | | | |
| Axis(F, 2&3) | Vxc | 9.06 | 2.5 | 37.60 | 45.78 |
| Axis(G, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, F&G) | Vyc | 9.06 | 2.5 | 37.60 | 45.78 |
| Axis(3, F&G) | Vyd | 0.375 | 2.5 | 25.07 | 25.69 |
| S-7 | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Axis(G, 2&3) | Vxc | 9.06 | 2.5 | 29.77 | 38.65 |
| Axis(H, 2&3) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(2, G&H) | Vyc | 9.06 | 2.5 | 29.77 | 38.65 |
| Axis(3, G&H) | Vyd | 0.375 | 2.5 | 19.85 | 20.94 |
| S-8 | | | | | |
| Axis(H, 2&3) | Vxc | 9.06 | 2.5 | 29.77 | 38.65 |
| Axis(I, 2&3) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(2, H&I) | Vyc | 9.06 | 2.5 | 29.77 | 38.65 |
| Axis(3, H&I) | Vyd | 0.375 | 2.5 | 19.85 | 20.94 |
| S-9 | | | | | |
| Axis(I, 2&3) | Vxc | 11.16 | 2.5 | 25.76 | 37.11 |
| Axis(J, 2&3) | Vxd | 0.375 | 2.5 | 16.75 | 18.11 |
| Axis(2, I&J) | Vyc | 9.06 | 2.5 | 25.76 | 35.01 |
| Axis(3, I&J) | Vyd | 0.375 | 2.5 | 16.75 | 18.11 |
| S-10 | | | | | |
| Axis(A, 1&2) | Vxc | 0.375 | 2.5 | 25.76 | 26.32 |
| Axis(B, 1&2) | Vxd | 11.16 | 2.5 | 16.75 | 28.90 |
| Axis(1, A&B) | Vyc | 0.375 | 2.5 | 25.76 | 26.32 |
| Axis(2, A&B) | Vyd | 9.06 | 2.5 | 16.75 | 26.80 |
| S-11 | | | | | |
| Axis(B, 1&2) | Vxc | 11.16 | 2.5 | 26.17 | 37.48 |
| Axis(C, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, B&C) | Vyc | 0.375 | 2.5 | 26.17 | 26.69 |
| Axis(2, B&C) | Vyd | 9.06 | 2.5 | 17.45 | 27.44 |
| S-12 | | | | | |
| Axis(C, 1&2) | Vxc | 9.06 | 2.5 | 26.17 | 35.38 |
| Axis(D, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, C&D) | Vyc | 0.375 | 2.5 | 26.17 | 26.69 |
| Axis(2, C&D) | Vyd | 9.06 | 2.5 | 17.45 | 27.44 |
| S-13 | | | | | |
| Axis(D, 1&2) | Vxc | 9.06 | 2.5 | 31.64 | 40.36 |
| Axis(E, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, D&E) | Vyc | 0.375 | 2.5 | 31.64 | 31.67 |
| Axis(2, D&E) | Vyd | 9.06 | 2.5 | 21.10 | 30.76 |
| S-14 | | | | | |
| Axis(E, 1&2) | Vxc | 9.06 | 2.5 | 27.83 | 36.88 |

| | | | | | |
|---|---|---|---|---|---|
| Axis(F, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, E&F) | Vyc | 0.375 | 2.5 | 27.83 | 28.20 |
| Axis(2, E&F) | Vyd | 0 | 2.5 | 18.55 | 19.38 |
| S-15 | | | | | |
| Axis(F, 1&2) | Vxc | 9.06 | 2.5 | 26.17 | 35.38 |
| Axis(G, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, F&G) | Vyc | 0.375 | 2.5 | 26.17 | 26.69 |
| Axis(2, F&G) | Vyd | 9.06 | 2.5 | 17.45 | 27.44 |
| S-16 | | | | | |
| Axis(G, 1&2) | Vxc | 9.06 | 2.5 | 26.17 | 35.38 |
| Axis(H, 1&2) | Vxd | 9.06 | 2.5 | 0.00 | 11.56 |
| Axis(1, G&H) | Vyc | 0.375 | 2.5 | 26.17 | 26.69 |
| Axis(2, G&H) | Vyd | 9.06 | 2.5 | 17.45 | 27.44 |
| S-17 | | | | | |
| Axis(H, 1&2) | Vxc | 9.06 | 2.5 | 26.17 | 35.38 |
| Axis(I, 1&2) | Vxd | 11.16 | 2.5 | 0.00 | 13.66 |
| Axis(1, H&I) | Vyc | 0.375 | 2.5 | 26.17 | 26.69 |
| Axis(2, H&I) | Vyd | 9.06 | 2.5 | 17.45 | 27.44 |
| S-18 | | | | | |
| Axis(I, 1&2) | Vxc | 11.16 | 2.5 | 25.76 | 37.11 |
| Axis(J, 1&2) | Vxd | 0.375 | 2.5 | 16.75 | 18.11 |
| Axis(1, I&J) | Vyc | 0.375 | 2.5 | 25.76 | 26.32 |
| Axis(2, I&J) | Vyd | 9.06 | 2.5 | 16.75 | 26.80 |

Table D. 20: Check for shear reinforcement on the 2nd , 3rd & 4th floor

| **Panel** | **d** | **K** | **crdc** | **Vmin** | **Vrdc** | **check for shear** | **ρshear** | **As provide** |
|---|---|---|---|---|---|---|---|---|
| S-1 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-2 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S-3 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-4 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-5 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-6 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-7 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-8 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-9 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-10 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-11 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S-12 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-13 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-14 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-15 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-16 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-17 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| S-18 | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 202 | 1.99 | 0.12 | 99.2 | 74.5 | SAEE | 0.00147 | 297.5 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |
| | 190 | 2 | 0.12 | 94.0 | 70.0 | SAEE | 0.00145 | 275.7 |

## Appendix G structural analysis and design of beam

Table G. 1:Flexural Design for the beam on axis B for all story

axis B
story 7

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 52.9 | 250 | 254 | 0.0551 | 240.981 | single | 504.898 | 97.5 | 3000 | 504.898 | 2.51243 | 3 |
| span | 1 to 2 | 35.96 | 250 | 254 | 0.03746 | 245.306 | single | 337.165 | 97.5 | 3000 | 337.165 | 1.67777 | 2 |
| suport | 2 | 52.9 | 250 | 254 | 0.0551 | 240.981 | single | 504.898 | 97.5 | 3000 | 504.898 | 2.51243 | 3 |
| span | 2to3 | 36 | 250 | 254 | 0.0375 | 245.296 | single | 337.554 | 97.5 | 3000 | 337.554 | 1.6797 | 2 |
| suport | 3 to 2 | 51.6 | 250 | 254 | 0.05375 | 241.319 | single | 491.801 | 97.5 | 3000 | 491.801 | 2.44726 | 3 |

axis B
story 6

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 77.76 | 250 | 352 | 0.081 | 324.725 | single | 550.771 | 130 | 4000 | 550.771 | 1.75405 | 2 |
| span | 1 to 2 | 59.52 | 250 | 352 | 0.062 | 331.553 | single | 412.896 | 130 | 4000 | 412.896 | 1.31496 | 2 |
| suport | 2 | 77.76 | 250 | 352 | 0.081 | 324.725 | single | 550.771 | 130 | 4000 | 550.771 | 1.75405 | 2 |
| span | 2to3 | 59.6 | 250 | 352 | 0.06208 | 331.523 | single | 413.488 | 130 | 4000 | 413.488 | 1.31684 | 2 |
| suport | 3 | 86.2 | 250 | 352 | 0.08979 | 321.457 | single | 616.758 | 130 | 4000 | 616.758 | 1.9642 | 2 |

axis B
story 5

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 81.9 | 250 | 352 | 0.08531 | 323.131 | single | 582.956 | 130 | 4000 | 582.956 | 1.85655 | 2 |
| span | 1 to 2 | 62.3 | 250 | 352 | 0.0649 | 330.531 | single | 433.517 | 130 | 4000 | 433.517 | 1.38063 | 2 |
| suport | 2 | 81.9 | 250 | 352 | 0.08531 | 323.131 | single | 582.956 | 130 | 4000 | 582.956 | 1.85655 | 2 |
| suport | 2 to3 | 88.15 | 250 | 352 | 0.09182 | 320.691 | single | 632.216 | 130 | 4000 | 632.216 | 2.01343 | 3 |
| span | 2 to3 | 62.4 | 250 | 352 | 0.065 | 330.495 | single | 434.261 | 130 | 4000 | 434.261 | 1.383 | 2 |
| suport | 3 to 2 | 88.15 | 250 | 352 | 0.09182 | 320.691 | single | 632.216 | 130 | 4000 | 632.216 | 2.01343 | 3 |

axis B
story 4

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 90.5 | 250 | 352 | 0.09427 | 319.763 | single | 650.954 | 130 | 4000 | 650.954 | 2.0731 | 3 |
| span | 1 to 2 | 67.1 | 250 | 352 | 0.0699 | 328.752 | single | 469.445 | 130 | 4000 | 469.445 | 1.49505 | 2 |
| suport | 2 | 90.5 | 250 | 352 | 0.09427 | 319.763 | single | 650.954 | 130 | 4000 | 650.954 | 2.0731 | 3 |
| suport | 2 to3 | 93.7 | 250 | 352 | 0.0976 | 318.49 | single | 676.665 | 130 | 4000 | 676.665 | 2.15499 | 3 |
| span | 2 to3 | 67.5 | 250 | 352 | 0.07031 | 328.603 | single | 472.458 | 130 | 4000 | 472.458 | 1.50464 | 2 |
| suport | 3 to 2 | 93.7 | 250 | 352 | 0.0976 | 318.49 | single | 676.665 | 130 | 4000 | 676.665 | 2.15499 | 3 |

axis B
story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 88.45 | 250 | 352 | 0.09214 | 320.573 | single | 634.601 | 130 | 4000 | 634.601 | 2.02102 | 3 |
| span | 1 to 2 | 63.1 | 250 | 352 | 0.06573 | 330.236 | single | 439.476 | 130 | 4000 | 439.476 | 1.3996 | 2 |
| suport | 2 | 88.45 | 250 | 352 | 0.09214 | 320.573 | single | 634.601 | 130 | 4000 | 634.601 | 2.02102 | 3 |
| suport | 2 to3 | 88.1 | 250 | 352 | 0.09177 | 320.711 | single | 631.819 | 130 | 4000 | 631.819 | 2.01216 | 3 |
| span | 2 to3 | 63.2 | 250 | 352 | 0.06583 | 330.199 | single | 440.222 | 130 | 4000 | 440.222 | 1.40198 | 2 |
| suport | 3 to 2 | 88.1 | 250 | 352 | 0.09177 | 320.711 | single | 631.819 | 130 | 4000 | 631.819 | 2.01216 | 3 |

axis B
story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 85.2 | 250 | 352 | 0.08875 | 321.848 | single | 608.863 | 130 | 4000 | 608.863 | 1.93905 | 2 |
| span | 1 to 2 | 60.4 | 250 | 352 | 0.06292 | 331.23 | single | 419.409 | 130 | 4000 | 419.409 | 1.3357 | 2 |
| suport | 2 | 85.2 | 250 | 352 | 0.08875 | 321.848 | single | 608.863 | 130 | 4000 | 608.863 | 1.93905 | 2 |
| suport | 2 to3 | 86.3 | 250 | 352 | 0.0899 | 321.418 | single | 617.549 | 130 | 4000 | 617.549 | 1.96672 | 2 |
| span | 2 to3 | 60.4 | 250 | 352 | 0.06292 | 331.23 | single | 419.409 | 130 | 4000 | 419.409 | 1.3357 | 2 |
| suport | 3 to 2 | 86.3 | 250 | 352 | 0.0899 | 321.418 | single | 617.549 | 130 | 4000 | 617.549 | 1.96672 | 2 |

axis B
story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 21.6 | 300 | 352 | 0.01875 | 346.076 | single | 143.553 | 156 | 4800 | 156 | 0.49682 | 2 |
| span | 1 to 2 | 15.1 | 300 | 352 | 0.01311 | 347.88 | single | 99.8339 | 156 | 4800 | 156 | 0.49682 | 2 |
| suport | 2 | 21.6 | 300 | 352 | 0.01875 | 346.076 | single | 143.553 | 156 | 4800 | 156 | 0.49682 | 2 |
| suport | 2 to3 | 21.25 | 300 | 352 | 0.01845 | 346.173 | single | 141.187 | 156 | 4800 | 156 | 0.49682 | 2 |
| span | 2 to3 | 15.3 | 300 | 352 | 0.01328 | 347.825 | single | 101.172 | 156 | 4800 | 156 | 0.49682 | 2 |
| suport | 3 to 2 | 21.25 | 300 | 352 | 0.01845 | 346.173 | single | 141.187 | 156 | 4800 | 156 | 0.49682 | 2 |

Table G. 2: Flexural Design for the beam on axis C for all story

axis C

story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 43.6 | 250 | 254 | 0.04542 | 243.375 | single | 412.041 | 97.5 | 3000 | 412.041 | 2.05036 | 3 |
| span | 1 to 2 | 33.5 | 250 | 254 | 0.0349 | 245.921 | single | 313.314 | 97.5 | 3000 | 313.314 | 1.55909 | 2 |
| suport | 2 | 43.6 | 250 | 254 | 0.04542 | 243.375 | single | 412.041 | 97.5 | 3000 | 412.041 | 2.05036 | 3 |
| span | 2to3 | 33.57 | 250 | 254 | 0.03497 | 245.903 | single | 313.991 | 97.5 | 3000 | 313.991 | 1.56245 | 2 |
| suport | 3 to 2 | 45.4 | 250 | 254 | 0.04729 | 242.916 | single | 429.864 | 97.5 | 3000 | 429.864 | 2.13905 | 3 |

axis C

story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 71.2 | 250 | 352 | 0.07417 | 327.216 | single | 500.468 | 130 | 4000 | 500.468 | 1.59385 | 2 |
| span | 1 to 2 | 55.57 | 250 | 352 | 0.05789 | 332.992 | single | 383.828 | 130 | 4000 | 383.828 | 1.22238 | 2 |
| suport | 2 | 71.2 | 250 | 352 | 0.07417 | 327.216 | single | 500.468 | 130 | 4000 | 500.468 | 1.59385 | 2 |
| span | 2to3 | 55.7 | 250 | 352 | 0.05802 | 332.945 | single | 384.781 | 130 | 4000 | 384.781 | 1.22542 | 2 |
| suport | 3 | 74.7 | 250 | 352 | 0.07781 | 325.892 | single | 527.203 | 130 | 4000 | 527.203 | 1.67899 | 2 |

axis C

story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 74.3 | 250 | 352 | 0.0774 | 326.044 | single | 524.135 | 130 | 4000 | 524.135 | 1.66922 | 2 |
| span | 1 to 2 | 57.9 | 250 | 352 | 0.06031 | 332.145 | single | 400.942 | 130 | 4000 | 400.942 | 1.27689 | 2 |
| suport | 2 | 74.3 | 250 | 352 | 0.0774 | 326.044 | single | 524.135 | 130 | 4000 | 524.135 | 1.66922 | 2 |
| suport | 2 to3 | 78.2 | 250 | 352 | 0.08146 | 324.556 | single | 554.176 | 130 | 4000 | 554.176 | 1.76489 | 2 |
| span | 2 to3 | 58 | 250 | 352 | 0.06042 | 332.108 | single | 401.679 | 130 | 4000 | 401.679 | 1.27923 | 2 |
| suport | 3 to 2 | 78.2 | 250 | 352 | 0.08146 | 324.556 | single | 554.176 | 130 | 4000 | 554.176 | 1.76489 | 2 |

axis C

story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 81.5 | 250 | 352 | 0.0849 | 323.286 | single | 579.831 | 130 | 4000 | 579.831 | 1.8466 | 2 |
| span | 1 to 2 | 62.6 | 250 | 352 | 0.06521 | 330.421 | single | 435.75 | 130 | 4000 | 435.75 | 1.38774 | 2 |
| suport | 2 | 81.5 | 250 | 352 | 0.0849 | 323.286 | single | 579.831 | 130 | 4000 | 579.831 | 1.8466 | 2 |
| suport | 2 to3 | 85 | 250 | 352 | 0.08854 | 321.926 | single | 607.286 | 130 | 4000 | 607.286 | 1.93403 | 2 |
| span | 2 to3 | 62.7 | 250 | 352 | 0.06531 | 330.384 | single | 436.495 | 130 | 4000 | 436.495 | 1.39011 | 2 |
| suport | 3 to 2 | 86 | 250 | 352 | 0.08958 | 321.535 | single | 615.177 | 130 | 4000 | 615.177 | 1.95916 | 2 |

axis C

story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 77.7 | 250 | 352 | 0.08094 | 324.748 | single | 550.307 | 130 | 4000 | 550.307 | 1.75257 | 2 |
| span | 1 to 2 | 58.99 | 250 | 352 | 0.06145 | 331.746 | single | 408.98 | 130 | 4000 | 408.98 | 1.30249 | 2 |
| suport | 2 | 77.7 | 250 | 352 | 0.08094 | 324.748 | single | 550.307 | 130 | 4000 | 550.307 | 1.75257 | 2 |
| suport | 2 to3 | 80.2 | 250 | 352 | 0.08354 | 323.787 | single | 569.698 | 130 | 4000 | 569.698 | 1.81433 | 2 |
| span | 2 to3 | 59 | 250 | 352 | 0.06146 | 331.743 | single | 409.054 | 130 | 4000 | 409.054 | 1.30272 | 2 |
| suport | 3 to 2 | 80.2 | 250 | 352 | 0.08354 | 323.787 | single | 569.698 | 130 | 4000 | 569.698 | 1.81433 | 2 |

axis C

story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 76.2 | 250 | 352 | 0.07938 | 325.321 | single | 538.733 | 130 | 4000 | 538.733 | 1.71571 | 2 |
| span | 1 to 2 | 56.6 | 250 | 352 | 0.05896 | 332.618 | single | 391.382 | 130 | 4000 | 391.382 | 1.24644 | 2 |
| suport | 2 | 76.2 | 250 | 352 | 0.07938 | 325.321 | single | 538.733 | 130 | 4000 | 538.733 | 1.71571 | 2 |
| suport | 2 to3 | 77.6 | 250 | 352 | 0.08083 | 324.786 | single | 549.534 | 130 | 4000 | 549.534 | 1.75011 | 2 |
| span | 2 to3 | 56.5 | 250 | 352 | 0.05885 | 332.654 | single | 390.648 | 130 | 4000 | 390.648 | 1.2441 | 2 |
| suport | 3 to 2 | 77.6 | 250 | 352 | 0.08083 | 324.786 | single | 549.534 | 130 | 4000 | 549.534 | 1.75011 | 2 |

axis C

story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 18.4 | 300 | 352 | 0.01597 | 346.966 | single | 121.972 | 156 | 4800 | 156 | 0.49682 | 2 |
| span | 1 to 2 | 12.37 | 300 | 352 | 0.01074 | 348.632 | single | 81.608 | 156 | 4800 | 156 | 0.49682 | 2 |
| suport | 2 | 18.4 | 300 | 352 | 0.01597 | 346.966 | single | 121.972 | 156 | 4800 | 156 | 0.49682 | 2 |
| suport | 2 to3 | 17.8 | 300 | 352 | 0.01545 | 347.133 | single | 117.938 | 156 | 4800 | 156 | 0.49682 | 2 |
| span | 2 to3 | 12.4 | 300 | 352 | 0.01076 | 348.624 | single | 81.8078 | 156 | 4800 | 156 | 0.49682 | 2 |
| suport | 3 to 2 | 17.8 | 300 | 352 | 0.01545 | 347.133 | single | 117.938 | 156 | 4800 | 156 | 0.49682 | 2 |

Table G. 3: Flexural Design for the beam on axis D for all story

axis D
story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| span | 1 to 2 | 33.5 | 250 | 252 | 0.0349 | 243.985 | single | 315.801 | 97.5 | 3000 | 315.801 | 1.57146 | 2 |
| suport | 2 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| suport | 2 to3 | 45.5 | 250 | 252 | 0.0474 | 240.978 | single | 434.275 | 97.5 | 3000 | 434.275 | 2.161 | 3 |
| span | 2 to3 | 33.53 | 250 | 252 | 0.03493 | 243.977 | single | 316.093 | 97.5 | 3000 | 316.093 | 1.57291 | 2 |
| suport | 3 to 2 | 45.5 | 250 | 252 | 0.0474 | 240.978 | single | 434.275 | 97.5 | 3000 | 434.275 | 2.161 | 3 |

axis D
story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 74 | 250 | 352 | 0.07708 | 326.158 | single | 521.837 | 130 | 4000 | 521.837 | 1.6619 | 2 |
| span | 1 to 2 | 55.53 | 250 | 352 | 0.05784 | 333.007 | single | 383.535 | 130 | 4000 | 383.535 | 1.22145 | 2 |
| suport | 2 | 74 | 250 | 352 | 0.07708 | 326.158 | single | 521.837 | 130 | 4000 | 521.837 | 1.6619 | 2 |
| suport | 2 to3 | 75.2 | 250 | 352 | 0.07833 | 325.702 | single | 531.041 | 130 | 4000 | 531.041 | 1.69121 | 2 |
| span | 2 to3 | 55.55 | 250 | 352 | 0.05786 | 332.999 | single | 383.682 | 130 | 4000 | 383.682 | 1.22192 | 2 |
| suport | 3 to 2 | 75.2 | 250 | 352 | 0.07833 | 325.702 | single | 531.041 | 130 | 4000 | 531.041 | 1.69121 | 2 |

axis D
story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 78 | 250 | 352 | 0.08125 | 324.633 | single | 552.628 | 130 | 4000 | 552.628 | 1.75996 | 2 |
| span | 1 to 2 | 57.9 | 250 | 352 | 0.06031 | 332.145 | single | 400.942 | 130 | 4000 | 400.942 | 1.27689 | 2 |
| suport | 2 | 78 | 250 | 352 | 0.08125 | 324.633 | single | 552.628 | 130 | 4000 | 552.628 | 1.75996 | 2 |
| suport | 2 to3 | 78.14 | 250 | 352 | 0.0814 | 324.579 | single | 553.711 | 130 | 4000 | 553.711 | 1.76341 | 2 |
| span | 2 to3 | 57.9 | 250 | 352 | 0.06031 | 332.145 | single | 400.942 | 130 | 4000 | 400.942 | 1.27689 | 2 |
| suport | 3 to 2 | 78.14 | 250 | 352 | 0.0814 | 324.579 | single | 553.711 | 130 | 4000 | 553.711 | 1.76341 | 2 |

axis D
story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 84.6 | 250 | 352 | 0.08813 | 322.082 | single | 604.136 | 130 | 4000 | 604.136 | 1.924 | 2 |
| span | 1 to 2 | 62.6 | 250 | 352 | 0.06521 | 330.421 | single | 435.75 | 130 | 4000 | 435.75 | 1.38774 | 2 |
| suport | 2 | 84.6 | 250 | 352 | 0.08813 | 322.082 | single | 604.136 | 130 | 4000 | 604.136 | 1.924 | 2 |
| suport | 2 to3 | 85.4 | 250 | 352 | 0.08896 | 321.77 | single | 610.44 | 130 | 4000 | 610.44 | 1.94408 | 2 |
| span | 2 to3 | 62.6 | 250 | 352 | 0.06521 | 330.421 | single | 435.75 | 130 | 4000 | 435.75 | 1.38774 | 2 |
| suport | 3 to 2 | 85.4 | 250 | 352 | 0.08896 | 321.77 | single | 610.44 | 130 | 4000 | 610.44 | 1.94408 | 2 |

axis D
story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 80.7 | 250 | 352 | 0.08406 | 323.595 | single | 573.592 | 130 | 4000 | 573.592 | 1.82672 | 2 |
| span | 1 to 2 | 58.9 | 250 | 352 | 0.06135 | 331.779 | single | 408.316 | 130 | 4000 | 408.316 | 1.30037 | 2 |
| suport | 2 | 80.7 | 250 | 352 | 0.08406 | 323.595 | single | 573.592 | 130 | 4000 | 573.592 | 1.82672 | 2 |
| suport | 2 to3 | 80.1 | 250 | 352 | 0.08344 | 323.826 | single | 568.92 | 130 | 4000 | 568.92 | 1.81185 | 2 |
| span | 2 to3 | 58.9 | 250 | 352 | 0.06135 | 331.779 | single | 408.316 | 130 | 4000 | 408.316 | 1.30037 | 2 |
| suport | 3 to 2 | 80 | 250 | 352 | 0.08333 | 323.864 | single | 568.142 | 130 | 4000 | 568.142 | 1.80937 | 2 |

axis D
story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 77.67 | 250 | 352 | 0.08091 | 324.759 | single | 550.076 | 130 | 4000 | 550.076 | 1.75183 | 2 |
| span | 1 to 2 | 56.6 | 250 | 352 | 0.05896 | 332.618 | single | 391.382 | 130 | 4000 | 391.382 | 1.24644 | 2 |
| suport | 2 | 77.67 | 250 | 352 | 0.08091 | 324.759 | single | 550.076 | 130 | 4000 | 550.076 | 1.75183 | 2 |
| suport | 2 to3 | 77.67 | 250 | 352 | 0.08091 | 324.759 | single | 550.076 | 130 | 4000 | 550.076 | 1.75183 | 2 |
| span | 2 to3 | 56.5 | 250 | 352 | 0.05885 | 332.654 | single | 390.648 | 130 | 4000 | 390.648 | 1.2441 | 2 |
| suport | 3 to 2 | 77.67 | 250 | 352 | 0.08091 | 324.759 | single | 550.076 | 130 | 4000 | 550.076 | 1.75183 | 2 |

axis D
story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 17 | 300 | 352 | 0.01476 | 347.355 | single | 112.566 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 1 to 2 | 12.3 | 300 | 352 | 0.01068 | 348.651 | single | 81.1417 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 | 17 | 300 | 352 | 0.01476 | 347.355 | single | 112.566 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 to3 | 17 | 300 | 352 | 0.01476 | 347.355 | single | 112.566 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 2 to3 | 12.43 | 300 | 352 | 0.01079 | 348.616 | single | 82.0077 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 3 to 2 | 17 | 300 | 352 | 0.01476 | 347.355 | single | 112.566 | 156 | 4800 | 156 | 0.77627 | 2 |

Table G. 4: Flexural Design for the beam on axis E for all story

axis E
story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| span | 1 to 2 | 34.2 | 250 | 252 | 0.03563 | 243.811 | single | 322.629 | 97.5 | 3000 | 322.629 | 1.60544 | 2 |
| suport | 2 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| suport | 2 to3 | 26 | 250 | 252 | 0.02708 | 245.826 | single | 243.263 | 97.5 | 3000 | 243.263 | 1.21051 | 2 |
| span | 2 to3 | 19.16 | 250 | 252 | 0.01996 | 247.48 | single | 178.068 | 97.5 | 3000 | 178.068 | 0.88609 | 2 |
| suport | 3 to 2 | 26 | 250 | 252 | 0.02708 | 245.826 | single | 243.263 | 97.5 | 3000 | 243.263 | 1.21051 | 2 |

axis E
story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 77.3 | 250 | 352 | 0.08052 | 324.901 | single | 547.217 | 130 | 4000 | 547.217 | 1.74273 | 2 |
| span | 1 to 2 | 56.6 | 250 | 352 | 0.05896 | 332.618 | single | 391.382 | 130 | 4000 | 391.382 | 1.24644 | 2 |
| suport | 2 | 77.3 | 250 | 352 | 0.08052 | 324.901 | single | 547.217 | 130 | 4000 | 547.217 | 1.74273 | 2 |
| suport | 2 to3 | 47.3 | 250 | 352 | 0.04927 | 335.964 | single | 323.816 | 130 | 4000 | 323.816 | 1.03126 | 2 |
| span | 2 to3 | 33.15 | 250 | 352 | 0.03453 | 340.925 | single | 223.643 | 130 | 4000 | 223.643 | 0.71224 | 2 |
| suport | 3 to 2 | 47.3 | 250 | 352 | 0.04927 | 335.964 | single | 323.816 | 130 | 4000 | 323.816 | 1.03126 | 2 |

axis E
story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 79.1 | 250 | 352 | 0.0824 | 324.211 | single | 561.151 | 130 | 4000 | 561.151 | 1.7871 | 2 |
| span | 1 to 2 | 59.13 | 250 | 352 | 0.06159 | 331.695 | single | 410.014 | 130 | 4000 | 410.014 | 1.30578 | 2 |
| suport | 2 | 79.1 | 250 | 352 | 0.0824 | 324.211 | single | 561.151 | 130 | 4000 | 561.151 | 1.7871 | 2 |
| suport | 2 to3 | 47.36 | 250 | 352 | 0.04933 | 335.943 | single | 324.248 | 130 | 4000 | 324.248 | 1.03264 | 2 |
| span | 2 to3 | 34.2 | 250 | 352 | 0.03563 | 340.562 | single | 230.973 | 130 | 4000 | 230.973 | 0.73558 | 2 |
| suport | 3 to 2 | 47.36 | 250 | 352 | 0.04933 | 335.943 | single | 324.248 | 130 | 4000 | 324.248 | 1.03264 | 2 |

axis E
story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 85.1 | 250 | 352 | 0.08865 | 321.887 | single | 608.074 | 130 | 4000 | 608.074 | 1.93654 | 2 |
| span | 1 to 2 | 63.99 | 250 | 352 | 0.06666 | 329.907 | single | 446.119 | 130 | 4000 | 446.119 | 1.42076 | 2 |
| suport | 2 | 85.1 | 250 | 352 | 0.08865 | 321.887 | single | 608.074 | 130 | 4000 | 608.074 | 1.93654 | 2 |
| suport | 2 to3 | 51 | 250 | 352 | 0.05313 | 334.641 | single | 350.527 | 130 | 4000 | 350.527 | 1.11633 | 2 |
| span | 2 to3 | 36.3 | 250 | 352 | 0.03781 | 339.833 | single | 245.681 | 130 | 4000 | 245.681 | 0.78242 | 2 |
| suport | 3 to 2 | 51 | 250 | 352 | 0.05313 | 334.641 | single | 350.527 | 130 | 4000 | 350.527 | 1.11633 | 2 |

axis E

story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 80.7 | 250 | 352 | 0.08406 | 323.595 | single | 573.592 | 130 | 4000 | 573.592 | 1.82672 | 2 |
| span | 1 to 2 | 60.1 | 250 | 352 | 0.0626 | 331.34 | single | 417.187 | 130 | 4000 | 417.187 | 1.32862 | 2 |
| suport | 2 | 80.7 | 250 | 352 | 0.08406 | 323.595 | single | 573.592 | 130 | 4000 | 573.592 | 1.82672 | 2 |
| suport | 2 to3 | 48.8 | 250 | 352 | 0.05083 | 335.429 | single | 334.618 | 130 | 4000 | 334.618 | 1.06566 | 2 |
| span | 2 to3 | 34.74 | 250 | 352 | 0.03619 | 340.375 | single | 234.749 | 130 | 4000 | 234.749 | 0.74761 | 2 |
| suport | 3 to 2 | 48.8 | 250 | 352 | 0.05083 | 335.429 | single | 334.618 | 130 | 4000 | 334.618 | 1.06566 | 2 |

axis E

story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 76.5 | 250 | 352 | 0.07969 | 325.206 | single | 541.044 | 130 | 4000 | 541.044 | 1.72307 | 2 |
| span | 1 to 2 | 57.9 | 250 | 352 | 0.06031 | 332.145 | single | 400.942 | 130 | 4000 | 400.942 | 1.27689 | 2 |
| suport | 2 | 76.5 | 250 | 352 | 0.07969 | 325.206 | single | 541.044 | 130 | 4000 | 541.044 | 1.72307 | 2 |
| suport | 2 to3 | 50.2 | 250 | 352 | 0.05229 | 334.928 | single | 344.733 | 130 | 4000 | 344.733 | 1.09787 | 2 |
| span | 2 to3 | 33.36 | 250 | 352 | 0.03475 | 340.852 | single | 225.108 | 130 | 4000 | 225.108 | 0.7169 | 2 |
| suport | 3 to 2 | 50.2 | 250 | 352 | 0.05229 | 334.928 | single | 344.733 | 130 | 4000 | 344.733 | 1.09787 | 2 |

axis E

story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 19.33 | 300 | 352 | 0.01678 | 346.708 | single | 128.233 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 1 to 2 | 12.37 | 300 | 352 | 0.01074 | 348.632 | single | 81.608 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 | 19.33 | 300 | 352 | 0.01678 | 346.708 | single | 128.233 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 to3 | 18.8 | 300 | 352 | 0.01632 | 346.855 | single | 124.664 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 2 to3 | 12.8 | 300 | 352 | 0.01111 | 348.514 | single | 84.4735 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 3 to 2 | 18.8 | 300 | 352 | 0.01632 | 346.855 | single | 124.664 | 156 | 4800 | 156 | 0.77627 | 2 |

Table G. 5: Flexural Design for the beam on axis F for all story

axis F
story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| span | 1 to 2 | 34.2 | 250 | 252 | 0.03563 | 243.811 | single | 322.629 | 97.5 | 3000 | 322.629 | 1.60544 | 2 |
| suport | 2 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| suport | 2 to3 | 26 | 250 | 252 | 0.02708 | 245.826 | single | 243.263 | 97.5 | 3000 | 243.263 | 1.21051 | 2 |
| span | 2 to3 | 19.16 | 250 | 252 | 0.01996 | 247.48 | single | 178.068 | 97.5 | 3000 | 178.068 | 0.88609 | 2 |
| suport | 3 to 2 | 26 | 250 | 252 | 0.02708 | 245.826 | single | 243.263 | 97.5 | 3000 | 243.263 | 1.21051 | 2 |

axis F
story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 77.2 | 250 | 352 | 0.08042 | 324.939 | single | 546.444 | 130 | 4000 | 541.815 | 1.72553 | 2 |
| span | 1 to 2 | 56.6 | 250 | 352 | 0.05896 | 332.618 | single | 391.382 | 130 | 4000 | 391.382 | 1.24644 | 2 |
| suport | 2 | 77.2 | 250 | 352 | 0.08042 | 324.939 | single | 546.444 | 130 | 4000 | 541.815 | 1.72553 | 2 |
| suport | 2 to3 | 47.3 | 250 | 352 | 0.04927 | 335.964 | single | 323.816 | 130 | 4000 | 323.816 | 1.03126 | 2 |
| span | 2 to3 | 33.15 | 250 | 352 | 0.03453 | 340.925 | single | 223.643 | 130 | 4000 | 223.643 | 0.71224 | 2 |
| suport | 3 to 2 | 47.3 | 250 | 352 | 0.04927 | 335.964 | single | 323.816 | 130 | 4000 | 323.816 | 1.03126 | 2 |

axis F
story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 79.1 | 250 | 352 | 0.0824 | 324.211 | single | 561.151 | 130 | 4000 | 561.151 | 1.7871 | 2 |
| span | 1 to 2 | 59.13 | 250 | 352 | 0.06159 | 331.695 | single | 410.014 | 130 | 4000 | 410.014 | 1.30578 | 2 |
| suport | 2 | 79.1 | 250 | 352 | 0.0824 | 324.211 | single | 561.151 | 130 | 4000 | 561.151 | 1.7871 | 2 |
| suport | 2 to3 | 47.36 | 250 | 352 | 0.04933 | 335.943 | single | 324.248 | 130 | 4000 | 324.248 | 1.03264 | 2 |
| span | 2 to3 | 34.2 | 250 | 352 | 0.03563 | 340.562 | single | 230.973 | 130 | 4000 | 230.973 | 0.73558 | 2 |
| suport | 3 to 2 | 47.36 | 250 | 352 | 0.04933 | 335.943 | single | 324.248 | 130 | 4000 | 324.248 | 1.03264 | 2 |

axis F
story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 85.1 | 250 | 352 | 0.08865 | 321.887 | single | 608.074 | 130 | 4000 | 608.074 | 1.93654 | 2 |
| span | 1 to 2 | 63.99 | 250 | 352 | 0.06666 | 329.907 | single | 446.119 | 130 | 4000 | 446.119 | 1.42076 | 2 |
| suport | 2 | 85.1 | 250 | 352 | 0.08865 | 321.887 | single | 608.074 | 130 | 4000 | 608.074 | 1.93654 | 2 |
| suport | 2 to3 | 51 | 250 | 352 | 0.05313 | 334.641 | single | 350.527 | 130 | 4000 | 350.527 | 1.11633 | 2 |
| span | 2 to3 | 36.3 | 250 | 352 | 0.03781 | 339.833 | single | 245.681 | 130 | 4000 | 245.681 | 0.78242 | 2 |
| suport | 3 to 2 | 51 | 250 | 352 | 0.05313 | 334.641 | single | 350.527 | 130 | 4000 | 350.527 | 1.11633 | 2 |

axis F
story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 80.7 | 250 | 352 | 0.08406 | 323.595 | single | 573.592 | 130 | 4000 | 573.592 | 1.82672 | 2 |
| span | 1 to 2 | 60.1 | 250 | 352 | 0.0626 | 331.34 | single | 417.187 | 130 | 4000 | 417.187 | 1.32862 | 2 |
| suport | 2 | 80.7 | 250 | 352 | 0.08406 | 323.595 | single | 573.592 | 130 | 4000 | 573.592 | 1.82672 | 2 |
| suport | 2 to3 | 48.8 | 250 | 352 | 0.05083 | 335.429 | single | 334.618 | 130 | 4000 | 334.618 | 1.06566 | 2 |
| span | 2 to3 | 34.74 | 250 | 352 | 0.03619 | 340.375 | single | 234.749 | 130 | 4000 | 234.749 | 0.74761 | 2 |
| suport | 3 to 2 | 48.8 | 250 | 352 | 0.05083 | 335.429 | single | 334.618 | 130 | 4000 | 334.618 | 1.06566 | 2 |

axis F
story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 76.5 | 250 | 352 | 0.07969 | 325.206 | single | 541.044 | 130 | 4000 | 541.044 | 1.72307 | 2 |
| span | 1 to 2 | 57.9 | 250 | 352 | 0.06031 | 332.145 | single | 400.942 | 130 | 4000 | 400.942 | 1.27689 | 2 |
| suport | 2 | 76.5 | 250 | 352 | 0.07969 | 325.206 | single | 541.044 | 130 | 4000 | 541.044 | 1.72307 | 2 |
| suport | 2 to3 | 50.2 | 250 | 352 | 0.05229 | 334.928 | single | 344.733 | 130 | 4000 | 344.733 | 1.09787 | 2 |
| span | 2 to3 | 33.36 | 250 | 352 | 0.03475 | 340.852 | single | 225.108 | 130 | 4000 | 225.108 | 0.7169 | 2 |
| suport | 3 to 2 | 50.2 | 250 | 352 | 0.05229 | 334.928 | single | 344.733 | 130 | 4000 | 344.733 | 1.09787 | 2 |

axis F
story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 19.33 | 300 | 352 | 0.01678 | 346.708 | single | 128.233 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 1 to 2 | 12.37 | 300 | 352 | 0.01074 | 348.632 | single | 81.608 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 | 19.33 | 300 | 352 | 0.01678 | 346.708 | single | 128.233 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 to3 | 18.8 | 300 | 352 | 0.01632 | 346.855 | single | 124.664 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 2 to3 | 12.8 | 300 | 352 | 0.01111 | 348.514 | single | 84.4735 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 3 to 2 | 18.8 | 300 | 352 | 0.01632 | 346.855 | single | 124.664 | 156 | 4800 | 156 | 0.77627 | 2 |

Table G. 6: Flexural Design for the beam on axis G for all story

axis G
story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| span | 1 to 2 | 33.5 | 250 | 252 | 0.0349 | 243.985 | single | 315.801 | 97.5 | 3000 | 315.801 | 1.57146 | 2 |
| suport | 2 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| suport | 2 to3 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |
| span | 2 to3 | 33.53 | 250 | 252 | 0.03493 | 243.977 | single | 316.093 | 97.5 | 3000 | 316.093 | 1.57291 | 2 |
| suport | 3 to 2 | 45.04 | 250 | 252 | 0.04692 | 241.094 | single | 429.677 | 97.5 | 3000 | 429.677 | 2.13812 | 3 |

axis G
story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 74 | 250 | 352 | 0.07708 | 326.158 | single | 521.837 | 130 | 4000 | 521.837 | 1.6619 | 2 |
| span | 1 to 2 | 55.5 | 250 | 352 | 0.05781 | 333.017 | single | 383.316 | 130 | 4000 | 383.316 | 1.22075 | 2 |
| suport | 2 | 74 | 250 | 352 | 0.07708 | 326.158 | single | 521.837 | 130 | 4000 | 521.837 | 1.6619 | 2 |
| suport | 2 to3 | 75.2 | 250 | 352 | 0.07833 | 325.702 | single | 531.041 | 130 | 4000 | 531.041 | 1.69121 | 2 |
| span | 2 to3 | 55.6 | 250 | 352 | 0.05792 | 332.981 | single | 384.048 | 130 | 4000 | 384.048 | 1.22308 | 2 |
| suport | 3 to 2 | 75.2 | 250 | 352 | 0.07833 | 325.702 | single | 531.041 | 130 | 4000 | 531.041 | 1.69121 | 2 |

axis G
story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 78 | 250 | 352 | 0.08125 | 324.633 | single | 552.628 | 130 | 4000 | 552.628 | 1.75996 | 2 |
| span | 1 to 2 | 57.9 | 250 | 352 | 0.06031 | 332.145 | single | 400.942 | 130 | 4000 | 400.942 | 1.27689 | 2 |
| suport | 2 | 78 | 250 | 352 | 0.08125 | 324.633 | single | 552.628 | 130 | 4000 | 552.628 | 1.75996 | 2 |
| suport | 2 to3 | 78.7 | 250 | 352 | 0.08198 | 324.364 | single | 558.049 | 130 | 4000 | 558.049 | 1.77723 | 2 |
| span | 2 to3 | 57.95 | 250 | 352 | 0.06036 | 332.126 | single | 401.311 | 130 | 4000 | 401.311 | 1.27806 | 2 |
| suport | 3 to 2 | 78.78 | 250 | 352 | 0.08206 | 324.334 | single | 558.669 | 130 | 4000 | 558.669 | 1.7792 | 2 |

axis G
story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 84.6 | 250 | 352 | 0.08813 | 322.082 | single | 604.136 | 130 | 4000 | 604.136 | 1.924 | 2 |
| span | 1 to 2 | 62.6 | 250 | 352 | 0.06521 | 330.421 | single | 435.75 | 130 | 4000 | 435.75 | 1.38774 | 2 |
| suport | 2 | 84.6 | 250 | 352 | 0.08813 | 322.082 | single | 604.136 | 130 | 4000 | 604.136 | 1.924 | 2 |
| suport | 2 to3 | 85.5 | 250 | 352 | 0.08906 | 321.731 | single | 611.229 | 130 | 4000 | 611.229 | 1.94659 | 2 |
| span | 2 to3 | 62.7 | 250 | 352 | 0.06531 | 330.384 | single | 436.495 | 130 | 4000 | 436.495 | 1.39011 | 2 |
| suport | 3 to 2 | 85.5 | 250 | 352 | 0.08906 | 321.731 | single | 611.229 | 130 | 4000 | 611.229 | 1.94659 | 2 |

axis G
story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 80.2 | 250 | 352 | 0.08354 | 323.787 | single | 569.698 | 130 | 4000 | 569.698 | 1.81433 | 2 |
| span | 1 to 2 | 58.96 | 250 | 352 | 0.06142 | 331.757 | single | 408.759 | 130 | 4000 | 408.759 | 1.30178 | 2 |
| suport | 2 | 80.2 | 250 | 352 | 0.08354 | 323.787 | single | 569.698 | 130 | 4000 | 569.698 | 1.81433 | 2 |
| suport | 2 to3 | 80.6 | 250 | 352 | 0.08396 | 323.633 | single | 572.812 | 130 | 4000 | 572.812 | 1.82424 | 2 |
| span | 2 to3 | 58.96 | 250 | 352 | 0.06142 | 331.757 | single | 408.759 | 130 | 4000 | 408.759 | 1.30178 | 2 |
| suport | 3 to 2 | 80.6 | 250 | 352 | 0.08396 | 323.633 | single | 572.812 | 130 | 4000 | 572.812 | 1.82424 | 2 |

axis G
story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 77.6 | 250 | 352 | 0.08083 | 324.786 | single | 549.534 | 130 | 4000 | 549.534 | 1.75011 | 2 |
| span | 1 to 2 | 56.56 | 250 | 352 | 0.05892 | 332.633 | single | 391.089 | 130 | 4000 | 391.089 | 1.24551 | 2 |
| suport | 2 | 77.6 | 250 | 352 | 0.08083 | 324.786 | single | 549.534 | 130 | 4000 | 549.534 | 1.75011 | 3 |
| suport | 2 to3 | 77.6 | 250 | 352 | 0.08083 | 324.786 | single | 549.534 | 130 | 4000 | 549.534 | 1.75011 | 2 |
| span | 2 to3 | 56.54 | 250 | 352 | 0.0589 | 332.64 | single | 390.942 | 130 | 4000 | 390.942 | 1.24504 | 2 |
| suport | 3 to 2 | 77.6 | 250 | 352 | 0.08083 | 324.786 | single | 549.534 | 130 | 4000 | 549.534 | 1.75011 | 2 |

axis G
story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 17.6 | 300 | 352 | 0.01528 | 347.188 | single | 116.594 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 1 to 2 | 12.37 | 300 | 352 | 0.01074 | 348.632 | single | 81.608 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 | 17.6 | 300 | 352 | 0.01528 | 347.188 | single | 116.594 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 to3 | 17.7 | 300 | 352 | 0.01536 | 347.161 | single | 117.266 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 2 to3 | 12.37 | 300 | 352 | 0.01074 | 348.632 | single | 81.608 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 3 to 2 | 17.7 | 300 | 352 | 0.01536 | 347.161 | single | 117.266 | 156 | 4800 | 156 | 0.77627 | 2 |

Table G. 7: Flexural Design for the beam on axis H for all story

axis H
story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 44 | 250 | 252 | 0.04583 | 241.358 | single | 419.297 | 97.5 | 3000 | 419.297 | 2.08647 | 3 |
| span | 1 to 2 | 33.5 | 250 | 252 | 0.0349 | 243.985 | single | 315.801 | 97.5 | 3000 | 315.801 | 1.57146 | 2 |
| suport | 2 | 44 | 250 | 252 | 0.04583 | 241.358 | single | 419.297 | 97.5 | 3000 | 419.297 | 2.08647 | 3 |
| suport | 2 to3 | 45.44 | 250 | 252 | 0.04733 | 240.993 | single | 433.675 | 97.5 | 3000 | 433.675 | 2.15802 | 3 |
| span | 2 to3 | 33.57 | 250 | 252 | 0.03497 | 243.967 | single | 316.483 | 97.5 | 3000 | 316.483 | 1.57486 | 2 |
| suport | 3 to 2 | 45.44 | 250 | 252 | 0.04733 | 240.993 | single | 433.675 | 97.5 | 3000 | 433.675 | 2.15802 | 3 |

axis H
story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 71.3 | 250 | 352 | 0.07427 | 327.178 | single | 501.228 | 130 | 4000 | 501.228 | 1.59627 | 2 |
| span | 1 to 2 | 55.97 | 250 | 352 | 0.0583 | 332.847 | single | 386.76 | 130 | 4000 | 386.76 | 1.23172 | 2 |
| suport | 2 | 71.27 | 250 | 352 | 0.07424 | 327.189 | single | 501 | 130 | 4000 | 501 | 1.59554 | 2 |
| suport | 2 to3 | 74.78 | 250 | 352 | 0.0779 | 325.861 | single | 527.816 | 130 | 4000 | 527.816 | 1.68094 | 2 |
| span | 2 to3 | 55.7 | 250 | 352 | 0.05802 | 332.945 | single | 384.781 | 130 | 4000 | 384.781 | 1.22542 | 2 |
| suport | 3 to 2 | 74.7 | 250 | 352 | 0.07781 | 325.892 | single | 527.203 | 130 | 4000 | 527.203 | 1.67899 | 2 |

axis H
story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 75.1 | 250 | 352 | 0.07823 | 325.74 | single | 530.273 | 130 | 4000 | 530.273 | 1.68877 | 2 |
| span | 1 to 2 | 57.92 | 250 | 352 | 0.06033 | 332.137 | single | 401.09 | 130 | 4000 | 401.09 | 1.27736 | 2 |
| suport | 2 | 75.1 | 250 | 352 | 0.07823 | 325.74 | single | 530.273 | 130 | 4000 | 530.273 | 1.68877 | 2 |
| suport | 2 to3 | 78.2 | 250 | 352 | 0.08146 | 324.556 | single | 554.176 | 130 | 4000 | 554.176 | 1.76489 | 2 |
| span | 2 to3 | 58.06 | 250 | 352 | 0.06048 | 332.086 | single | 402.121 | 130 | 4000 | 402.121 | 1.28064 | 2 |
| suport | 3 to 2 | 78.28 | 250 | 352 | 0.08154 | 324.525 | single | 554.795 | 130 | 4000 | 554.795 | 1.76686 | 2 |

axis H
story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 82 | 250 | 352 | 0.08542 | 323.092 | single | 583.738 | 130 | 4000 | 583.738 | 1.85904 | 2 |
| span | 1 to 2 | 62.55 | 250 | 352 | 0.06516 | 330.439 | single | 435.378 | 130 | 4000 | 435.378 | 1.38655 | 2 |
| suport | 2 | 82 | 250 | 352 | 0.08542 | 323.092 | single | 583.738 | 130 | 4000 | 583.738 | 1.85904 | 2 |
| suport | 2 to3 | 85 | 250 | 352 | 0.08854 | 321.926 | single | 607.286 | 130 | 4000 | 607.286 | 1.93403 | 2 |
| span | 2 to3 | 62.77 | 250 | 352 | 0.06539 | 330.358 | single | 437.016 | 130 | 4000 | 437.016 | 1.39177 | 2 |
| suport | 3 to 2 | 85 | 250 | 352 | 0.08854 | 321.926 | single | 607.286 | 130 | 4000 | 607.286 | 1.93403 | 2 |

axis H
story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 77.3 | 250 | 352 | 0.08052 | 324.901 | single | 547.217 | 130 | 4000 | 547.217 | 1.74273 | 2 |
| span | 1 to 2 | 58.96 | 250 | 352 | 0.06142 | 331.757 | single | 408.759 | 130 | 4000 | 408.759 | 1.30178 | 2 |
| suport | 2 | 77.3 | 250 | 352 | 0.08052 | 324.901 | single | 547.217 | 130 | 4000 | 547.217 | 1.74273 | 2 |
| suport | 2 to3 | 80.41 | 250 | 352 | 0.08376 | 323.706 | single | 571.333 | 130 | 4000 | 571.333 | 1.81953 | 2 |
| span | 2 to3 | 59.07 | 250 | 352 | 0.06153 | 331.717 | single | 409.571 | 130 | 4000 | 409.571 | 1.30437 | 2 |
| suport | 3 to 2 | 80.4 | 250 | 352 | 0.08375 | 323.71 | single | 571.255 | 130 | 4000 | 571.255 | 1.81928 | 2 |

axis H
story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 76.33 | 250 | 352 | 0.07951 | 325.271 | single | 539.734 | 130 | 4000 | 539.734 | 1.7189 | 2 |
| span | 1 to 2 | 56.55 | 250 | 352 | 0.05891 | 332.636 | single | 391.015 | 130 | 4000 | 391.015 | 1.24527 | 2 |
| suport | 2 | 76.33 | 250 | 352 | 0.07951 | 325.271 | single | 539.734 | 130 | 4000 | 539.734 | 1.7189 | 3 |
| suport | 2 to3 | 77.04 | 250 | 352 | 0.08025 | 325 | single | 545.209 | 130 | 4000 | 545.209 | 1.73634 | 2 |
| span | 2 to3 | 56.62 | 250 | 352 | 0.05898 | 332.611 | single | 391.529 | 130 | 4000 | 391.529 | 1.24691 | 2 |
| suport | 3 to 2 | 77.04 | 250 | 352 | 0.08025 | 325 | single | 545.209 | 130 | 4000 | 545.209 | 1.73634 | 2 |

axis H
story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 18.8 | 300 | 352 | 0.01632 | 346.855 | single | 124.664 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 1 to 2 | 12.4 | 300 | 352 | 0.01076 | 348.624 | single | 81.8078 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 | 18.8 | 300 | 352 | 0.01632 | 346.855 | single | 124.664 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 to3 | 17.94 | 300 | 352 | 0.01557 | 347.094 | single | 118.879 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 2 to3 | 12.38 | 300 | 352 | 0.01075 | 348.629 | single | 81.6746 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 3 to 2 | 17.9 | 300 | 352 | 0.01554 | 347.105 | single | 118.61 | 156 | 4800 | 156 | 0.77627 | 2 |

Table G. 8: Flexural Design for the beam on axis I for all story

axis I
story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 52.94 | 250 | 252 | 0.05515 | 239.073 | single | 509.312 | 97.5 | 3000 | 509.312 | 2.53439 | 3 |
| span | 1 to 2 | 35.99 | 250 | 252 | 0.03749 | 243.367 | single | 340.135 | 97.5 | 3000 | 340.135 | 1.69255 | 2 |
| suport | 2 | 52.94 | 250 | 252 | 0.05515 | 239.073 | single | 509.312 | 97.5 | 3000 | 509.312 | 2.53439 | 3 |
| suport | 2 to3 | 51 | 250 | 252 | 0.05313 | 239.573 | single | 489.625 | 97.5 | 3000 | 489.625 | 2.43643 | 3 |
| span | 2 to3 | 36.09 | 250 | 252 | 0.03759 | 243.342 | single | 341.114 | 97.5 | 3000 | 341.114 | 1.69742 | 2 |
| suport | 3 to 2 | 51 | 250 | 252 | 0.05313 | 239.573 | single | 489.625 | 97.5 | 3000 | 489.625 | 2.43643 | 3 |

axis I
story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 90 | 250 | 352 | 0.09375 | 319.961 | single | 646.957 | 130 | 4000 | 646.957 | 2.06037 | 3 |
| span | 1 to 2 | 59.87 | 250 | 352 | 0.06236 | 331.424 | single | 415.485 | 130 | 4000 | 415.485 | 1.3232 | 2 |
| suport | 2 | 90 | 250 | 352 | 0.09375 | 319.961 | single | 646.957 | 130 | 4000 | 646.957 | 2.06037 | 3 |
| suport | 2 to3 | 86.3 | 250 | 352 | 0.0899 | 321.418 | single | 617.549 | 130 | 4000 | 617.549 | 1.96672 | 2 |
| span | 2 to3 | 59.93 | 250 | 352 | 0.06243 | 331.402 | single | 415.929 | 130 | 4000 | 415.929 | 1.32461 | 2 |
| suport | 3 to 2 | 86.3 | 250 | 352 | 0.0899 | 321.418 | single | 617.549 | 130 | 4000 | 617.549 | 1.96672 | 2 |

axis I
story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 92.14 | 250 | 352 | 0.09598 | 319.112 | single | 664.102 | 130 | 4000 | 664.102 | 2.11498 | 3 |
| span | 1 to 2 | 62.3 | 250 | 352 | 0.0649 | 330.531 | single | 433.517 | 130 | 4000 | 433.517 | 1.38063 | 2 |
| suport | 2 | 92.14 | 250 | 352 | 0.09598 | 319.112 | single | 664.102 | 130 | 4000 | 664.102 | 2.11498 | 3 |
| suport | 2 to3 | 88.49 | 250 | 352 | 0.09218 | 320.558 | single | 634.92 | 130 | 4000 | 634.92 | 2.02204 | 3 |
| span | 2 to3 | 62.44 | 250 | 352 | 0.06504 | 330.48 | single | 434.559 | 130 | 4000 | 434.559 | 1.38394 | 2 |
| suport | 3 to 2 | 88.49 | 250 | 352 | 0.09218 | 320.558 | single | 634.92 | 130 | 4000 | 634.92 | 2.02204 | 3 |

axis I
story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 97.2 | 250 | 352 | 0.10125 | 317.084 | single | 705.053 | 130 | 4000 | 705.053 | 2.24539 | 3 |
| span | 1 to 2 | 67.5 | 250 | 352 | 0.07031 | 328.603 | single | 472.458 | 130 | 4000 | 472.458 | 1.50464 | 2 |
| suport | 2 | 97.2 | 250 | 352 | 0.10125 | 317.084 | single | 705.053 | 130 | 4000 | 705.053 | 2.24539 | 3 |
| suport | 2 to3 | 93.67 | 250 | 352 | 0.09757 | 318.502 | single | 676.423 | 130 | 4000 | 676.423 | 2.15421 | 3 |
| span | 2 to3 | 67.56 | 250 | 352 | 0.07038 | 328.581 | single | 472.91 | 130 | 4000 | 472.91 | 1.50608 | 2 |
| suport | 3 to 2 | 93.67 | 250 | 352 | 0.09757 | 318.502 | single | 676.423 | 130 | 4000 | 676.423 | 2.15421 | 3 |

axis I
story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 91.41 | 250 | 352 | 0.09522 | 319.403 | single | 658.242 | 130 | 4000 | 658.242 | 2.09631 | 3 |
| span | 1 to 2 | 63.34 | 250 | 352 | 0.06598 | 330.148 | single | 441.266 | 130 | 4000 | 441.266 | 1.40531 | 2 |
| suport | 2 | 91.43 | 250 | 352 | 0.09524 | 319.395 | single | 658.403 | 130 | 4000 | 658.403 | 2.09682 | 3 |
| suport | 2 to3 | 88.8 | 250 | 352 | 0.0925 | 320.435 | single | 637.387 | 130 | 4000 | 637.387 | 2.02989 | 3 |
| span | 2 to3 | 63.64 | 250 | 352 | 0.06629 | 330.037 | single | 443.505 | 130 | 4000 | 443.505 | 1.41244 | 2 |
| suport | 3 to 2 | 88.8 | 250 | 352 | 0.0925 | 320.435 | single | 637.387 | 130 | 4000 | 637.387 | 2.02989 | 3 |

axis I
story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 85.5 | 250 | 352 | 0.08906 | 321.731 | single | 611.229 | 130 | 4000 | 611.229 | 1.94659 | 2 |
| span | 1 to 2 | 60.4 | 250 | 352 | 0.06292 | 331.23 | single | 419.409 | 130 | 4000 | 419.409 | 1.3357 | 2 |
| suport | 2 | 85.5 | 250 | 352 | 0.08906 | 321.731 | single | 611.229 | 130 | 4000 | 611.229 | 1.94659 | 2 |
| suport | 2 to3 | 86.2 | 250 | 352 | 0.08979 | 321.457 | single | 616.758 | 130 | 4000 | 616.758 | 1.9642 | 2 |
| span | 2 to3 | 60.4 | 250 | 352 | 0.06292 | 331.23 | single | 419.409 | 130 | 4000 | 419.409 | 1.3357 | 2 |
| suport | 3 to 2 | 86.2 | 250 | 352 | 0.08979 | 321.457 | single | 616.758 | 130 | 4000 | 616.758 | 1.9642 | 2 |

axis I
story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | 1 | 21.3 | 300 | 352 | 0.01849 | 346.159 | single | 141.525 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 1 to 2 | 15.1 | 300 | 352 | 0.01311 | 347.88 | single | 99.8339 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 | 21.3 | 300 | 352 | 0.01849 | 346.159 | single | 141.525 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 2 to3 | 21.3 | 300 | 352 | 0.01849 | 346.159 | single | 141.525 | 156 | 4800 | 156 | 0.77627 | 2 |
| span | 2 to3 | 15.14 | 300 | 352 | 0.01314 | 347.869 | single | 100.102 | 156 | 4800 | 156 | 0.77627 | 2 |
| suport | 3 to 2 | 21.3 | 300 | 352 | 0.01849 | 346.159 | single | 141.525 | 156 | 4800 | 156 | 0.77627 | 2 |

Table G. 9: Flexural Design for the beam on axis 1 for all story

axis 1
story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 48 | 250 | 252 | 0.05 | 240.341 | single | 459.35 | 97.5 | 3000 | 459.35 | 2.28578 | 3 |
| span | b to c | 30.2 | 250 | 252 | 0.03146 | 244.798 | single | 283.746 | 97.5 | 3000 | 283.746 | 1.41195 | 2 |
| suport | c | 48 | 250 | 252 | 0.05 | 240.341 | single | 459.35 | 97.5 | 3000 | 459.35 | 2.28578 | 3 |
| suport | c to d | 46.9 | 250 | 252 | 0.04885 | 240.622 | single | 448.3 | 97.5 | 3000 | 448.3 | 2.23079 | 3 |
| span | c tod | 31 | 250 | 252 | 0.03229 | 244.601 | single | 291.496 | 97.5 | 3000 | 291.496 | 1.45052 | 2 |
| suport | d | 46.9 | 250 | 252 | 0.04885 | 240.622 | single | 448.3 | 97.5 | 3000 | 448.3 | 2.23079 | 3 |
| suport | d to e | 44.9 | 250 | 252 | 0.04677 | 241.13 | single | 428.278 | 97.5 | 3000 | 428.278 | 2.13116 | 3 |
| span | d to e | 30.9 | 250 | 252 | 0.03219 | 244.626 | single | 290.527 | 97.5 | 3000 | 290.527 | 1.44569 | 2 |
| suport | e | 44.9 | 250 | 252 | 0.04677 | 241.13 | single | 428.278 | 97.5 | 3000 | 428.278 | 2.13116 | 3 |
| suport | e to f | 45.02 | 250 | 252 | 0.0469 | 241.099 | single | 429.477 | 97.5 | 3000 | 429.477 | 2.13713 | 3 |
| span | e to f | 30.8 | 250 | 252 | 0.03208 | 244.651 | single | 289.557 | 97.5 | 3000 | 289.557 | 1.44087 | 2 |
| suport | f | 44.9 | 250 | 252 | 0.04677 | 241.13 | single | 428.278 | 97.5 | 3000 | 428.278 | 2.13116 | 3 |
| suport | f to g | 44.9 | 250 | 252 | 0.04677 | 241.13 | single | 428.278 | 97.5 | 3000 | 428.278 | 2.13116 | 3 |
| span | f to g | 30.9 | 250 | 252 | 0.03219 | 244.626 | single | 290.527 | 97.5 | 3000 | 290.527 | 1.44569 | 2 |
| suport | g | 44.9 | 250 | 252 | 0.04677 | 241.13 | single | 428.278 | 97.5 | 3000 | 428.278 | 2.13116 | 3 |
| suport | g to h | 45.9 | 250 | 252 | 0.04781 | 240.876 | single | 438.278 | 97.5 | 3000 | 438.278 | 2.18092 | 3 |
| span | g to h | 31 | 250 | 252 | 0.03229 | 244.601 | single | 291.496 | 97.5 | 3000 | 291.496 | 1.45052 | 2 |
| suport | h | 45.9 | 250 | 252 | 0.04781 | 240.876 | single | 438.278 | 97.5 | 3000 | 438.278 | 2.18092 | 3 |
| suport | h to i | 47.99 | 250 | 252 | 0.04999 | 240.344 | single | 459.249 | 97.5 | 3000 | 459.249 | 2.28528 | 3 |
| span | h to i | 30.26 | 250 | 252 | 0.03152 | 244.783 | single | 284.327 | 97.5 | 3000 | 284.327 | 1.41484 | 2 |
| suport | i | 47.99 | 250 | 252 | 0.04999 | 240.344 | single | 459.249 | 97.5 | 3000 | 459.249 | 2.28528 | 3 |

axis 1
story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 103.5 | 250 | 352 | 0.10781 | 314.518 | single | 756.877 | 130 | 4000 | 756.877 | 2.41044 | 3 |
| span | b to c | 68.1 | 250 | 352 | 0.07094 | 328.379 | single | 476.982 | 130 | 4000 | 476.982 | 1.51905 | 2 |
| suport | c | 103.5 | 250 | 352 | 0.10781 | 314.518 | single | 756.877 | 130 | 4000 | 756.877 | 2.41044 | 3 |
| suport | c to d | 103.1 | 250 | 352 | 0.1074 | 314.682 | single | 753.558 | 130 | 4000 | 753.558 | 2.39987 | 3 |
| span | c tod | 67.89 | 250 | 352 | 0.07072 | 328.457 | single | 475.398 | 130 | 4000 | 475.398 | 1.51401 | 2 |
| suport | d | 103.1 | 250 | 352 | 0.1074 | 314.682 | single | 753.558 | 130 | 4000 | 753.558 | 2.39987 | 3 |
| suport | d to e | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| span | d to e | 67.98 | 250 | 352 | 0.07081 | 328.424 | single | 476.077 | 130 | 4000 | 476.077 | 1.51617 | 2 |
| suport | e | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| suport | e to f | 100.2 | 250 | 352 | 0.10438 | 315.868 | single | 729.613 | 130 | 4000 | 729.613 | 2.32361 | 3 |
| span | e to f | 67.8 | 250 | 352 | 0.07063 | 328.491 | single | 474.719 | 130 | 4000 | 474.719 | 1.51184 | 2 |
| suport | f | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| suport | f to g | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| span | f to g | 67.98 | 250 | 352 | 0.07081 | 328.424 | single | 476.077 | 130 | 4000 | 476.077 | 1.51617 | 2 |
| suport | g | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| suport | g to h | 103 | 250 | 352 | 0.10729 | 314.723 | single | 752.729 | 130 | 4000 | 752.729 | 2.39723 | 3 |
| span | g to h | 67.89 | 250 | 352 | 0.07072 | 328.457 | single | 475.398 | 130 | 4000 | 475.398 | 1.51401 | 2 |
| suport | h | 103 | 250 | 352 | 0.10729 | 314.723 | single | 752.729 | 130 | 4000 | 752.729 | 2.39723 | 3 |
| suport | h to i | 130.7 | 250 | 352 | 0.13615 | 302.843 | single | 992.633 | 130 | 4000 | 992.633 | 3.16125 | 3 |
| span | h to i | 68.1 | 250 | 352 | 0.07094 | 328.379 | single | 476.982 | 130 | 4000 | 476.982 | 1.51905 | 2 |
| suport | i | 103.76 | 250 | 352 | 0.10808 | 314.411 | single | 759.037 | 130 | 4000 | 759.037 | 2.41731 | 3 |

axis 1
story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 81.12 | 250 | 352 | 0.0845 | 323.432 | single | 576.866 | 130 | 4000 | 576.866 | 1.83715 | 2 |
| span | b to c | 51 | 250 | 352 | 0.05313 | 334.641 | single | 350.527 | 130 | 4000 | 350.527 | 1.11633 | 2 |
| suport | c | 81.12 | 250 | 352 | 0.0845 | 323.432 | single | 576.866 | 130 | 4000 | 576.866 | 1.83715 | 2 |
| suport | c to d | 106.6 | 250 | 352 | 0.11104 | 313.237 | single | 782.734 | 130 | 4000 | 782.734 | 2.49278 | 3 |
| span | c tod | 72.35 | 250 | 352 | 0.07536 | 326.782 | single | 509.226 | 130 | 4000 | 509.226 | 1.62174 | 2 |
| suport | d | 106.6 | 250 | 352 | 0.11104 | 313.237 | single | 782.734 | 130 | 4000 | 782.734 | 2.49278 | 3 |
| suport | d to e | 105.84 | 250 | 352 | 0.11025 | 313.552 | single | 776.372 | 130 | 4000 | 776.372 | 2.47252 | 3 |
| span | d to e | 71.88 | 250 | 352 | 0.07488 | 326.96 | single | 505.644 | 130 | 4000 | 505.644 | 1.61033 | 2 |
| suport | e | 105.84 | 250 | 352 | 0.11025 | 313.552 | single | 776.372 | 130 | 4000 | 776.372 | 2.47252 | 3 |
| suport | e to f | 105.99 | 250 | 352 | 0.11041 | 313.49 | single | 777.627 | 130 | 4000 | 777.627 | 2.47652 | 3 |
| span | e to f | 71.63 | 250 | 352 | 0.07461 | 327.054 | single | 503.74 | 130 | 4000 | 503.74 | 1.60427 | 2 |
| suport | f | 105.99 | 250 | 352 | 0.11041 | 313.49 | single | 777.627 | 130 | 4000 | 777.627 | 2.47652 | 3 |
| suport | f to g | 105.86 | 250 | 352 | 0.11027 | 313.544 | single | 776.54 | 130 | 4000 | 776.54 | 2.47306 | 3 |
| span | f to g | 71.87 | 250 | 352 | 0.07486 | 326.963 | single | 505.567 | 130 | 4000 | 505.567 | 1.61009 | 2 |
| suport | g | 105.86 | 250 | 352 | 0.11027 | 313.544 | single | 776.54 | 130 | 4000 | 776.54 | 2.47306 | 3 |
| suport | g to h | 106.74 | 250 | 352 | 0.11119 | 313.179 | single | 783.907 | 130 | 4000 | 783.907 | 2.49652 | 3 |
| span | g to h | 72.37 | 250 | 352 | 0.07539 | 326.775 | single | 509.379 | 130 | 4000 | 509.379 | 1.62223 | 2 |
| suport | h | 106.74 | 250 | 352 | 0.11119 | 313.179 | single | 783.907 | 130 | 4000 | 783.907 | 2.49652 | 3 |
| suport | h to i | 81 | 250 | 352 | 0.08438 | 323.479 | single | 575.93 | 130 | 4000 | 575.93 | 1.83417 | 2 |
| span | h to i | 51.05 | 250 | 352 | 0.05318 | 334.623 | single | 350.889 | 130 | 4000 | 350.889 | 1.11748 | 2 |
| suport | i | 81 | 250 | 352 | 0.08438 | 323.479 | single | 575.93 | 130 | 4000 | 575.93 | 1.83417 | 3 |

axis 1
story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 61.04 | 250 | 352 | 0.06358 | 330.995 | single | 424.154 | 130 | 4000 | 424.154 | 1.35081 | 2 |
| span | b to c | 33.13 | 250 | 352 | 0.03451 | 340.932 | single | 223.504 | 130 | 4000 | 223.504 | 0.71179 | 2 |
| suport | c | 61.04 | 250 | 352 | 0.06358 | 330.995 | single | 424.154 | 130 | 4000 | 424.154 | 1.35081 | 2 |
| suport | c to d | 109.07 | 250 | 352 | 0.11361 | 312.209 | single | 803.509 | 130 | 4000 | 803.509 | 2.55895 | 3 |
| span | c tod | 76.8 | 250 | 352 | 0.08 | 325.092 | single | 543.357 | 130 | 4000 | 543.357 | 1.73044 | 2 |
| suport | d | 109.07 | 250 | 352 | 0.11361 | 312.209 | single | 803.509 | 130 | 4000 | 803.509 | 2.55895 | 3 |
| suport | d to e | 109.85 | 250 | 352 | 0.11443 | 311.882 | single | 810.103 | 130 | 4000 | 810.103 | 2.57994 | 3 |
| span | d to e | 73.7 | 250 | 352 | 0.07677 | 326.271 | single | 519.54 | 130 | 4000 | 519.54 | 1.65459 | 2 |
| suport | e | 109.85 | 250 | 352 | 0.11443 | 311.882 | single | 810.103 | 130 | 4000 | 810.103 | 2.57994 | 3 |
| suport | e to f | 108.8 | 250 | 352 | 0.11333 | 312.321 | single | 801.231 | 130 | 4000 | 801.231 | 2.55169 | 3 |
| span | e to f | 73.95 | 250 | 352 | 0.07703 | 326.177 | single | 521.454 | 130 | 4000 | 521.454 | 1.66068 | 2 |
| suport | f | 108.8 | 250 | 352 | 0.11333 | 312.321 | single | 801.231 | 130 | 4000 | 801.231 | 2.55169 | 3 |
| suport | f to g | 109.68 | 250 | 352 | 0.11425 | 311.953 | single | 808.664 | 130 | 4000 | 808.664 | 2.57536 | 3 |
| span | f to g | 73.76 | 250 | 352 | 0.07683 | 326.249 | single | 519.999 | 130 | 4000 | 519.999 | 1.65605 | 2 |
| suport | g | 109.68 | 250 | 352 | 0.11425 | 311.953 | single | 808.664 | 130 | 4000 | 808.664 | 2.57536 | 3 |
| suport | g to h | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| span | g to h | 76.6 | 250 | 352 | 0.07979 | 325.168 | single | 541.815 | 130 | 4000 | 541.815 | 1.72553 | 2 |
| suport | h | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| suport | h to i | 61.03 | 250 | 352 | 0.06357 | 330.999 | single | 424.08 | 130 | 4000 | 424.08 | 1.35057 | 2 |
| span | h to i | 32.8 | 250 | 352 | 0.03417 | 341.046 | single | 221.203 | 130 | 4000 | 221.203 | 0.70447 | 2 |
| suport | i | 61.03 | 250 | 352 | 0.06357 | 330.999 | single | 424.08 | 130 | 4000 | 424.08 | 1.35057 | 2 |

axis 1
story 3

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 61.7 | 250 | 352 | 0.064271 | 330.7523 | single | 429.0547 | 130 | 4000 | 429.0547 | 1.366416 | 2 |
| span | b to c | 33.6 | 250 | 352 | 0.035 | 340.7693 | single | 226.7824 | 130 | 4000 | 226.7824 | 0.722237 | 2 |
| suport | c | 61.7 | 250 | 352 | 0.064271 | 330.7523 | single | 429.0547 | 130 | 4000 | 429.0547 | 1.366416 | 2 |
| suport | c to d | 87.65 | 250 | 352 | 0.091302 | 320.8881 | single | 628.2447 | 130 | 4000 | 628.2447 | 2.000779 | 3 |
| span | c tod | 51.99 | 250 | 352 | 0.054156 | 334.2854 | single | 357.7115 | 130 | 4000 | 357.7115 | 1.139208 | 2 |
| suport | d | 87.65 | 250 | 352 | 0.091302 | 320.8881 | single | 628.2447 | 130 | 4000 | 628.2447 | 2.000779 | 3 |
| suport | d to e | 107.7 | 250 | 352 | 0.112188 | 312.7802 | single | 791.9666 | 130 | 4000 | 791.9666 | 2.522187 | 3 |
| span | d to e | 73.34 | 250 | 352 | 0.076396 | 326.4077 | single | 516.7863 | 130 | 4000 | 516.7863 | 1.645816 | 2 |
| suport | e | 107.7 | 250 | 352 | 0.112188 | 312.7802 | single | 791.9666 | 130 | 4000 | 791.9666 | 2.522187 | 3 |
| suport | e to f | 106.9 | 250 | 352 | 0.111354 | 313.1129 | single | 785.2486 | 130 | 4000 | 785.2486 | 2.500792 | 3 |
| span | e to f | 72.13 | 250 | 352 | 0.075135 | 326.8652 | single | 507.5487 | 130 | 4000 | 507.5487 | 1.616397 | 2 |
| suport | f | 106.9 | 250 | 352 | 0.111354 | 313.1129 | single | 785.2486 | 130 | 4000 | 785.2486 | 2.500792 | 3 |
| suport | f to g | 107.61 | 250 | 352 | 0.112094 | 312.8177 | single | 791.21 | 130 | 4000 | 791.21 | 2.519777 | 3 |
| span | f to g | 73.16 | 250 | 352 | 0.076208 | 326.4758 | single | 515.4103 | 130 | 4000 | 515.4103 | 1.641434 | 2 |
| suport | g | 107.61 | 250 | 352 | 0.112094 | 312.8177 | single | 791.21 | 130 | 4000 | 791.21 | 2.519777 | 3 |
| suport | g to h | 90.9 | 250 | 352 | 0.094688 | 319.6049 | single | 654.1553 | 130 | 4000 | 654.1553 | 2.083297 | 3 |
| span | g to h | 56.9 | 250 | 352 | 0.059271 | 332.5088 | single | 393.5859 | 130 | 4000 | 393.5859 | 1.253458 | 2 |
| suport | h | 90.9 | 250 | 352 | 0.094688 | 319.6049 | single | 654.1553 | 130 | 4000 | 654.1553 | 2.083297 | 3 |
| suport | h to i | 59.89 | 250 | 352 | 0.062385 | 331.417 | single | 415.6329 | 130 | 4000 | 415.6329 | 1.323672 | 2 |
| span | h to i | 33.7 | 250 | 352 | 0.035104 | 340.7347 | single | 227.4804 | 130 | 4000 | 227.4804 | 0.72446 | 2 |
| suport | i | 59.89 | 250 | 352 | 0.062385 | 331.417 | single | 415.6329 | 130 | 4000 | 415.6329 | 1.323672 | 2 |

axis 1
story 2

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 58.9 | 250 | 352 | 0.061354 | 331.7794 | single | 408.316 | 130 | 4000 | 408.316 | 1.300369 | 2 |
| span | b to c | 33 | 250 | 352 | 0.034375 | 340.9765 | single | 222.5973 | 130 | 4000 | 222.5973 | 0.708909 | 2 |
| suport | c | 58.9 | 250 | 352 | 0.061354 | 331.7794 | single | 408.316 | 130 | 4000 | 408.316 | 1.300369 | 2 |
| suport | c to d | 51.62 | 250 | 352 | 0.053771 | 334.4185 | single | 355.0244 | 130 | 4000 | 355.0244 | 1.130651 | 2 |
| span | c tod | 35.43 | 250 | 352 | 0.036906 | 340.1355 | single | 239.5795 | 130 | 4000 | 239.5795 | 0.762992 | 2 |
| suport | d | 51.6 | 250 | 352 | 0.05375 | 334.4257 | single | 354.8792 | 130 | 4000 | 354.8792 | 1.130189 | 2 |
| suport | d to e | 50.7 | 250 | 352 | 0.052813 | 334.7489 | single | 348.3528 | 130 | 4000 | 348.3528 | 1.109404 | 2 |
| span | d to e | 35.11 | 250 | 352 | 0.036573 | 340.2465 | single | 237.3382 | 130 | 4000 | 237.3382 | 0.755854 | 2 |
| suport | e | 50.7 | 250 | 352 | 0.052813 | 334.7489 | single | 348.3528 | 130 | 4000 | 348.3528 | 1.109404 | 2 |
| suport | e to f | 50.1 | 250 | 352 | 0.052188 | 334.964 | single | 344.0092 | 130 | 4000 | 344.0092 | 1.095571 | 2 |
| span | e to f | 35.19 | 250 | 352 | 0.036656 | 340.2188 | single | 237.8983 | 130 | 4000 | 237.8983 | 0.757638 | 2 |
| suport | f | 50.1 | 250 | 352 | 0.052188 | 334.964 | single | 344.0092 | 130 | 4000 | 344.0092 | 1.095571 | 2 |
| suport | f to g | 50.5 | 250 | 352 | 0.052604 | 334.8206 | single | 346.9043 | 130 | 4000 | 346.9043 | 1.104791 | 2 |
| span | f to g | 35.1 | 250 | 352 | 0.036563 | 340.25 | single | 237.2681 | 130 | 4000 | 237.2681 | 0.755631 | 2 |
| suport | g | 50.5 | 250 | 352 | 0.052604 | 334.8206 | single | 346.9043 | 130 | 4000 | 346.9043 | 1.104791 | 2 |
| suport | g to h | 51.2 | 250 | 352 | 0.053333 | 334.5694 | single | 351.9769 | 130 | 4000 | 351.9769 | 1.120946 | 2 |
| span | g to h | 35.45 | 250 | 352 | 0.036927 | 340.1286 | single | 239.7196 | 130 | 4000 | 239.7196 | 0.763438 | 2 |
| suport | h | 51.2 | 250 | 352 | 0.053333 | 334.5694 | single | 351.9769 | 130 | 4000 | 351.9769 | 1.120946 | 2 |
| suport | h to i | 59.45 | 250 | 352 | 0.061927 | 331.5782 | single | 412.3788 | 130 | 4000 | 412.3788 | 1.313308 | 2 |
| span | h to i | 33 | 250 | 352 | 0.034375 | 340.9765 | single | 222.5973 | 130 | 4000 | 222.5973 | 0.708909 | 2 |
| suport | i | 59.45 | 250 | 352 | 0.061927 | 331.5782 | single | 412.3788 | 130 | 4000 | 412.3788 | 1.313308 | 2 |

axis 1
story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 25.7 | 300 | 352 | 0.022309 | 344.9278 | single | 171.3702 | 156 | 4000 | 171.3702 | 0.545765 | 2 |
| span | b to c | 13.5 | 300 | 352 | 0.011719 | 348.3212 | single | 89.14239 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | c | 25.7 | 300 | 352 | 0.022309 | 344.9278 | single | 171.3702 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | c to d | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | c tod | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | d | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | d to e | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | d to e | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | e | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | e to f | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | e to f | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | f | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | f to g | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | f to g | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | g | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | g to h | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | g to h | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | h | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | h to i | 24.8 | 300 | 352 | 0.021528 | 345.1805 | single | 165.2479 | 156 | 4000 | 165.9195 | 0.528406 | 2 |
| span | h to i | 13.5 | 300 | 352 | 0.011719 | 348.3212 | single | 89.14239 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | i | 24.8 | 300 | 352 | 0.021528 | 345.1805 | single | 165.2479 | 156 | 4000 | 165.2479 | 0.526267 | 2 |

Table G. 10: Flexural Design for the beam on axis 2 for all story

axis 2
story 7

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | A | 22.2 | 250 | 254 | 0.02313 | 248.706 | single | 205.304 | 97.5 | 3000 | 205.304 | 1.02192 | 2 |
| span | a tob | 12.24 | 250 | 254 | 0.01275 | 251.109 | single | 112.111 | 97.5 | 3000 | 112.111 | 0.55805 | 2 |
| suport | b | 22.2 | 250 | 254 | 0.02313 | 248.706 | single | 205.304 | 97.5 | 3000 | 205.304 | 1.02192 | 2 |
| suport | b to c | 44.91 | 250 | 254 | 0.04678 | 243.041 | single | 425.005 | 97.5 | 3000 | 425.005 | 2.11551 | 3 |
| span | b to c | 32.7 | 250 | 254 | 0.03406 | 246.12 | single | 305.584 | 97.5 | 3000 | 305.584 | 1.52108 | 2 |
| suport | c | 44.91 | 250 | 254 | 0.04678 | 243.041 | single | 425.005 | 97.5 | 3000 | 425.005 | 2.11551 | 3 |
| suport | c to d | 44.36 | 250 | 254 | 0.04621 | 243.181 | single | 419.558 | 97.5 | 3000 | 419.558 | 2.08839 | 3 |
| span | c tod | 32 | 250 | 254 | 0.03333 | 246.294 | single | 298.831 | 97.5 | 3000 | 298.831 | 1.48746 | 2 |
| suport | d | 44.36 | 250 | 254 | 0.04621 | 243.181 | single | 419.558 | 97.5 | 3000 | 419.558 | 2.08839 | 3 |
| suport | d to e | 45 | 250 | 254 | 0.04688 | 243.018 | single | 425.897 | 97.5 | 3000 | 425.897 | 2.11995 | 3 |
| span | d to e | 32.6 | 250 | 254 | 0.03396 | 246.145 | single | 304.619 | 97.5 | 3000 | 304.619 | 1.51627 | 2 |
| suport | d | 45.02 | 250 | 254 | 0.0469 | 243.013 | single | 426.095 | 97.5 | 3000 | 426.095 | 2.12093 | 3 |
| suport | e to f | 27.9 | 250 | 254 | 0.02906 | 247.309 | single | 259.474 | 97.5 | 3000 | 259.474 | 1.29156 | 2 |
| span | e to f | 17.63 | 250 | 254 | 0.01836 | 249.815 | single | 162.317 | 97.5 | 3000 | 162.317 | 0.80795 | 2 |
| suport | f | 27.96 | 250 | 254 | 0.02913 | 247.294 | single | 260.048 | 97.5 | 3000 | 260.048 | 1.29441 | 2 |
| suport | f to g | 45 | 250 | 254 | 0.04688 | 243.018 | single | 425.897 | 97.5 | 3000 | 425.897 | 2.11995 | 3 |
| span | f to g | 32.6 | 250 | 254 | 0.03396 | 246.145 | single | 304.619 | 97.5 | 3000 | 304.619 | 1.51627 | 2 |
| suport | g | 45 | 250 | 254 | 0.04688 | 243.018 | single | 425.897 | 97.5 | 3000 | 425.897 | 2.11995 | 3 |
| suport | g t o h | 44.3 | 250 | 254 | 0.04615 | 243.197 | single | 418.964 | 97.5 | 3000 | 418.964 | 2.08543 | 3 |
| span | g to h | 32 | 250 | 254 | 0.03333 | 246.294 | single | 298.831 | 97.5 | 3000 | 298.831 | 1.48746 | 2 |
| suport | h | 44.3 | 250 | 254 | 0.04615 | 243.197 | single | 418.964 | 97.5 | 3000 | 418.964 | 2.08543 | 3 |
| suport | h to i | 44.9 | 250 | 254 | 0.04677 | 243.043 | single | 424.906 | 97.5 | 3000 | 424.906 | 2.11501 | 3 |
| span | h to i | 32.7 | 250 | 254 | 0.03406 | 246.12 | single | 305.584 | 97.5 | 3000 | 305.584 | 1.52108 | 2 |
| suport | i | 44.9 | 250 | 254 | 0.04677 | 243.043 | single | 424.906 | 97.5 | 3000 | 424.906 | 2.11501 | 3 |
| suport | I to j | 22.2 | 250 | 254 | 0.02313 | 248.706 | single | 205.304 | 97.5 | 3000 | 205.304 | 1.02192 | 2 |
| span | I to j | 12.4 | 250 | 254 | 0.01292 | 251.071 | single | 113.594 | 97.5 | 3000 | 113.594 | 0.56543 | 2 |
| suport | j | 22.2 | 250 | 254 | 0.02313 | 248.706 | single | 205.304 | 97.5 | 3000 | 205.304 | 1.02192 | 2 |

axis 2
story 6

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | A | 39.78 | 250 | 352 | 0.04144 | 338.619 | single | 270.199 | 130 | 3000 | 270.199 | 0.86051 | 2 |
| span | a tob | 12.87 | 250 | 352 | 0.01341 | 347.785 | single | 85.1134 | 130 | 3000 | 85.1134 | 0.27106 | 2 |
| suport | b | 39.78 | 250 | 352 | 0.04144 | 338.619 | single | 270.199 | 130 | 3000 | 270.199 | 0.86051 | 2 |
| suport | b to c | 74.45 | 250 | 352 | 0.07755 | 325.987 | single | 525.285 | 130 | 3000 | 525.285 | 1.67288 | 2 |
| span | b to c | 54.43 | 250 | 352 | 0.0567 | 333.405 | single | 375.488 | 130 | 3000 | 375.488 | 1.19582 | 2 |
| suport | c | 74.45 | 250 | 352 | 0.07755 | 325.987 | single | 525.285 | 130 | 3000 | 525.285 | 1.67288 | 2 |
| suport | c to d | 73.9 | 250 | 352 | 0.07698 | 326.196 | single | 521.071 | 130 | 3000 | 521.071 | 1.65946 | 2 |
| span | c tod | 53.1 | 250 | 352 | 0.05531 | 333.886 | single | 365.786 | 130 | 3000 | 365.786 | 1.16492 | 2 |
| suport | d | 73.92 | 250 | 352 | 0.077 | 326.188 | single | 521.224 | 130 | 3000 | 521.224 | 1.65995 | 2 |
| suport | d to e | 76.8 | 250 | 352 | 0.08 | 325.092 | single | 543.357 | 130 | 3000 | 543.357 | 1.73044 | 2 |
| span | d to e | 53.92 | 250 | 352 | 0.05617 | 333.589 | single | 371.765 | 130 | 3000 | 371.765 | 1.18396 | 2 |
| suport | d | 76.833 | 250 | 352 | 0.08003 | 325.079 | single | 543.612 | 130 | 3000 | 543.612 | 1.73125 | 2 |
| suport | e to f | 48.33 | 250 | 352 | 0.05034 | 335.597 | single | 331.23 | 130 | 3000 | 331.23 | 1.05487 | 2 |
| span | e to f | 30.3 | 250 | 352 | 0.03156 | 341.906 | single | 203.829 | 130 | 3000 | 203.829 | 0.64914 | 2 |
| suport | f | 48.33 | 250 | 352 | 0.05034 | 335.597 | single | 331.23 | 130 | 3000 | 331.23 | 1.05487 | 2 |
| suport | f to g | 76.84 | 250 | 352 | 0.08004 | 325.077 | single | 543.666 | 130 | 3000 | 543.666 | 1.73142 | 2 |
| span | f to g | 53.9 | 250 | 352 | 0.05615 | 333.597 | single | 371.619 | 130 | 3000 | 371.619 | 1.1835 | 2 |
| suport | g | 76.81 | 250 | 352 | 0.08001 | 325.088 | single | 543.435 | 130 | 3000 | 543.435 | 1.73068 | 2 |
| suport | g t o h | 73.9 | 250 | 352 | 0.07698 | 326.196 | single | 521.071 | 130 | 3000 | 521.071 | 1.65946 | 2 |
| span | g to h | 53.15 | 250 | 352 | 0.05536 | 333.867 | single | 366.15 | 130 | 3000 | 366.15 | 1.16608 | 2 |
| suport | h | 73.93 | 250 | 352 | 0.07701 | 326.184 | single | 521.301 | 130 | 3000 | 521.301 | 1.66019 | 2 |
| suport | h to i | 74.4 | 250 | 352 | 0.0775 | 326.006 | single | 524.902 | 130 | 3000 | 524.902 | 1.67166 | 2 |
| span | h to i | 54.1 | 250 | 352 | 0.05635 | 333.524 | single | 373.078 | 130 | 3000 | 373.078 | 1.18815 | 2 |
| suport | i | 74.4 | 250 | 352 | 0.0775 | 326.006 | single | 524.902 | 130 | 3000 | 524.902 | 1.67166 | 2 |
| suport | I to j | 39.77 | 250 | 352 | 0.04143 | 338.623 | single | 270.128 | 130 | 3000 | 270.128 | 0.86028 | 2 |
| span | I to j | 22.87 | 250 | 352 | 0.02382 | 344.437 | single | 152.717 | 130 | 3000 | 152.717 | 0.48636 | 2 |
| suport | j | 39.77 | 250 | 352 | 0.04143 | 338.623 | single | 270.128 | 130 | 3000 | 270.128 | 0.86028 | 2 |

axis 2
story 5

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | A | 41.23 | 250 | 352 | 0.04295 | 338.111 | single | 280.469 | 130 | 3000 | 280.469 | 0.89321 | 2 |
| span | a tob | 23.38 | 250 | 352 | 0.02435 | 344.265 | single | 156.201 | 130 | 3000 | 156.201 | 0.49745 | 2 |
| suport | b | 41.23 | 250 | 352 | 0.04295 | 338.111 | single | 280.469 | 130 | 3000 | 280.469 | 0.89321 | 2 |
| suport | b to c | 77.45 | 250 | 352 | 0.08068 | 324.843 | single | 548.375 | 130 | 3000 | 548.375 | 1.74642 | 2 |
| span | b to c | 56.25 | 250 | 352 | 0.05859 | 332.745 | single | 388.813 | 130 | 3000 | 388.813 | 1.23826 | 2 |
| suport | c | 77.45 | 250 | 352 | 0.08068 | 324.843 | single | 548.375 | 130 | 3000 | 548.375 | 1.74642 | 2 |
| suport | c to d | 76.65 | 250 | 352 | 0.07984 | 325.149 | single | 542.201 | 130 | 3000 | 542.201 | 1.72675 | 2 |
| span | c tod | 55.16 | 250 | 352 | 0.05746 | 333.141 | single | 380.826 | 130 | 3000 | 380.826 | 1.21282 | 2 |
| suport | d | 76.65 | 250 | 352 | 0.07984 | 325.149 | single | 542.201 | 130 | 3000 | 542.201 | 1.72675 | 2 |
| suport | d to e | 78.8 | 250 | 352 | 0.08208 | 324.326 | single | 558.824 | 130 | 3000 | 558.824 | 1.77969 | 2 |
| span | d to e | 56.12 | 250 | 352 | 0.05846 | 332.792 | single | 387.86 | 130 | 3000 | 387.86 | 1.23522 | 2 |
| suport | d | 76.833 | 250 | 352 | 0.08003 | 325.079 | single | 543.612 | 130 | 3000 | 543.612 | 1.73125 | 2 |
| suport | e to f | 49.9 | 250 | 352 | 0.05198 | 335.036 | single | 342.563 | 130 | 3000 | 342.563 | 1.09096 | 2 |
| span | e to f | 31.13 | 250 | 352 | 0.03243 | 341.621 | single | 209.587 | 130 | 3000 | 209.587 | 0.66748 | 2 |
| suport | f | 49.9 | 250 | 352 | 0.05198 | 335.036 | single | 342.563 | 130 | 3000 | 342.563 | 1.09096 | 2 |
| suport | f to g | 78.7 | 250 | 352 | 0.08198 | 324.364 | single | 558.049 | 130 | 3000 | 558.049 | 1.77723 | 2 |
| span | f to g | 56.12 | 250 | 352 | 0.05846 | 332.792 | single | 387.86 | 130 | 3000 | 387.86 | 1.23522 | 2 |
| suport | g | 78.7 | 250 | 352 | 0.08198 | 324.364 | single | 558.049 | 130 | 3000 | 558.049 | 1.77723 | 2 |
| suport | g t o h | 76.66 | 250 | 352 | 0.07985 | 325.145 | single | 542.278 | 130 | 3000 | 542.278 | 1.727 | 2 |
| span | g to h | 55.1 | 250 | 352 | 0.0574 | 333.162 | single | 380.387 | 130 | 3000 | 380.387 | 1.21142 | 2 |
| suport | h | 76.66 | 250 | 352 | 0.07985 | 325.145 | single | 542.278 | 130 | 3000 | 542.278 | 1.727 | 2 |
| suport | h to i | 77.1 | 250 | 352 | 0.08031 | 324.977 | single | 545.672 | 130 | 3000 | 545.672 | 1.73781 | 2 |
| span | h to i | 56.28 | 250 | 352 | 0.05863 | 332.734 | single | 389.033 | 130 | 3000 | 389.033 | 1.23896 | 2 |
| suport | i | 77.43 | 250 | 352 | 0.08066 | 324.851 | single | 548.221 | 130 | 3000 | 548.221 | 1.74593 | 2 |
| suport | I to j | 41 | 250 | 352 | 0.04271 | 338.191 | single | 278.838 | 130 | 3000 | 278.838 | 0.88802 | 2 |
| span | I to j | 23.38 | 250 | 352 | 0.02435 | 344.265 | single | 156.201 | 130 | 3000 | 156.201 | 0.49745 | 2 |
| suport | j | 41.23 | 250 | 352 | 0.04295 | 338.111 | single | 280.469 | 130 | 3000 | 280.469 | 0.89321 | 2 |

axis 2
story 4

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | A | 43.85 | 250 | 352 | 0.04568 | 337.188 | single | 299.108 | 130 | 3000 | 299.108 | 0.95257 | 2 |
| span | a tob | 24.46 | 250 | 352 | 0.02548 | 343.899 | single | 163.59 | 130 | 3000 | 163.59 | 0.52099 | 2 |
| suport | b | 43.85 | 250 | 352 | 0.04568 | 337.188 | single | 299.108 | 130 | 3000 | 299.108 | 0.95257 | 2 |
| suport | b to c | 83.96 | 250 | 352 | 0.08746 | 322.331 | single | 599.102 | 130 | 3000 | 599.102 | 1.90797 | 2 |
| span | b to c | 60.7 | 250 | 352 | 0.06323 | 331.12 | single | 421.632 | 130 | 3000 | 421.632 | 1.34278 | 2 |
| suport | c | 83.96 | 250 | 352 | 0.08746 | 322.331 | single | 599.102 | 130 | 3000 | 599.102 | 1.90797 | 2 |
| suport | c to d | 82.43 | 250 | 352 | 0.08586 | 322.926 | single | 587.102 | 130 | 3000 | 587.102 | 1.86975 | 2 |
| span | c tod | 59.62 | 250 | 352 | 0.0621 | 331.516 | single | 413.636 | 130 | 3000 | 413.636 | 1.31731 | 2 |
| suport | d | 82.43 | 250 | 352 | 0.08586 | 322.926 | single | 587.102 | 130 | 3000 | 587.102 | 1.86975 | 2 |
| suport | d to e | 83.35 | 250 | 352 | 0.08682 | 322.568 | single | 594.311 | 130 | 3000 | 594.311 | 1.89271 | 2 |
| span | d to e | 60.6 | 250 | 352 | 0.06313 | 331.157 | single | 420.891 | 130 | 3000 | 420.891 | 1.34042 | 2 |
| suport | d | 83.35 | 250 | 352 | 0.08682 | 322.568 | single | 594.311 | 130 | 3000 | 594.311 | 1.89271 | 2 |
| suport | e to f | 53.1 | 250 | 352 | 0.05531 | 333.886 | single | 365.786 | 130 | 3000 | 365.786 | 1.16492 | 2 |
| span | e to f | 33.13 | 250 | 352 | 0.03451 | 340.932 | single | 223.504 | 130 | 3000 | 223.504 | 0.71179 | 2 |
| suport | f | 53.1 | 250 | 352 | 0.05531 | 333.886 | single | 365.786 | 130 | 3000 | 365.786 | 1.16492 | 2 |
| suport | f to g | 83.33 | 250 | 352 | 0.0868 | 322.576 | single | 594.155 | 130 | 3000 | 594.155 | 1.89221 | 2 |
| span | f to g | 60.66 | 250 | 352 | 0.06319 | 331.135 | single | 421.336 | 130 | 3000 | 421.336 | 1.34183 | 2 |
| suport | g | 83.3 | 250 | 352 | 0.08677 | 322.588 | single | 593.919 | 130 | 3000 | 593.919 | 1.89146 | 2 |
| suport | g t o h | 82.42 | 250 | 352 | 0.08585 | 322.929 | single | 587.023 | 130 | 3000 | 587.023 | 1.8695 | 2 |
| span | g to h | 59.6 | 250 | 352 | 0.06208 | 331.523 | single | 413.488 | 130 | 3000 | 413.488 | 1.31684 | 2 |
| suport | h | 82.42 | 250 | 352 | 0.08585 | 322.929 | single | 587.023 | 130 | 3000 | 587.023 | 1.8695 | 2 |
| suport | h to i | 83.9 | 250 | 352 | 0.0874 | 322.355 | single | 598.63 | 130 | 3000 | 598.63 | 1.90647 | 2 |
| span | h to i | 60.7 | 250 | 352 | 0.06323 | 331.12 | single | 421.632 | 130 | 3000 | 421.632 | 1.34278 | 2 |
| suport | i | 83.9 | 250 | 352 | 0.0874 | 322.355 | single | 598.63 | 130 | 3000 | 598.63 | 1.90647 | 2 |
| suport | I to j | 43.6 | 250 | 352 | 0.04542 | 337.276 | single | 297.325 | 130 | 3000 | 297.325 | 0.9469 | 2 |
| span | I to j | 24.46 | 250 | 352 | 0.02548 | 343.899 | single | 163.59 | 130 | 3000 | 163.59 | 0.52099 | 2 |
| suport | j | 43 | 250 | 352 | 0.04479 | 337.488 | single | 293.05 | 130 | 3000 | 293.05 | 0.93328 | 2 |

axis 2
story 3

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | A | 42.1 | 250 | 352 | 0.04385 | 337.805 | single | 286.647 | 130 | 3000 | 286.647 | 0.91289 | 2 |
| span | a tob | 23.6 | 250 | 352 | 0.02458 | 344.19 | single | 157.704 | 130 | 3000 | 157.704 | 0.50224 | 2 |
| suport | b | 42.1 | 250 | 352 | 0.04385 | 337.805 | single | 286.647 | 130 | 3000 | 286.647 | 0.91289 | 2 |
| suport | b to c | 79.9 | 250 | 352 | 0.08323 | 323.903 | single | 567.365 | 130 | 3000 | 567.365 | 1.80689 | 2 |
| span | b to c | 57.43 | 250 | 352 | 0.05982 | 332.316 | single | 397.483 | 130 | 3000 | 397.483 | 1.26587 | 2 |
| suport | c | 79.9 | 250 | 352 | 0.08323 | 323.903 | single | 567.365 | 130 | 3000 | 567.365 | 1.80689 | 2 |
| suport | c to d | 78.1 | 250 | 352 | 0.08135 | 324.594 | single | 553.402 | 130 | 3000 | 553.402 | 1.76243 | 2 |
| span | c tod | 56.1 | 250 | 352 | 0.05844 | 332.8 | single | 387.713 | 130 | 3000 | 387.713 | 1.23475 | 2 |
| suport | d | 78.1 | 250 | 352 | 0.08135 | 324.594 | single | 553.402 | 130 | 3000 | 553.402 | 1.76243 | 2 |
| suport | d to e | 78.2 | 250 | 352 | 0.08146 | 324.556 | single | 554.176 | 130 | 3000 | 554.176 | 1.76489 | 2 |
| span | d to e | 57.2 | 250 | 352 | 0.05958 | 332.4 | single | 395.791 | 130 | 3000 | 395.791 | 1.26048 | 2 |
| suport | d | 78.2 | 250 | 352 | 0.08146 | 324.556 | single | 554.176 | 130 | 3000 | 554.176 | 1.76489 | 2 |
| suport | e to f | 50.5 | 250 | 352 | 0.0526 | 334.821 | single | 346.904 | 130 | 3000 | 346.904 | 1.10479 | 2 |
| span | e to f | 31.6 | 250 | 352 | 0.03292 | 341.459 | single | 212.853 | 130 | 3000 | 212.853 | 0.67787 | 2 |
| suport | f | 50.5 | 250 | 352 | 0.0526 | 334.821 | single | 346.904 | 130 | 3000 | 346.904 | 1.10479 | 2 |
| suport | f to g | 78.2 | 250 | 352 | 0.08146 | 324.556 | single | 554.176 | 130 | 3000 | 554.176 | 1.76489 | 2 |
| span | f to g | 57.2 | 250 | 352 | 0.05958 | 332.4 | single | 395.791 | 130 | 3000 | 395.791 | 1.26048 | 2 |
| suport | g | 78.2 | 250 | 352 | 0.08146 | 324.556 | single | 554.176 | 130 | 3000 | 554.176 | 1.76489 | 2 |
| suport | g t o h | 78.1 | 250 | 352 | 0.08135 | 324.594 | single | 553.402 | 130 | 3000 | 553.402 | 1.76243 | 2 |
| span | g to h | 56.2 | 250 | 352 | 0.05854 | 332.763 | single | 388.447 | 130 | 3000 | 388.447 | 1.23709 | 2 |
| suport | h | 78.1 | 250 | 352 | 0.08135 | 324.594 | single | 553.402 | 130 | 3000 | 553.402 | 1.76243 | 2 |
| suport | h to i | 79 | 250 | 352 | 0.08229 | 324.249 | single | 560.375 | 130 | 3000 | 560.375 | 1.78463 | 2 |
| span | h to i | 57.43 | 250 | 352 | 0.05982 | 332.316 | single | 397.483 | 130 | 3000 | 397.483 | 1.26587 | 2 |
| suport | i | 79 | 250 | 352 | 0.08229 | 324.249 | single | 560.375 | 130 | 3000 | 560.375 | 1.78463 | 2 |
| suport | I to j | 47.2 | 250 | 352 | 0.04917 | 336 | single | 323.098 | 130 | 3000 | 323.098 | 1.02897 | 2 |
| span | I to j | 23.6 | 250 | 352 | 0.02458 | 344.19 | single | 157.704 | 130 | 3000 | 157.704 | 0.50224 | 2 |
| suport | j | 47.2 | 250 | 352 | 0.04917 | 336 | single | 323.098 | 130 | 3000 | 323.098 | 1.02897 | 2 |

axis 2
story 2

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | A | 42.25 | 250 | 352 | 0.04401 | 337.752 | single | 287.713 | 130 | 3000 | 287.713 | 0.91628 | 2 |
| span | a tob | 23.38 | 250 | 352 | 0.02435 | 344.265 | single | 156.201 | 130 | 3000 | 156.201 | 0.49745 | 2 |
| suport | b | 42.25 | 250 | 352 | 0.04401 | 337.752 | single | 287.713 | 130 | 3000 | 287.713 | 0.91628 | 2 |
| suport | b to c | 75.6 | 250 | 352 | 0.07875 | 325.55 | single | 534.115 | 130 | 3000 | 534.115 | 1.701 | 2 |
| span | b to c | 54.5 | 250 | 352 | 0.05677 | 333.38 | single | 376 | 130 | 3000 | 376 | 1.19745 | 2 |
| suport | c | 75.6 | 250 | 352 | 0.07875 | 325.55 | single | 534.115 | 130 | 3000 | 534.115 | 1.701 | 2 |
| suport | c to d | 74.2 | 250 | 352 | 0.07729 | 326.082 | single | 523.369 | 130 | 3000 | 523.369 | 1.66678 | 2 |
| span | c tod | 53 | 250 | 352 | 0.05521 | 333.922 | single | 365.058 | 130 | 3000 | 365.058 | 1.1626 | 2 |
| suport | d | 74.2 | 250 | 352 | 0.07729 | 326.082 | single | 523.369 | 130 | 3000 | 523.369 | 1.66678 | 2 |
| suport | d to e | 73.1 | 250 | 352 | 0.07615 | 326.499 | single | 514.952 | 130 | 3000 | 514.952 | 1.63997 | 2 |
| span | d to e | 54.4 | 250 | 352 | 0.05667 | 333.416 | single | 375.269 | 130 | 3000 | 375.269 | 1.19513 | 2 |
| suport | d | 73.1 | 250 | 352 | 0.07615 | 326.499 | single | 514.952 | 130 | 3000 | 514.952 | 1.63997 | 2 |
| suport | e to f | 48.6 | 250 | 352 | 0.05063 | 335.5 | single | 333.176 | 130 | 3000 | 333.176 | 1.06107 | 2 |
| span | e to f | 33.3 | 250 | 352 | 0.03469 | 340.873 | single | 224.689 | 130 | 3000 | 224.689 | 0.71557 | 2 |
| suport | f | 48.66 | 250 | 352 | 0.05069 | 335.479 | single | 333.609 | 130 | 3000 | 333.609 | 1.06245 | 2 |
| suport | f to g | 73.1 | 250 | 352 | 0.07615 | 326.499 | single | 514.952 | 130 | 3000 | 514.952 | 1.63997 | 2 |
| span | f to g | 54.4 | 250 | 352 | 0.05667 | 333.416 | single | 375.269 | 130 | 3000 | 375.269 | 1.19513 | 2 |
| suport | g | 73.1 | 250 | 352 | 0.07615 | 326.499 | single | 514.952 | 130 | 3000 | 514.952 | 1.63997 | 2 |
| suport | g t o h | 74.2 | 250 | 352 | 0.07729 | 326.082 | single | 523.369 | 130 | 3000 | 523.369 | 1.66678 | 2 |
| span | g to h | 53.2 | 250 | 352 | 0.05542 | 333.849 | single | 366.515 | 130 | 3000 | 366.515 | 1.16724 | 2 |
| suport | h | 74.2 | 250 | 352 | 0.07729 | 326.082 | single | 523.369 | 130 | 3000 | 523.369 | 1.66678 | 2 |
| suport | h to i | 75.6 | 250 | 352 | 0.07875 | 325.55 | single | 534.115 | 130 | 3000 | 534.115 | 1.701 | 2 |
| span | h to i | 54.5 | 250 | 352 | 0.05677 | 333.38 | single | 376 | 130 | 3000 | 376 | 1.19745 | 2 |
| suport | i | 75.6 | 250 | 352 | 0.07875 | 325.55 | single | 534.115 | 130 | 3000 | 534.115 | 1.701 | 2 |
| suport | I to j | 42.2 | 250 | 352 | 0.04396 | 337.769 | single | 287.357 | 130 | 3000 | 287.357 | 0.91515 | 2 |
| span | I to j | 23.32 | 250 | 352 | 0.02429 | 344.285 | single | 155.79 | 130 | 3000 | 155.79 | 0.49615 | 2 |
| suport | j | 42.2 | 250 | 352 | 0.04396 | 337.769 | single | 287.357 | 130 | 3000 | 287.357 | 0.91515 | 2 |

axis 2

story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | A | 18.46 | 300 | 352 | 0.016024 | 346.9498 | single | 122.3758 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | a tob | 13.5 | 300 | 352 | 0.011719 | 348.3212 | single | 89.14239 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | b | 18.46 | 300 | 352 | 0.016024 | 346.9498 | single | 122.3758 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | b to c | 18.99 | 300 | 352 | 0.016484 | 346.8026 | single | 125.9427 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | b to c | 12 | 300 | 352 | 0.010417 | 348.7339 | single | 79.14392 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | c | 18.99 | 300 | 352 | 0.016484 | 346.8026 | single | 125.9427 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | c to d | 18 | 300 | 352 | 0.015625 | 347.0774 | single | 119.2825 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | c tod | 12 | 300 | 352 | 0.010417 | 348.7339 | single | 79.14392 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | d | 18 | 300 | 352 | 0.015625 | 347.0774 | single | 119.2825 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | d to e | 19 | 300 | 352 | 0.016493 | 346.7998 | single | 126.0101 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | d to e | 12 | 300 | 352 | 0.010417 | 348.7339 | single | 79.14392 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | d | 19 | 300 | 352 | 0.016493 | 346.7998 | single | 126.0101 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | e to f | 19 | 300 | 352 | 0.016493 | 346.7998 | single | 126.0101 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | e to f | 12 | 300 | 352 | 0.010417 | 348.7339 | single | 79.14392 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | f | 19 | 300 | 352 | 0.016493 | 346.7998 | single | 126.0101 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | f to g | 19 | 300 | 352 | 0.016493 | 346.7998 | single | 126.0101 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | f to g | 12 | 300 | 352 | 0.010417 | 348.7339 | single | 79.14392 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | g | 19 | 300 | 352 | 0.016493 | 346.7998 | single | 126.0101 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | g t o h | 18 | 300 | 352 | 0.015625 | 347.0774 | single | 119.2825 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | g to h | 12 | 300 | 352 | 0.010417 | 348.7339 | single | 79.14392 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | h | 18 | 300 | 352 | 0.015625 | 347.0774 | single | 119.2825 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | h to i | 19 | 300 | 352 | 0.016493 | 346.7998 | single | 126.0101 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | h to i | 12 | 300 | 352 | 0.010417 | 348.7339 | single | 79.14392 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | i | 18 | 300 | 352 | 0.015625 | 347.0774 | single | 119.2825 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | l to j | 18 | 300 | 352 | 0.015625 | 347.0774 | single | 119.2825 | 156 | 3000 | 156 | 0.496815 | 2 |
| span | l to j | 13 | 300 | 352 | 0.011285 | 348.4589 | single | 85.80691 | 156 | 3000 | 156 | 0.496815 | 2 |
| suport | j | 18 | 300 | 352 | 0.015625 | 347.0774 | single | 119.2825 | 156 | 3000 | 156 | 0.496815 | 2 |

Table G. 11: Flexural Design for the beam on axis 3 for all story

axis 3
story 7

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 47.8 | 250 | 252 | 0.04979 | 240.392 | single | 457.339 | 97.5 | 3000 | 457.339 | 2.27577 | 3 |
| span | b to c | 30.39 | 250 | 252 | 0.03166 | 244.751 | single | 285.585 | 97.5 | 3000 | 285.585 | 1.42111 | 2 |
| suport | c | 47.8 | 250 | 252 | 0.04979 | 240.392 | single | 457.339 | 97.5 | 3000 | 457.339 | 2.27577 | 3 |
| suport | c to d | 44.85 | 250 | 252 | 0.04672 | 241.142 | single | 427.779 | 97.5 | 3000 | 427.779 | 2.12868 | 3 |
| span | c tod | 31.09 | 250 | 252 | 0.03239 | 244.579 | single | 292.369 | 97.5 | 3000 | 292.369 | 1.45486 | 2 |
| suport | d | 48.58 | 250 | 252 | 0.0506 | 240.193 | single | 465.187 | 97.5 | 3000 | 465.187 | 2.31482 | 3 |
| suport | d to e | 46.89 | 250 | 252 | 0.04884 | 240.624 | single | 448.2 | 97.5 | 3000 | 448.2 | 2.23029 | 3 |
| span | d to e | 31.93 | 250 | 252 | 0.03326 | 244.372 | single | 300.523 | 97.5 | 3000 | 300.523 | 1.49544 | 2 |
| suport | e | 46.89 | 250 | 252 | 0.04884 | 240.624 | single | 448.2 | 97.5 | 3000 | 448.2 | 2.23029 | 3 |
| suport | e to f | 11.32 | 250 | 252 | 0.01179 | 249.35 | single | 104.416 | 97.5 | 3000 | 104.416 | 0.51959 | 2 |
| span | e to f | 3.48 | 250 | 252 | 0.00363 | 251.191 | single | 31.8644 | 97.5 | 3000 | 97.5 | 0.48517 | 2 |
| suport | f | 11.32 | 250 | 252 | 0.01179 | 249.35 | single | 104.416 | 97.5 | 3000 | 104.416 | 0.51959 | 2 |
| suport | f to g | 46.8 | 250 | 252 | 0.04875 | 240.647 | single | 447.297 | 97.5 | 3000 | 447.297 | 2.2258 | 3 |
| span | f to g | 31.93 | 250 | 252 | 0.03326 | 244.372 | single | 300.523 | 97.5 | 3000 | 300.523 | 1.49544 | 2 |
| suport | g | 46.89 | 250 | 252 | 0.04884 | 240.624 | single | 448.2 | 97.5 | 3000 | 448.2 | 2.23029 | 3 |
| suport | g to h | 44.8 | 250 | 252 | 0.04667 | 241.155 | single | 427.279 | 97.5 | 3000 | 427.279 | 2.12619 | 3 |
| span | g to h | 31.09 | 250 | 252 | 0.03239 | 244.579 | single | 292.369 | 97.5 | 3000 | 292.369 | 1.45486 | 2 |
| suport | h | 44.8 | 250 | 252 | 0.04667 | 241.155 | single | 427.279 | 97.5 | 3000 | 427.279 | 2.12619 | 3 |
| suport | h to i | 47.8 | 250 | 252 | 0.04979 | 240.392 | single | 457.339 | 97.5 | 3000 | 457.339 | 2.27577 | 3 |
| span | h to i | 30.38 | 250 | 252 | 0.03165 | 244.754 | single | 285.488 | 97.5 | 3000 | 285.488 | 1.42062 | 2 |
| suport | i | 47.8 | 250 | 252 | 0.04979 | 240.392 | single | 457.339 | 97.5 | 3000 | 457.339 | 2.27577 | 3 |

axis 3
story 6

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 104.3 | 250 | 352 | 0.10865 | 314.189 | single | 763.527 | 130 | 4000 | 763.527 | 2.43161 | 3 |
| span | b to c | 67.78 | 250 | 352 | 0.0706 | 328.498 | single | 474.568 | 130 | 4000 | 474.568 | 1.51136 | 2 |
| suport | c | 104.3 | 250 | 352 | 0.10865 | 314.189 | single | 763.527 | 130 | 4000 | 763.527 | 2.43161 | 3 |
| suport | c to d | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| span | c tod | 68.3 | 250 | 352 | 0.07115 | 328.304 | single | 478.492 | 130 | 4000 | 478.492 | 1.52386 | 2 |
| suport | d | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| suport | d to e | 102.64 | 250 | 352 | 0.10692 | 314.871 | single | 749.746 | 130 | 4000 | 749.746 | 2.38773 | 3 |
| span | d to e | 70.72 | 250 | 352 | 0.07367 | 327.396 | single | 496.82 | 130 | 4000 | 496.82 | 1.58223 | 2 |
| suport | e | 102.64 | 250 | 352 | 0.10692 | 314.871 | single | 749.746 | 130 | 4000 | 749.746 | 2.38773 | 3 |
| suport | e to f | 28 | 250 | 352 | 0.02917 | 342.694 | single | 187.924 | 130 | 4000 | 187.924 | 0.59848 | 2 |
| span | e to f | 7.59 | 250 | 352 | 0.00791 | 349.527 | single | 49.945 | 130 | 4000 | 130 | 0.41401 | 2 |
| suport | f | 28 | 250 | 352 | 0.02917 | 342.694 | single | 187.924 | 130 | 4000 | 187.924 | 0.59848 | 2 |
| suport | f to g | 102.6 | 250 | 352 | 0.10688 | 314.887 | single | 749.415 | 130 | 4000 | 749.415 | 2.38667 | 3 |
| span | f to g | 70.73 | 250 | 352 | 0.07368 | 327.393 | single | 496.896 | 130 | 4000 | 496.896 | 1.58247 | 2 |
| suport | g | 102.6 | 250 | 352 | 0.10688 | 314.887 | single | 749.415 | 130 | 4000 | 749.415 | 2.38667 | 3 |
| suport | g to h | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| span | g to h | 68.3 | 250 | 352 | 0.07115 | 328.304 | single | 478.492 | 130 | 4000 | 478.492 | 1.52386 | 2 |
| suport | h | 100.1 | 250 | 352 | 0.10427 | 315.909 | single | 728.791 | 130 | 4000 | 728.791 | 2.32099 | 3 |
| suport | h to i | 104.47 | 250 | 352 | 0.10882 | 314.119 | single | 764.942 | 130 | 4000 | 764.942 | 2.43612 | 3 |
| span | h to i | 67.8 | 250 | 352 | 0.07063 | 328.491 | single | 474.719 | 130 | 4000 | 474.719 | 1.51184 | 2 |
| suport | i | 104.47 | 250 | 352 | 0.10882 | 314.119 | single | 764.942 | 130 | 4000 | 764.942 | 2.43612 | 3 |

axis 3
story 5

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 109.36 | 250 | 352 | 0.11392 | 312.087 | single | 805.959 | 130 | 4000 | 805.959 | 2.56675 | 3 |
| span | b to c | 71.77 | 250 | 352 | 0.07476 | 327.001 | single | 504.806 | 130 | 4000 | 504.806 | 1.60766 | 2 |
| suport | c | 109.36 | 250 | 352 | 0.11392 | 312.087 | single | 805.959 | 130 | 4000 | 805.959 | 2.56675 | 3 |
| suport | c to d | 105.83 | 250 | 352 | 0.11024 | 313.557 | single | 776.289 | 130 | 4000 | 776.289 | 2.47226 | 3 |
| span | c tod | 71.1 | 250 | 352 | 0.07406 | 327.253 | single | 499.707 | 130 | 4000 | 499.707 | 1.59142 | 2 |
| suport | d | 105.8 | 250 | 352 | 0.11021 | 313.569 | single | 776.038 | 130 | 4000 | 776.038 | 2.47146 | 3 |
| suport | d to e | 106.78 | 250 | 352 | 0.11123 | 313.163 | single | 784.242 | 130 | 4000 | 784.242 | 2.49759 | 3 |
| span | d to e | 74.8 | 250 | 352 | 0.07792 | 325.854 | single | 527.97 | 130 | 4000 | 527.97 | 1.68143 | 2 |
| suport | e | 106.78 | 250 | 352 | 0.11123 | 313.163 | single | 784.242 | 130 | 4000 | 784.242 | 2.49759 | 3 |
| suport | e to f | 28.51 | 250 | 352 | 0.0297 | 342.519 | single | 191.444 | 130 | 4000 | 191.444 | 0.6097 | 2 |
| span | e to f | 7.94 | 250 | 352 | 0.00827 | 349.412 | single | 52.2653 | 130 | 4000 | 130 | 0.41401 | 2 |
| suport | f | 28.51 | 250 | 352 | 0.0297 | 342.519 | single | 191.444 | 130 | 4000 | 191.444 | 0.6097 | 2 |
| suport | f to g | 106.7 | 250 | 352 | 0.11115 | 313.196 | single | 783.572 | 130 | 4000 | 783.572 | 2.49545 | 3 |
| span | f to g | 74.8 | 250 | 352 | 0.07792 | 325.854 | single | 527.97 | 130 | 4000 | 527.97 | 1.68143 | 2 |
| suport | g | 106.7 | 250 | 352 | 0.11115 | 313.196 | single | 783.572 | 130 | 4000 | 783.572 | 2.49545 | 3 |
| suport | g to h | 105.8 | 250 | 352 | 0.11021 | 313.569 | single | 776.038 | 130 | 4000 | 776.038 | 2.47146 | 3 |
| span | g to h | 72.1 | 250 | 352 | 0.0751 | 326.876 | single | 507.32 | 130 | 4000 | 507.32 | 1.61567 | 2 |
| suport | h | 105.86 | 250 | 352 | 0.11027 | 313.544 | single | 776.54 | 130 | 4000 | 776.54 | 2.47306 | 3 |
| suport | h to i | 109.45 | 250 | 352 | 0.11401 | 312.05 | single | 806.719 | 130 | 4000 | 806.719 | 2.56917 | 2 |
| span | h to i | 71.78 | 250 | 352 | 0.07477 | 326.997 | single | 504.882 | 130 | 4000 | 504.882 | 1.6079 | 2 |
| suport | i | 109.45 | 250 | 352 | 0.11401 | 312.05 | single | 806.719 | 130 | 4000 | 806.719 | 2.56917 | 3 |

axis 3
story 4

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 112.5 | 250 | 352 | 0.11719 | 310.767 | single | 832.623 | 130 | 4000 | 832.623 | 2.65166 | 3 |
| span | b to c | 73.7 | 250 | 352 | 0.07677 | 326.271 | single | 519.54 | 130 | 4000 | 519.54 | 1.65459 | 2 |
| suport | c | 112.5 | 250 | 352 | 0.11719 | 310.767 | single | 832.623 | 130 | 4000 | 832.623 | 2.65166 | 3 |
| suport | c to d | 100.7 | 250 | 352 | 0.1049 | 315.664 | single | 733.727 | 130 | 4000 | 733.727 | 2.33671 | 3 |
| span | c tod | 74.26 | 250 | 352 | 0.07735 | 326.059 | single | 523.829 | 130 | 4000 | 523.829 | 1.66824 | 2 |
| suport | d | 100.7 | 250 | 352 | 0.1049 | 315.664 | single | 733.727 | 130 | 4000 | 733.727 | 2.33671 | 3 |
| suport | d to e | 108 | 250 | 352 | 0.1125 | 312.655 | single | 794.49 | 130 | 4000 | 794.49 | 2.53022 | 3 |
| span | d to e | 77 | 250 | 352 | 0.08021 | 325.015 | single | 544.9 | 130 | 4000 | 544.9 | 1.73535 | 2 |
| suport | e | 108 | 250 | 352 | 0.1125 | 312.655 | single | 794.49 | 130 | 4000 | 794.49 | 2.53022 | 3 |
| suport | e to f | 28 | 250 | 352 | 0.02917 | 342.694 | single | 187.924 | 130 | 4000 | 187.924 | 0.59848 | 2 |
| span | e to f | 7.56 | 250 | 352 | 0.00788 | 349.536 | single | 49.7462 | 130 | 4000 | 49.7462 | 0.15843 | 2 |
| suport | f | 28 | 250 | 352 | 0.02917 | 342.694 | single | 187.924 | 130 | 4000 | 187.924 | 0.59848 | 2 |
| suport | f to g | 100 | 250 | 352 | 0.10417 | 315.95 | single | 727.969 | 130 | 4000 | 727.969 | 2.31837 | 3 |
| span | f to g | 77 | 250 | 352 | 0.08021 | 325.015 | single | 544.9 | 130 | 4000 | 544.9 | 1.73535 | 2 |
| suport | g | 100 | 250 | 352 | 0.10417 | 315.95 | single | 727.969 | 130 | 4000 | 727.969 | 2.31837 | 3 |
| suport | g to h | 108.7 | 250 | 352 | 0.11323 | 312.363 | single | 800.387 | 130 | 4000 | 800.387 | 2.549 | 3 |
| span | g to h | 74.2 | 250 | 352 | 0.07729 | 326.082 | single | 523.369 | 130 | 4000 | 523.369 | 1.66678 | 2 |
| suport | h | 108 | 250 | 352 | 0.1125 | 312.655 | single | 794.49 | 130 | 4000 | 794.49 | 2.53022 | 3 |
| suport | h to i | 112.75 | 250 | 352 | 0.11745 | 310.661 | single | 834.757 | 130 | 4000 | 834.757 | 2.65846 | 3 |
| span | h to i | 73.7 | 250 | 352 | 0.07677 | 326.271 | single | 519.54 | 130 | 4000 | 519.54 | 1.65459 | 2 |
| suport | i | 112.75 | 250 | 352 | 0.11745 | 310.661 | single | 834.757 | 130 | 4000 | 834.757 | 2.65846 | 3 |

axis 3
story 3

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 107 | 250 | 352 | 0.11146 | 313.071 | single | 786.087 | 130 | 4000 | 786.087 | 2.50346 | 3 |
| span | b to c | 72.8 | 250 | 352 | 0.07583 | 326.612 | single | 512.66 | 130 | 4000 | 512.66 | 1.63268 | 2 |
| suport | c | 107 | 250 | 352 | 0.11146 | 313.071 | single | 786.087 | 130 | 4000 | 786.087 | 2.50346 | 3 |
| suport | c to d | 106 | 250 | 352 | 0.11042 | 313.486 | single | 777.71 | 130 | 4000 | 777.71 | 2.47678 | 3 |
| span | c tod | 72.3 | 250 | 352 | 0.07531 | 326.801 | single | 508.845 | 130 | 4000 | 508.845 | 1.62053 | 2 |
| suport | d | 106 | 250 | 352 | 0.11042 | 313.486 | single | 777.71 | 130 | 4000 | 777.71 | 2.47678 | 3 |
| suport | d to e | 104 | 250 | 352 | 0.10833 | 314.312 | single | 761.031 | 130 | 4000 | 761.031 | 2.42367 | 3 |
| span | d to e | 75.84 | 250 | 352 | 0.079 | 325.458 | single | 535.962 | 130 | 4000 | 535.962 | 1.70688 | 2 |
| suport | e | 104 | 250 | 352 | 0.10833 | 314.312 | single | 761.031 | 130 | 4000 | 761.031 | 2.42367 | 3 |
| suport | e to f | 29 | 250 | 352 | 0.03021 | 342.352 | single | 194.83 | 130 | 4000 | 194.83 | 0.62048 | 2 |
| span | e to f | 7 | 250 | 352 | 0.00729 | 349.72 | single | 46.0371 | 130 | 4000 | 46.0371 | 0.14661 | 2 |
| suport | f | 29 | 250 | 352 | 0.03021 | 342.352 | single | 194.83 | 130 | 4000 | 194.83 | 0.62048 | 2 |
| suport | f to g | 104 | 250 | 352 | 0.10833 | 314.312 | single | 761.031 | 130 | 4000 | 761.031 | 2.42367 | 3 |
| span | f to g | 75.84 | 250 | 352 | 0.079 | 325.458 | single | 535.962 | 130 | 4000 | 535.962 | 1.70688 | 2 |
| suport | g | 104 | 250 | 352 | 0.10833 | 314.312 | single | 761.031 | 130 | 4000 | 761.031 | 2.42367 | 3 |
| suport | g to h | 106 | 250 | 352 | 0.11042 | 313.486 | single | 777.71 | 130 | 4000 | 777.71 | 2.47678 | 3 |
| span | g to h | 72.3 | 250 | 352 | 0.07531 | 326.801 | single | 508.845 | 130 | 4000 | 508.845 | 1.62053 | 2 |
| suport | h | 106 | 250 | 352 | 0.11042 | 313.486 | single | 777.71 | 130 | 4000 | 777.71 | 2.47678 | 3 |
| suport | h to i | 106.8 | 250 | 352 | 0.11125 | 313.154 | single | 784.41 | 130 | 4000 | 784.41 | 2.49812 | 3 |
| span | h to i | 73 | 250 | 352 | 0.07604 | 326.536 | single | 514.188 | 130 | 4000 | 514.188 | 1.63754 | 2 |
| suport | i | 106.8 | 250 | 352 | 0.11125 | 313.154 | single | 784.41 | 130 | 4000 | 784.41 | 2.49812 | 3 |

axis 3
story 2

| type | Location | oment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 60 | 250 | 352 | 0.0625 | 331.377 | single | 416.447 | 130 | 4000 | 416.447 | 1.32626 | 2 |
| span | b to c | 32.46 | 250 | 352 | 0.03381 | 341.163 | single | 218.835 | 130 | 4000 | 218.835 | 0.69693 | 2 |
| suport | c | 60.8 | 250 | 352 | 0.06333 | 331.083 | single | 422.374 | 130 | 4000 | 422.374 | 1.34514 | 2 |
| suport | c to d | 50 | 250 | 352 | 0.05208 | 335 | single | 343.286 | 130 | 4000 | 343.286 | 1.09327 | 2 |
| span | c tod | 35.58 | 250 | 352 | 0.03706 | 340.083 | single | 240.631 | 130 | 4000 | 240.631 | 0.76634 | 2 |
| suport | d | 50 | 250 | 352 | 0.05208 | 335 | single | 343.286 | 130 | 4000 | 343.286 | 1.09327 | 2 |
| suport | d to e | 52.74 | 250 | 352 | 0.05494 | 334.015 | single | 363.165 | 130 | 4000 | 363.165 | 1.15658 | 2 |
| span | d to e | 35.9 | 250 | 352 | 0.0374 | 339.972 | single | 242.874 | 130 | 4000 | 242.874 | 0.77348 | 2 |
| suport | e | 52.74 | 250 | 352 | 0.05494 | 334.015 | single | 363.165 | 130 | 4000 | 363.165 | 1.15658 | 2 |
| suport | e to f | 24 | 250 | 352 | 0.025 | 344.055 | single | 160.441 | 130 | 4000 | 160.441 | 0.51096 | 2 |
| span | e to f | 12 | 250 | 352 | 0.0125 | 348.073 | single | 79.2941 | 130 | 4000 | 79.2941 | 0.25253 | 2 |
| suport | f | 24 | 250 | 352 | 0.025 | 344.055 | single | 160.441 | 130 | 4000 | 160.441 | 0.51096 | 2 |
| suport | f to g | 52.2 | 250 | 352 | 0.05438 | 334.21 | single | 359.238 | 130 | 4000 | 359.238 | 1.14407 | 2 |
| span | f to g | 35.9 | 250 | 352 | 0.0374 | 339.972 | single | 242.874 | 130 | 4000 | 242.874 | 0.77348 | 2 |
| suport | g | 52.2 | 250 | 352 | 0.05438 | 334.21 | single | 359.238 | 130 | 4000 | 359.238 | 1.14407 | 2 |
| suport | g to h | 50.2 | 250 | 352 | 0.05229 | 334.928 | single | 344.733 | 130 | 4000 | 344.733 | 1.09787 | 2 |
| span | g to h | 35.67 | 250 | 352 | 0.03716 | 340.052 | single | 241.261 | 130 | 4000 | 241.261 | 0.76835 | 2 |
| suport | h | 50.2 | 250 | 352 | 0.05229 | 334.928 | single | 344.733 | 130 | 4000 | 344.733 | 1.09787 | 2 |
| suport | h to i | 60.89 | 250 | 352 | 0.06343 | 331.05 | single | 423.041 | 130 | 4000 | 423.041 | 1.34726 | 2 |
| span | h to i | 32.44 | 250 | 352 | 0.03379 | 341.17 | single | 218.696 | 130 | 4000 | 218.696 | 0.69648 | 2 |
| suport | i | 60.89 | 250 | 352 | 0.06343 | 331.05 | single | 423.041 | 130 | 4000 | 423.041 | 1.34726 | 2 |

axis 3
story 1

| type | Location | ment (KN | b | d | k | Z | beam type | As,cal | As,min | Asmax | As,prov | No,bar | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| suport | b | 25 | 300 | 352 | 0.021701 | 345.1244 | single | 166.6076 | 156 | 4000 | 159.13 | 0.506783 | 2 |
| span | b to c | 14 | 300 | 352 | 0.012153 | 348.1835 | single | 92.48053 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | c | 25 | 300 | 352 | 0.021701 | 345.1244 | single | 166.6076 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | c to d | 21.2 | 300 | 352 | 0.018403 | 346.1874 | single | 140.8494 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | c tod | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | d | 21.36 | 300 | 352 | 0.018542 | 346.1428 | single | 141.9307 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | d to e | 23.4 | 300 | 352 | 0.020313 | 345.5728 | single | 155.7424 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | d to e | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | e | 23.4 | 300 | 352 | 0.020313 | 345.5728 | single | 155.7424 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | e to f | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | e to f | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | f | 21.3 | 300 | 352 | 0.01849 | 346.1595 | single | 141.5252 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | f to g | 23 | 300 | 352 | 0.019965 | 345.6847 | single | 153.0306 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | f to g | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | g | 23 | 300 | 352 | 0.019965 | 345.6847 | single | 153.0306 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | g to h | 21.2 | 300 | 352 | 0.018403 | 346.1874 | single | 140.8494 | 156 | 4000 | 156 | 0.496815 | 2 |
| span | g to h | 14.4 | 300 | 352 | 0.0125 | 348.0732 | single | 95.15297 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | h | 21 | 300 | 352 | 0.018229 | 346.2431 | single | 139.4982 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | h to i | 25 | 300 | 352 | 0.021701 | 345.1244 | single | 166.6076 | 156 | 4000 | 166.6 | 0.530573 | 2 |
| span | h to i | 13.5 | 300 | 352 | 0.011719 | 348.3212 | single | 89.14239 | 156 | 4000 | 156 | 0.496815 | 2 |
| suport | i | 25 | 300 | 352 | 0.021701 | 345.1244 | single | 166.6076 | 156 | 4000 | 166.6 | 0.530573 | 2 |

Table G. 12: Shear Design for the beam on axis B for all story

axis B

| | | | | Story -7 | | | | |
|---|---|---|---|---|---|---|---|---|
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 60.69 | 49.021728 | 190.05 | 152.3 | 563.9 | 256.32 | 8 c/c 250mm |
| | near 2 | 65.59 | 53.921728 | 190.05 | 152.3 | 512.7 | 256.32 | 8c/c 250mm |
| 2 to 3 | near 2 | 66.37 | 54.696184 | 190.05 | 152.3 | 505.4 | 256.32 | 8 c/c 250mm |
| | near 3 | 59.97 | 48.29618 | 190.05 | 152.3 | 572.4 | 256.32 | 8 c/c 250mm |
| axis B | | | | | | | | |
| | | | | Story -6 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 100.07 | 76.681808 | 264 | 270 | 360.5 | 256.32 | 8 c/c 260mm |
| | near 2 | 108.01 | 84.621808 | 264 | 270 | 326.7 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 109.69 | 85.994956 | 264 | 270 | 321.5 | 256.32 | 8 c/c 260mm |
| | near 3 | 101.12 | 77.42496 | 264 | 270 | 357.1 | 256.32 | 8 c/c 260mm |
| axis B | | | | | | | | |
| | | | | Story -5 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 104.02 | 79.664044 | 264 | 270 | 347.0 | 256.32 | 8 c/c 260mm |
| | near 2 | 112.67 | 88.314044 | 264 | 270 | 313.0 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 114.27 | 89.70498 | 264 | 270 | 308.2 | 256.32 | 8 c/c 260mm |
| | near 3 | 104.28 | 79.71498 | 264 | 270 | 346.8 | 256.32 | 8 c/c 260mm |
| axis B | | | | | | | | |
| | | | | Story -4 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 111.14 | 84.890104 | 264 | 270 | 325.7 | 256.32 | 8 c/c 260mm |
| | near 2 | 122.4 | 96.150104 | 264 | 270 | 287.5 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 123.87 | 97.409916 | 264 | 270 | 283.8 | 256.32 | 8 c/c 260mm |
| | near 3 | 111.54 | 85.07992 | 264 | 270 | 324.9 | 256.32 | 8 c/c 260mm |
| axis B | | | | | | | | |
| | | | | Story -3 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 104.95 | 80.10398 | 264 | 270 | 345.1 | 256.32 | 8 c/c 260mm |
| | near 2 | 116.1 | 91.25398 | 264 | 270 | 303.0 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 117.2 | 92.15728 | 264 | 270 | 300.0 | 256.32 | 8 c/c 260mm |
| | near 3 | 105.6 | 80.55728 | 264 | 270 | 343.2 | 256.32 | 8 c/c 260mm |
| axis B | | | | | | | | |
| | | | | Story -2 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 to 2 | near 1 | 98.03 | 74.445108 | 264 | 270 | 371.4 | 256.32 | 8 c/c 260mm |
| | near 2 | 111.8 | 88.215108 | 264 | 270 | 313.4 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 112.38 | 88.587168 | 264 | 270 | 312.1 | 256.32 | 8 c/c 260mm |
| | near 3 | 99.3 | 75.50717 | 264 | 270 | 366.1 | 256.32 | 8 c/c 260mm |
| axis B | | | | | | | | |
| | | | | Story -1 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 32.98 | 24.97504 | 264 | 270 | 1106.9 | 213.6 | 8 c/c 260mm |
| | near 2 | 32.42 | 24.41504 | 264 | 270 | 1132.3 | 213.6 | 8c/c 260mm |
| 2 to 3 | near 2 | 32.63 | 24.627488 | 264 | 270 | 1122.6 | 213.6 | 8 c/c 260mm |
| | near 3 | 32.75 | 24.74749 | 264 | 270 | 1117.1 | 213.6 | 8 c/c 260mm |

Table G. 13: Shear Design for the beam on axis C for all story

| axis C | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Story -7 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 53.97 | 43.894704 | 190.05 | 152.3 | 629.8 | 256.32 | 8 c/c 250mm |
| | near 2 | 55.07 | 44.994704 | 190.05 | 152.3 | 614.4 | 256.32 | 8c/c 250mm |
| 2 to 3 | near 2 | 55.73 | 45.65378 | 190.05 | 152.3 | 605.6 | 256.32 | 8 c/c 250mm |
| | near 3 | 53.32 | 43.24378 | 190.05 | 152.3 | 639.3 | 256.32 | 8 c/c 250mm |
| axis C | | | | | | | | |
| | | | | Story -6 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 91.54 | 70.928088 | 264 | 270 | 389.8 | 256.32 | 8 c/c 260mm |
| | near 2 | 91.84 | 71.228088 | 264 | 270 | 388.1 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 93.3 | 72.688088 | 264 | 270 | 380.3 | 256.32 | 8 c/c 260mm |
| | near 3 | 90.08 | 69.46809 | 264 | 270 | 398.0 | 256.32 | 8 c/c 260mm |
| axis C | | | | | | | | |
| | | | | Story -5 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 94.35 | 73.004116 | 264 | 270 | 378.7 | 256.32 | 8 c/c 260mm |
| | near 2 | 95.56 | 74.214116 | 264 | 270 | 372.5 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 97.03 | 75.684116 | 264 | 270 | 365.3 | 256.32 | 8 c/c 260mm |
| | near 3 | 92.88 | 71.53412 | 264 | 270 | 386.5 | 256.32 | 8 c/c 260mm |
| axis C | | | | | | | | |

| | | | | Story -4 | | | | |
|---|---|---|---|---|---|---|---|---|
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 100.0.3 | 77.877144 | 264 | 270 | 355.0 | 256.32 | 8 c/c 260mm |
| | near 2 | 103.14 | 80.217144 | 264 | 270 | 344.6 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 104.54 | 81.613772 | 264 | 270 | 338.7 | 256.32 | 8 c/c 260mm |
| | near 3 | 99.43 | 76.50377 | 264 | 270 | 361.4 | 256.32 | 8 c/c 260mm |
| axis C | | | | | | | | |
| | | | | Story -3 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 95.67 | 73.919476 | 337.5 | 270 | 374.0 | 256.32 | 8 c/c 260mm |
| | near 2 | 97.84 | 76.089476 | 337.5 | 270 | 363.3 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 98.97 | 77.219476 | 337.5 | 270 | 358.0 | 256.32 | 8 c/c 260mm |
| | near 3 | 94.54 | 72.78948 | 337.5 | 270 | 379.8 | 256.32 | 8 c/c 260mm |
| axis C | | | | | | | | |
| | | | | Story - 2 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 89.68 | 68.9703 | 264 | 270 | 400.8 | 256.32 | 8 c/c 260mm |
| | near 2 | 94.57 | 73.8603 | 264 | 270 | 374.3 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 95.11 | 74.416036 | 264 | 270 | 371.5 | 256.32 | 8 c/c 260mm |
| | near 3 | 89 | 68.30604 | 264 | 270 | 404.7 | 256.32 | 8 c/c 260mm |
| axis C | | | | | | | | |
| | | | | Story -1 | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 27.49 | 20.848576 | 264 | 270 | 1326.0 | 213.6 | 8 c/c 260mm |
| | near 2 | 26.77 | 20.128576 | 264 | 270 | 1373.5 | 213.6 | 8c/c 260mm |
| 2 to 3 | near 2 | 27 | 20.358576 | 264 | 270 | 1357.9 | 213.6 | 8 c/c 260mm |
| | near 3 | 27.26 | 20.61858 | 264 | 270 | 1340.8 | 213.6 | 8 c/c 260mm |

Table G. 14: Shear Design for the beam on axis D for all story

axis D

| | | | | Story -7 | | | | |
|---|---|---|---|---|---|---|---|---|
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 53.39 | 43.314704 | 190.05 | 152.3 | 638.3 | 256.32 | 8 c/c 250mm |
| | near 2 | 55.65 | 45.574704 | 190.05 | 152.3 | 606.6 | 256.32 | 8c/c 250mm |
| 2 to 3 | near 2 | 55.77 | 45.69378 | 190.05 | 152.3 | 605.0 | 256.32 | 8 c/c 250mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | near 3 | 53.28 | 43.20378 | 190.05 | 152.3 | 639.9 | 256.32 | 8 c/c 250mm |
| axis D | | | | | | | | |
| Story -6 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 90.21 | 69.599212 | 264 | 211.2 | 397.2 | 256.32 | 8 c/c 260mm |
| | near 2 | 93.16 | 72.549212 | 264 | 211.2 | 381.1 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 93.44 | 72.83146 | 264 | 211.2 | 379.6 | 256.32 | 8 c/c 260mm |
| | near 3 | 89.91 | 69.30146 | 264 | 211.2 | 398.9 | 256.32 | 8 c/c 260mm |
| axis D | | | | | | | | |
| Story -5 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 93.04 | 71.694116 | 264 | 211.2 | 385.6 | 256.32 | 8 c/c 260mm |
| | near 2 | 96.87 | 75.524116 | 264 | 211.2 | 366.1 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 97.17 | 75.824116 | 264 | 211.2 | 364.6 | 256.32 | 8 c/c 260mm |
| | near 3 | 92.74 | 71.39412 | 264 | 211.2 | 387.2 | 256.32 | 8 c/c 260mm |
| axis d | | | | | | | | |
| Story -4 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 99.33 | 76.430748 | 264 | 211.2 | 361.7 | 256.32 | 8 c/c 260mm |
| | near 2 | 104.4 | 81.500748 | 264 | 211.2 | 339.2 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 104.67 | 81.743772 | 264 | 211.2 | 338.2 | 256.32 | 8 c/c 260mm |
| | near 3 | 99.3 | 76.37377 | 264 | 211.2 | 362.0 | 256.32 | 8 c/c 260mm |
| axis D | | | | | | | | |
| Story -3 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 94.58 | 72.828352 | 264 | 211.2 | 379.6 | 256.32 | 8 c/c 260mm |
| | near 2 | 98.94 | 77.188352 | 264 | 211.2 | 358.2 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 99.08 | 77.329476 | 264 | 211.2 | 357.5 | 256.32 | 8 c/c 260mm |
| | near 3 | 94.43 | 72.67948 | 264 | 211.2 | 380.4 | 256.32 | 8 c/c 260mm |
| axis D | | | | | | | | |
| Story -2 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 89.07 | 68.36592 | 264 | 211.2 | 404.4 | 256.32 | 8 c/c 260mm |
| | near 2 | 95.13 | 74.42592 | 264 | 211.2 | 371.5 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 95.16 | 74.457044 | 264 | 211.2 | 371.3 | 256.32 | 8 c/c 260mm |
| | near 3 | 89.03 | 68.32704 | 264 | 211.2 | 404.6 | 256.32 | 8 c/c 260mm |

| axis D | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Story -1 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 27.23 | 20.588576 | 264 | 211.2 | 1342.8 | 213.6 | 8 c/c 260mm |
| | near 2 | 27.03 | 20.388576 | 264 | 211.2 | 1355.9 | 213.6 | 8c/c 260mm |
| 2 to 3 | near 2 | 27.03 | 20.388576 | 264 | 211.2 | 1355.9 | 213.6 | 8 c/c 260mm |
| | near 3 | 27.23 | 20.58858 | 264 | 211.2 | 1342.8 | 213.6 | 8 c/c 260mm |

Table G. 15: Shear Design for the beam on axis E for all story

| axis E | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Story -7 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 52.8 | 42.724704 | 190.05 | 152.3 | 647.1 | 256.32 | 8 c/c 250mm |
| | near 2 | 56.24 | 46.164704 | 190.05 | 152.3 | 598.8 | 256.32 | 8c/c 250mm |
| 2 to 3 | near 2 | 33.8 | 27.563 | 190.05 | 152.3 | 1003.0 | 256.32 | 8 c/c 250mm |
| | near 3 | 33.7 | 27.463 | 190.05 | 152.3 | 1006.7 | 256.32 | 8 c/c 250mm |
| axis E | | | | | | | | |
| Story -6 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 88.55 | 67.938088 | 264 | 211.2 | 406.9 | 256.32 | 8 c/c 260mm |
| | near 2 | 94.83 | 74.218088 | 264 | 211.2 | 372.5 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 58.44 | 45.202652 | 264 | 211.2 | 611.6 | 256.32 | 8 c/c 260mm |
| | near 3 | 59.33 | 46.09265 | 264 | 211.2 | 599.8 | 256.32 | 8 c/c 260mm |
| axis E | | | | | | | | |
| Story -5 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 91.68 | 70.334116 | 264 | 211.2 | 393.1 | 256.32 | 8 c/c 260mm |
| | near 2 | 98.23 | 76.884116 | 264 | 211.2 | 359.6 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 60.67 | 47.065104 | 264 | 211.2 | 587.4 | 256.32 | 8 c/c 260mm |
| | near 3 | 60.37 | 46.7651 | 264 | 211.2 | 591.2 | 256.32 | 8 c/c 260mm |
| axis E | | | | | | | | |
| Story -4 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 98.85 | 75.901292 | 264 | 211.2 | 364.2 | 256.32 | 8 c/c 260mm |
| | near 2 | 105.32 | 82.371292 | 264 | 211.2 | 335.6 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 64.94 | 50.488732 | 264 | 211.2 | 547.6 | 256.32 | 8 c/c 260mm |
| | near 3 | 63.63 | 49.17873 | 264 | 211.2 | 562.1 | 256.32 | 8 c/c 260mm |

| axis E | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Story -3 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 93.98 | 72.227228 | 264 | 211.2 | 382.8 | 256.32 | 8 c/c 260mm |
| | near 2 | 99.55 | 77.797228 | 264 | 211.2 | 355.4 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 62.48 | 48.614336 | 264 | 211.2 | 568.7 | 256.32 | 8 c/c 260mm |
| | near 3 | 60.88 | 47.01434 | 264 | 211.2 | 588.0 | 256.32 | 8 c/c 260mm |
| axis E | | | | | | | | |
| Story -2 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 89.22 | 68.52154 | 264 | 211.2 | 403.5 | 256.32 | 8 c/c 260mm |
| | near 2 | 94.93 | 74.23154 | 264 | 211.2 | 372.4 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 61.4 | 48.060368 | 264 | 211.2 | 575.2 | 256.32 | 8 c/c 260mm |
| | near 3 | 57.28 | 43.94037 | 264 | 211.2 | 629.2 | 256.32 | 8 c/c 260mm |
| axis E | | | | | | | | |
| Story -1 | | | | | | | | |
| span | loc | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 28.68 | 21.793776 | 264 | 211.2 | 1268.5 | 213.6 | 8 c/c 260mm |
| | near 2 | 27.58 | 20.693776 | 264 | 211.2 | 1335.9 | 213.6 | 8c/c 260mm |
| 2 to 3 | near 2 | 26.76 | 20.118576 | 264 | 211.2 | 1374.1 | 213.6 | 8 c/c 260mm |
| | near 3 | 27.5 | 20.85858 | 264 | 211.2 | 1325.4 | 213.6 | 8 c/c 260mm |

Table G. 16: Shear Design for the beam on axis F for all story

| axis F | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Story -7 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 52.8 | 42.7247 | 190.05 | 152.4 | 647.1 | 256.32 | 8 c/c 150mm |
| | near 2 | 56.24 | 46.1647 | 190.05 | 152.4 | 598.8 | 256.32 | 9 c/c 150mm |
| 2 to 3 | near 2 | 33.84 | 27.603 | 190.05 | 152.4 | 1001.5 | 256.32 | 8 c/c 100mm |
| | near 3 | 33.66 | 27.423 | 190.05 | 152.4 | 1008.1 | 256.32 | 8 c/c 150mm |
| axis F | | | | | | | | |
| Story -6 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 88.55 | 67.93809 | 264 | 211.2 | 406.9 | 256.32 | 8 c/c 260mm |
| | near 2 | 94.83 | 74.21809 | 264 | 211.2 | 372.5 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 58.44 | 45.14645 | 264 | 211.2 | 612.4 | 256.32 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | near 3 | 59.83 | 46.5365 | 264 | 211.2 | 594.1 | 256.32 | 8 c/c 260mm |
| axis F | | | | | | | | |
| Story -5 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 91.68 | 70.33412 | 264 | 211.2 | 393.1 | 256.32 | 8 c/c 260mm |
| | near 2 | 98.23 | 76.88412 | 264 | 211.2 | 359.6 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 60.67 | 47.0089 | 264 | 211.2 | 588.1 | 256.32 | 8 c/c 260mm |
| | near 3 | 60.87 | 47.2089 | 264 | 211.2 | 585.6 | 256.32 | 8 c/c 260mm |
| axis F | | | | | | | | |
| Story -4 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 98.65 | 75.72377 | 264 | 211.2 | 365.1 | 256.32 | 8 c/c 260mm |
| | near 2 | 105.32 | 82.39377 | 264 | 211.2 | 335.5 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 64.94 | 50.48873 | 264 | 211.2 | 547.6 | 256.32 | 8 c/c 260mm |
| | near 3 | 63.63 | 49.1787 | 264 | 211.2 | 562.1 | 256.32 | 8 c/c 260mm |
| axis F | | | | | | | | |
| Story -3 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 93.96 | 72.20948 | 264 | 211.2 | 382.9 | 256.32 | 8 c/c 260mm |
| | near 2 | 99.55 | 77.79948 | 264 | 211.2 | 355.3 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 62.46 | 48.59658 | 264 | 211.2 | 568.9 | 256.32 | 8 c/c 260mm |
| | near 3 | 60.88 | 47.0166 | 264 | 211.2 | 588.0 | 256.32 | 8 c/c 260mm |
| axis F | | | | | | | | |
| Story -2 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 89.22 | 68.51592 | 264 | 211.2 | 403.5 | 256.32 | 8 c/c 260mm |
| | near 2 | 94.98 | 74.27592 | 264 | 211.2 | 372.2 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 61.4 | 48.06037 | 264 | 211.2 | 575.2 | 256.32 | 8 c/c 260mm |
| | near 3 | 57.28 | 43.9404 | 264 | 211.2 | 629.2 | 256.32 | 8 c/c 260mm |
| axis F | | | | | | | | |
| Story -1 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 26.68 | 20.03858 | 264 | 211.2 | 1379.6 | 213.6 | 8 c/c 260mm |
| | near 2 | 27.58 | 20.93858 | 264 | 211.2 | 1320.3 | 213.6 | 8c/c 260mm |
| 2 to 3 | near 2 | 26.76 | 20.11858 | 264 | 211.2 | 1374.1 | 213.6 | 8 c/c 260mm |
| | near 3 | 27.5 | 20.8586 | 264 | 211.2 | 1325.4 | 213.6 | 8 c/c 260mm |

Table G. 17: Shear Design for the beam on axis G for all story

axis G

| Story -7 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 53.39 | 43.3147 | 190.5 | 152.4 | 638.3 | 256.32 | 8 c/c 250mm |
| | near 2 | 55.65 | 45.5747 | 190.5 | 152.4 | 606.6 | 256.32 | 8c/c 250mm |
| 2 to 3 | near 2 | 55.77 | 45.69378 | 190.5 | 152.4 | 605.0 | 256.32 | 8 c/c 250mm |
| | near 3 | 53.28 | 43.2038 | 190.5 | 152.4 | 639.9 | 256.32 | 8 c/c 250mm |
| axis G | | | | | | | | |
| Story -6 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 90.21 | 69.59809 | 264 | 211.2 | 397.2 | 256.32 | 8 c/c 260mm |
| | near 2 | 93.17 | 72.55809 | 264 | 211.2 | 381.0 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 93.45 | 72.83809 | 264 | 211.2 | 379.5 | 256.32 | 8 c/c 260mm |
| | near 3 | 89.93 | 69.3181 | 264 | 211.2 | 398.8 | 256.32 | 8 c/c 260mm |
| axis G | | | | | | | | |
| Story -5 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 93.03 | 71.68412 | 264 | 211.2 | 385.7 | 256.32 | 8 c/c 260mm |
| | near 2 | 96.88 | 75.53412 | 264 | 211.2 | 366.0 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 91.78 | 71.04108 | 264 | 211.2 | 389.2 | 256.32 | 8 c/c 260mm |
| | near 3 | 92.73 | 71.9911 | 264 | 211.2 | 384.0 | 256.32 | 8 c/c 260mm |
| axis G | | | | | | | | |
| Story -4 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 99.54 | 76.61714 | 264 | 211.2 | 360.8 | 256.32 | 8 c/c 260mm |
| | near 2 | 104.4 | 81.47714 | 264 | 211.2 | 339.3 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 104.68 | 81.75377 | 264 | 211.2 | 338.2 | 256.32 | 8 c/c 260mm |
| | near 3 | 99.29 | 76.3638 | 264 | 211.2 | 362.0 | 256.32 | 8 c/c 260mm |
| axis G | | | | | | | | |
| Story -3 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 94.58 | 72.82723 | 264 | 211.2 | 379.6 | 256.32 | 8 c/c 260mm |
| | near 2 | 98.95 | 77.19723 | 264 | 211.2 | 358.1 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 99.09 | 77.33835 | 264 | 211.2 | 357.5 | 256.32 | 8 c/c 260mm |
| | near 3 | 94.43 | 72.6784 | 264 | 211.2 | 380.4 | 256.32 | 8 c/c 260mm |
| axis G | | | | | | | | |

| Story -2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 89.06 | 68.35592 | 264 | 211.2 | 404.4 | 256.32 | 8 c/c 260mm |
| | near 2 | 95.14 | 74.43592 | 264 | 211.2 | 371.4 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 95.17 | 74.46592 | 264 | 211.2 | 371.3 | 256.32 | 8 c/c 260mm |
| | near 3 | 89.03 | 68.3259 | 264 | 211.2 | 404.6 | 256.32 | 8 c/c 260mm |
| axis G | | | | | | | | |
| Story -1 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 27.23 | 20.58858 | 264 | 270 | 1342.8 | 213.6 | 8 c/c 260mm |
| | near 2 | 27.03 | 20.38858 | 264 | 270 | 1355.9 | 213.6 | 8c/c 260mm |
| 2 to 3 | near 2 | 27.03 | 20.41306 | 264 | 270 | 1354.3 | 213.6 | 8 c/c 260mm |
| | near 3 | 27.03 | 20.4131 | 264 | 270 | 1354.3 | 213.6 | 8 c/c 260mm |

Table G. 18: Shear Design for the beam on axis I for all story

axis I

| Story -7 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 60.69 | 49.02173 | 190.05 | 152.4 | 563.9 | 256.32 | 8 c/c 250mm |
| | near 2 | 65.59 | 53.92173 | 190.05 | 152.4 | 512.7 | 256.32 | 8c/c 250mm |
| 2 to 3 | near 2 | 66.3 | 54.63173 | 190.05 | 152.4 | 506.0 | 256.32 | 8 c/c 250mm |
| | near 3 | 59.98 | 48.3117 | 190.05 | 152.4 | 572.2 | 256.32 | 8 c/c 250mm |
| axis I | | | | | | | | |
| Story -6 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 102.66 | 78.90763 | 264 | 211.2 | 350.4 | 256.32 | 8 c/c 260mm |
| | near 2 | 108.66 | 84.90763 | 264 | 211.2 | 325.6 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 109.59 | 85.86686 | 264 | 211.2 | 322.0 | 256.32 | 8 c/c 260mm |
| | near 3 | 101.47 | 77.7469 | 264 | 211.2 | 355.6 | 256.32 | 8 c/c 260mm |
| axis I | | | | | | | | |
| Story -5 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 105.87 | 81.30386 | 264 | 211.2 | 340.0 | 256.32 | 8 c/c 260mm |
| | near 2 | 112.69 | 88.12386 | 264 | 211.2 | 313.7 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 114.68 | 90.06665 | 264 | 211.2 | 306.9 | 256.32 | 8 c/c 260mm |
| | near 3 | 104.3 | 79.6866 | 264 | 211.2 | 346.9 | 256.32 | 8 c/c 260mm |

| axis I | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Story -4 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 112.98 | 86.51992 | 264 | 211.2 | 319.5 | 256.32 | 8 c/c 260mm |
| | near 2 | 122.43 | 95.96992 | 264 | 211.2 | 288.1 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 123.85 | 97.38992 | 264 | 211.2 | 283.9 | 256.32 | 8 c/c 260mm |
| | near 3 | 111.56 | 85.0999 | 264 | 211.2 | 324.9 | 256.32 | 8 c/c 260mm |
| axis I | | | | | | | | |
| Story -3 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 106.77 | 81.71941 | 264 | 211.2 | 338.3 | 256.32 | 8 c/c 260mm |
| | near 2 | 116.1 | 91.04941 | 264 | 211.2 | 303.6 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 117.1 | 92.05953 | 264 | 211.2 | 300.3 | 256.32 | 8 c/c 260mm |
| | near 3 | 105.68 | 80.6395 | 264 | 211.2 | 342.8 | 256.32 | 8 c/c 260mm |
| axis I | | | | | | | | |
| Story -2 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 99.82 | 76.0238 | 264 | 211.2 | 363.6 | 256.32 | 8 c/c 260mm |
| | near 2 | 111.89 | 88.0938 | 264 | 211.2 | 313.8 | 256.32 | 8c/c 260mm |
| 2 to 3 | near 2 | 112.37 | 88.5738 | 264 | 211.2 | 312.1 | 256.32 | 8 c/c 260mm |
| | near 3 | 99.34 | 75.5438 | 264 | 211.2 | 366.0 | 256.32 | 8 c/c 260mm |
| AXIS I | | | | | | | | |
| Story -1 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| 1 to 2 | near 1 | 32.96 | 24.95749 | 264 | 211.2 | 1107.7 | 213.6 | 8 c/c 260mm |
| | near 2 | 32.42 | 24.41749 | 264 | 211.2 | 1132.2 | 213.6 | 8c/c 260mm |
| 2 to 3 | near 2 | 32.64 | 24.63749 | 264 | 211.2 | 1122.1 | 213.6 | 8 c/c 260mm |
| | near 3 | 32.74 | 24.7375 | 264 | 211.2 | 1117.6 | 213.6 | 8 c/c 260mm |

Table G. 19: Shear Design for the beam on axis 1 for all story

AXIS 1

| Story -7 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 60.43 | 50 | 190.05 | 152.3 | 552.9 | 256.32 | 8 c/c 250mm |
| | near c | 58.08 | 49.479 | 190.05 | 152.3 | 558.7 | 256.32 | 8c/c 250mm |
| C TO D | near c | 59.61 | 48.68462 | 190.05 | 152.3 | 567.9 | 256.32 | 8 c/c 250mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | near d | 58.63 | 47.7046 | 190.05 | 152.3 | 579.5 | 256.32 | 8 c/c 250mm |
| d to e | near d | 59.13 | 48.2037 | 190.05 | 152.3 | 573.5 | 256.32 | 8 c/c 250mm |
| | near e | 59.12 | 48.1937 | 190.05 | 152.3 | 573.6 | 256.32 | 8c/c 250mm |
| e to f | near e | 59.12 | 48.1946 | 190.05 | 152.3 | 573.6 | 256.32 | 8 c/c 250mm |
| | near f | 59.12 | 48.1946 | 190.05 | 152.3 | 573.6 | 256.32 | 8 c/c 250mm |
| f to g | near f | 59.11 | 48.1846 | 190.05 | 152.3 | 573.7 | 256.32 | 8 c/c 250mm |
| | near g | 59.13 | 48.2046 | 190.05 | 152.3 | 573.5 | 256.32 | 8c/c 250mm |
| g to h | near g | 58.67 | 47.7446 | 190.05 | 152.3 | 579.0 | 256.32 | 8 c/c 250mm |
| | near h | 59.57 | 48.6446 | 190.05 | 152.3 | 568.3 | 256.32 | 8 c/c 250mm |
| h to i | near h | 57.05 | 46.2346 | 190.05 | 152.3 | 597.9 | 256.32 | 8 c/c 250mm |
| | near i | 60 | 49.1846 | 190.05 | 152.3 | 562.1 | 256.32 | 8 c/c 250mm |
| AXIS 1 | | | | | | | | |
| Story -6 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 135.73 | 105.5585 | 264 | 211.2 | 261.9 | 256.32 | 8 c/c 260mm |
| | near c | 132.7 | 102.5285 | 264 | 211.2 | 269.6 | 256.32 | 8c/c 260mm |
| C TO D | near c | 135.45 | 105.3324 | 264 | 211.2 | 262.5 | 256.32 | 8 c/c 260mm |
| | near d | 132.5 | 102.382 | 264 | 211.2 | 270.0 | 256.32 | 8 c/c 260mm |
| d to e | near d | 134.11 | 103.953 | 264 | 211.2 | 265.9 | 256.32 | 8 c/c 260mm |
| | near e | 134.19 | 104.033 | 264 | 211.2 | 265.7 | 256.32 | 8c/c 260mm |
| e to f | near e | 134.15 | 103.987 | 264 | 211.2 | 265.9 | 256.32 | 8 c/c 260mm |
| | near f | 134.2 | 104.037 | 264 | 211.2 | 265.7 | 256.32 | 8 c/c 260mm |
| f to g | near f | 134.2 | 104.043 | 264 | 211.2 | 265.7 | 256.32 | 8 c/c 260mm |
| | near g | 134.1 | 103.943 | 264 | 211.2 | 266.0 | 256.32 | 8c/c 260mm |
| g to h | near g | 132.9 | 102.744 | 264 | 211.2 | 269.1 | 256.32 | 8 c/c 260mm |
| | near h | 135.39 | 105.234 | 264 | 211.2 | 262.7 | 256.32 | 8 c/c 260mm |
| h to i | near h | 132.5 | 102.343 | 264 | 211.2 | 270.1 | 256.32 | 8 c/c 260mm |
| | near i | 135.8 | 105.643 | 264 | 211.2 | 261.7 | 256.32 | 8 c/c 260mm |
| AXIS 1 | | | | | | | | |
| Story -5 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 83.2 | 59.95568 | 264 | 211.2 | 461.1 | 256.32 | 8 c/c 260mm |
| | near c | 123.6 | 100.3557 | 264 | 211.2 | 275.5 | 256.32 | 8c/c 260mm |
| C TO D | near c | 142.37 | 110.4967 | 264 | 211.2 | 250.2 | 256.32 | 8 c/c 260mm |
| | near d | 141.2 | 109.327 | 264 | 211.2 | 252.9 | 256.32 | 8 c/c 260mm |
| d to e | near d | 141.67 | 109.806 | 264 | 211.2 | 251.8 | 256.32 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | near e | 141.82 | 109.956 | 264 | 211.2 | 251.4 | 256.32 | 8c/c 260mm |
| e to f | near e | 141.79 | 109.916 | 264 | 211.2 | 251.5 | 256.32 | 8 c/c 260mm |
| | near f | 141.79 | 109.916 | 264 | 211.2 | 251.5 | 256.32 | 8 c/c 260mm |
| f to g | near f | 141.02 | 109.236 | 264 | 211.2 | 253.1 | 256.32 | 8 c/c 260mm |
| | near g | 141.76 | 109.976 | 264 | 211.2 | 251.4 | 256.32 | 8c/c 260mm |
| g to h | near g | 141.2 | 109.335 | 264 | 211.2 | 252.9 | 256.32 | 8 c/c 260mm |
| | near h | 142.3 | 110.435 | 264 | 211.2 | 250.3 | 256.32 | 8 c/c 260mm |
| h to i | near h | 123.6 | 100.299 | 264 | 211.2 | 275.6 | 256.32 | 8 c/c 260mm |
| | near i | 83.7 | 60.3995 | 264 | 211.2 | 457.7 | 256.32 | 8 c/c 260mm |
| AXIS 1 | | | | | | | | |
| Story -4 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 70.15 | 54.61295 | 264 | 211.2 | 506.2 | 256.32 | 8 c/c 260mm |
| | near c | 68.08 | 52.54295 | 264 | 211.2 | 526.2 | 256.32 | 8c/c 260mm |
| C TO D | near c | 143.99 | 111.3277 | 264 | 211.2 | 248.3 | 256.32 | 8 c/c 260mm |
| | near d | 146.6 | 113.938 | 264 | 211.2 | 242.6 | 256.32 | 8 c/c 260mm |
| d to e | near d | 145.02 | 112.433 | 264 | 211.2 | 245.9 | 256.32 | 8 c/c 260mm |
| | near e | 144.9 | 112.313 | 264 | 211.2 | 246.1 | 256.32 | 8c/c 260mm |
| e to f | near e | 145.3 | 112.635 | 264 | 211.2 | 245.4 | 256.32 | 8 c/c 260mm |
| | near f | 145.31 | 112.645 | 264 | 211.2 | 245.4 | 256.32 | 8 c/c 260mm |
| f to g | near f | 146.1 | 113.324 | 264 | 211.2 | 244.0 | 256.32 | 8 c/c 260mm |
| | near g | 145.5 | 112.724 | 264 | 211.2 | 245.3 | 256.32 | 8c/c 260mm |
| g to h | near g | 146.4 | 113.512 | 264 | 211.2 | 243.5 | 256.32 | 8 c/c 260mm |
| | near h | 146.2 | 113.312 | 264 | 211.2 | 244.0 | 256.32 | 8 c/c 260mm |
| h to i | near h | 69 | 54.1528 | 264 | 211.2 | 510.5 | 256.32 | 8 c/c 260mm |
| | near i | 70.2 | 54.4528 | 264 | 211.2 | 507.7 | 256.32 | 8 c/c 260mm |
| AXIS 1 | | | | | | | | |
| Story -3 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 69.1 | 54.15305 | 264 | 211.2 | 510.5 | 256.32 | 8 c/c 260mm |
| | near c | 63.88 | 48.93305 | 264 | 211.2 | 565.0 | 256.32 | 8c/c 260mm |
| C TO D | near c | 80.9 | 57.45336 | 264 | 211.2 | 481.2 | 256.32 | 8 c/c 260mm |
| | near d | 127.7 | 104.253 | 264 | 211.2 | 265.2 | 256.32 | 8 c/c 260mm |
| d to e | near d | 141.7 | 109.632 | 264 | 211.2 | 252.2 | 256.32 | 8 c/c 260mm |
| | near e | 143.6 | 111.532 | 264 | 211.2 | 247.9 | 256.32 | 8c/c 260mm |
| e to f | near e | 142.7 | 110.627 | 264 | 211.2 | 249.9 | 256.32 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | near f | 142.65 | 110.577 | 264 | 211.2 | 250.0 | 256.32 | 8 c/c 260mm |
| f to g | near f | 143.47 | 111.394 | 264 | 211.2 | 248.2 | 256.32 | 8 c/c 260mm |
| | near g | 141.9 | 109.824 | 264 | 211.2 | 251.7 | 256.32 | 8c/c 260mm |
| g to h | near g | 131.3 | 107.089 | 264 | 211.2 | 258.2 | 256.32 | 8 c/c 260mm |
| | near h | 84.1 | 59.889 | 264 | 211.2 | 461.6 | 256.32 | 8 c/c 260mm |
| h to i | near h | 64 | 49.0429 | 264 | 211.2 | 563.7 | 256.32 | 8 c/c 260mm |
| | near i | 69.07 | 54.1129 | 264 | 211.2 | 510.9 | 256.32 | 8 c/c 260mm |
| AXIS 1 | | | | | | | | |
| Story -2 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 67.8 | 53.188 | 264 | 211.2 | 519.8 | 256.32 | 8 c/c 260mm |
| | near c | 62.2 | 47.588 | 264 | 211.2 | 580.9 | 256.32 | 8c/c 260mm |
| C TO D | near c | 65.71 | 51.09238 | 264 | 211.2 | 541.1 | 256.32 | 8 c/c 260mm |
| | near d | 64.34 | 49.7224 | 264 | 211.2 | 556.0 | 256.32 | 8 c/c 260mm |
| d to e | near d | 65.19 | 50.5791 | 264 | 211.2 | 546.6 | 256.32 | 8 c/c 260mm |
| | near e | 64.8 | 50.1891 | 264 | 211.2 | 550.8 | 256.32 | 8c/c 260mm |
| e to f | near e | 65.02 | 50.4024 | 264 | 211.2 | 548.5 | 256.32 | 8 c/c 260mm |
| | near f | 65.03 | 50.4124 | 264 | 211.2 | 548.4 | 256.32 | 8 c/c 260mm |
| f to g | near f | 64.89 | 50.2791 | 264 | 211.2 | 549.8 | 256.32 | 8 c/c 260mm |
| | near g | 65.1 | 50.4891 | 264 | 211.2 | 547.6 | 256.32 | 8c/c 260mm |
| g to h | near g | 64.38 | 49.7702 | 264 | 211.2 | 555.5 | 256.32 | 8 c/c 260mm |
| | near h | 65.6 | 50.9902 | 264 | 211.2 | 542.2 | 256.32 | 8 c/c 260mm |
| h to i | near h | 62.18 | 47.5601 | 264 | 211.2 | 581.3 | 256.32 | 8 c/c 260mm |
| | near i | 67.89 | 53.2701 | 264 | 211.2 | 519.0 | 256.32 | 8 c/c 260mm |
| AXIS 1 | | | | | | | | |
| Story -1 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 34 | 26.044 | 264 | 211.2 | 1061.5 | 213.6 | 8 c/c 260mm |
| | near c | 31 | 23.044 | 264 | 211.2 | 1199.7 | 213.6 | 8c/c 260mm |
| C TO D | near c | 32.91 | 24.90871 | 264 | 211.2 | 1109.9 | 213.6 | 8 c/c 260mm |
| | near d | 32.46 | 24.4587 | 264 | 211.2 | 1130.3 | 213.6 | 8 c/c 260mm |
| d to e | near d | 32.6 | 24.6073 | 264 | 211.2 | 1123.5 | 213.6 | 8 c/c 260mm |
| | near e | 32.7 | 24.7073 | 264 | 211.2 | 1118.9 | 213.6 | 8c/c 260mm |
| e to f | near e | 32.68 | 24.6787 | 264 | 211.2 | 1120.2 | 213.6 | 8 c/c 260mm |
| | near f | 32.69 | 24.6887 | 264 | 211.2 | 1119.8 | 213.6 | 8 c/c 260mm |
| f to g | near f | 32.68 | 24.6787 | 264 | 211.2 | 1120.2 | 213.6 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | near g | 32.69 | 24.6887 | 264 | 211.2 | 1119.8 | 213.6 | 8c/c 260mm |
| g to h | near g | 32.46 | 24.4587 | 264 | 211.2 | 1130.3 | 213.6 | 8 c/c 260mm |
| | near h | 32.91 | 24.9087 | 264 | 211.2 | 1109.9 | 213.6 | 8 c/c 260mm |
| h to i | near h | 31.36 | 23.3587 | 264 | 211.2 | 1183.5 | 213.6 | 8 c/c 260mm |
| | near i | 34.01 | 26.0087 | 264 | 211.2 | 1062.9 | 213.6 | 8 c/c 260mm |

Table G. 20: Shear Design for the beam on axis 2 for all story

AXIS 2

| Story -7 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| a to b | near a | 23.95 | 19.15906 | 190.5 | 152.3 | 1443.0 | 256.32 | 8 c/c 250mm |
| | near b | 27.9 | 23.10906 | 190.5 | 152.3 | 1196.3 | 256.32 | 8c/c 250mm |
| b TO c | near b | 53.9 | 43.82655 | 190.5 | 152.3 | 630.8 | 256.32 | 8 c/c 250mm |
| | near c | 55.12 | 45.0466 | 190.5 | 152.3 | 613.7 | 256.32 | 8 c/c 250mm |
| c to d | near c | 54.58 | 44.5038 | 190.5 | 152.3 | 621.2 | 256.32 | 8 c/c 250mm |
| | near d | 54.47 | 44.3938 | 190.5 | 152.3 | 622.7 | 256.32 | 8c/c 250mm |
| d to e | near d | 53.93 | 43.8538 | 190.5 | 152.3 | 630.4 | 256.32 | 8 c/c 250mm |
| | near e | 55.12 | 45.0438 | 190.5 | 152.3 | 613.8 | 256.32 | 8 c/c 250mm |
| e to f | near e | 33.75 | 27.513 | 190.5 | 152.3 | 1004.8 | 256.32 | 8 c/c 250mm |
| | near f | 33.75 | 27.513 | 190.5 | 152.3 | 1004.8 | 256.32 | 8c/c 250mm |
| f to g | near f | 55.12 | 45.0438 | 190.5 | 152.3 | 613.8 | 256.32 | 8 c/c 250mm |
| | near g | 53.93 | 43.8538 | 190.5 | 152.3 | 630.4 | 256.32 | 8 c/c 250mm |
| g to h | near g | 54.47 | 44.3938 | 190.5 | 152.3 | 622.7 | 256.32 | 8 c/c 250mm |
| | near h | 54.58 | 44.5038 | 190.5 | 152.3 | 621.2 | 256.32 | 8 c/c 250mm |
| h to i | near h | 55.12 | 45.0438 | 190.5 | 152.3 | 613.8 | 256.32 | 8 c/c 250mm |
| | near i | 53.93 | 43.8538 | 190.5 | 152.3 | 630.4 | 256.32 | 8 c/c 250mm |
| I to j | near i | 27.9 | 23.1137 | 190.5 | 152.3 | 1196.1 | 256.32 | 8 c/c 250mm |
| | near j | 23.9 | 19.1137 | 190.5 | 152.3 | 1446.4 | 256.32 | 8 c/c 250mm |
| AXIS 2 | | | | | | | | |
| Story -6 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| a to b | near a | 43.3 | 32.7625 | 264 | 211.2 | 843.8 | 256.32 | 8 c/c 260mm |
| | near b | 50.45 | 39.9125 | 264 | 211.2 | 692.7 | 256.32 | 8c/c 260mm |
| b TO c | near b | 90.87 | 70.28057 | 264 | 211.2 | 393.4 | 256.32 | 8 c/c 260mm |
| | near c | 92.31 | 71.7206 | 264 | 211.2 | 385.5 | 256.32 | 8 c/c 260mm |
| c to d | near c | 91.85 | 71.2606 | 264 | 211.2 | 388.0 | 256.32 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | near d | 91.33 | 70.7406 | 264 | 211.2 | 390.8 | 256.32 | 8c/c 260mm |
| d to e | near d | 89.93 | 69.3181 | 264 | 211.2 | 398.8 | 256.32 | 8 c/c 260mm |
| | near e | 93.45 | 72.8381 | 264 | 211.2 | 379.5 | 256.32 | 8 c/c 260mm |
| e to f | near e | 59.13 | 45.8365 | 264 | 211.2 | 603.1 | 256.32 | 8 c/c 260mm |
| | near f | 59.14 | 45.8465 | 264 | 211.2 | 603.0 | 256.32 | 8c/c 260mm |
| f to g | near f | 93.44 | 72.829 | 264 | 211.2 | 379.6 | 256.32 | 8 c/c 260mm |
| | near g | 89.932 | 69.321 | 264 | 211.2 | 398.8 | 256.32 | 8 c/c 260mm |
| g to h | near g | 91.52 | 70.9092 | 264 | 211.2 | 389.9 | 256.32 | 8 c/c 260mm |
| | near h | 91.85 | 71.2392 | 264 | 211.2 | 388.1 | 256.32 | 8 c/c 260mm |
| h to i | near h | 92.5 | 71.8881 | 264 | 211.2 | 384.6 | 256.32 | 8 c/c 260mm |
| | near i | 90.88 | 70.2681 | 264 | 211.2 | 393.4 | 256.32 | 8 c/c 260mm |
| I to j | near i | 50.44 | 39.9036 | 264 | 211.2 | 692.8 | 256.32 | 8 c/c 260mm |
| | near j | 43.3 | 32.7636 | 264 | 211.2 | 843.8 | 256.32 | 8 c/c 260mm |
| AXIS 2 | | | | | | | | |
| Story -5 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| a to b | near a | 43.99 | 33.22433 | 264 | 211.2 | 832.1 | 256.32 | 8 c/c 260mm |
| | near b | 51.79 | 41.02433 | 264 | 211.2 | 673.9 | 256.32 | 8c/c 260mm |
| b TO c | near b | 93.99 | 72.64412 | 264 | 211.2 | 380.6 | 256.32 | 8 c/c 260mm |
| | near c | 95.92 | 74.5741 | 264 | 211.2 | 370.7 | 256.32 | 8 c/c 260mm |
| c to d | near c | 95.08 | 73.7341 | 264 | 211.2 | 374.9 | 256.32 | 8 c/c 260mm |
| | near d | 94.83 | 73.4841 | 264 | 211.2 | 376.2 | 256.32 | 8c/c 260mm |
| d to e | near d | 93.51 | 72.1641 | 264 | 211.2 | 383.1 | 256.32 | 8 c/c 260mm |
| | near e | 96.4 | 75.0541 | 264 | 211.2 | 368.3 | 256.32 | 8 c/c 260mm |
| e to f | near e | 60.77 | 47.1089 | 264 | 211.2 | 586.8 | 256.32 | 8 c/c 260mm |
| | near f | 60.77 | 47.1089 | 264 | 211.2 | 586.8 | 256.32 | 8c/c 260mm |
| f to g | near f | 96.39 | 75.0239 | 264 | 211.2 | 368.5 | 256.32 | 8 c/c 260mm |
| | near g | 93.7 | 72.3339 | 264 | 211.2 | 382.2 | 256.32 | 8 c/c 260mm |
| g to h | near g | 94.83 | 73.4841 | 264 | 211.2 | 376.2 | 256.32 | 8 c/c 260mm |
| | near h | 95.08 | 73.7341 | 264 | 211.2 | 374.9 | 256.32 | 8 c/c 260mm |
| h to i | near h | 95.91 | 74.5641 | 264 | 211.2 | 370.8 | 256.32 | 8 c/c 260mm |
| | near i | 94 | 72.6541 | 264 | 211.2 | 380.5 | 256.32 | 8 c/c 260mm |
| I to j | near i | 51.79 | 41.0243 | 264 | 211.2 | 673.9 | 256.32 | 8 c/c 260mm |
| | near j | 43.99 | 33.2243 | 264 | 211.2 | 832.1 | 256.32 | 8 c/c 260mm |
| AXIS 2 | | | | | | | | |
| Story -4 | | | | | | | | |

| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
|---|---|---|---|---|---|---|---|---|
| a to b | near a | 45.69 | 34.43202 | 264 | 211.2 | 802.9 | 256.32 | 8 c/c 260mm |
| | near b | 54.47 | 43.21202 | 264 | 211.2 | 639.8 | 256.32 | 8c/c 260mm |
| b TO c | near b | 100.75 | 77.8204 | 264 | 211.2 | 355.2 | 256.32 | 8 c/c 260mm |
| | near c | 103.25 | 80.3204 | 264 | 211.2 | 344.2 | 256.32 | 8 c/c 260mm |
| c to d | near c | 102.05 | 79.126 | 264 | 211.2 | 349.4 | 256.32 | 8 c/c 260mm |
| | near d | 101.9 | 78.976 | 264 | 211.2 | 350.1 | 256.32 | 8c/c 260mm |
| d to e | near d | 101 | 78.0816 | 264 | 211.2 | 354.1 | 256.32 | 8 c/c 260mm |
| | near e | 102.9 | 79.9816 | 264 | 211.2 | 345.6 | 256.32 | 8 c/c 260mm |
| e to f | near e | 64.2 | 49.7678 | 264 | 211.2 | 555.5 | 256.32 | 8 c/c 260mm |
| | near f | 64.2 | 49.7678 | 264 | 211.2 | 555.5 | 256.32 | 8c/c 260mm |
| f to g | near f | 102.92 | 75.0239 | 264 | 211.2 | 368.5 | 256.32 | 8 c/c 260mm |
| | near g | 101.2 | 72.3339 | 264 | 211.2 | 382.2 | 256.32 | 8 c/c 260mm |
| g to h | near g | 101.9 | 79.9769 | 264 | 211.2 | 345.7 | 256.32 | 8 c/c 260mm |
| | near h | 102.04 | 78.2569 | 264 | 211.2 | 353.3 | 256.32 | 8 c/c 260mm |
| h to i | near h | 103.22 | 80.2994 | 264 | 211.2 | 344.3 | 256.32 | 8 c/c 260mm |
| | near i | 100.7 | 77.7794 | 264 | 211.2 | 355.4 | 256.32 | 8 c/c 260mm |
| I to j | near i | 54.48 | 43.222 | 264 | 211.2 | 639.6 | 256.32 | 8 c/c 260mm |
| | near j | 45.68 | 34.422 | 264 | 211.2 | 803.1 | 256.32 | 8 c/c 260mm |
| AXIS 2 | | | | | | | | |
| Story -3 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| a to b | near a | 44.34 | 33.44844 | 264 | 211.2 | 826.5 | 256.32 | 8 c/c 260mm |
| | near b | 52.56 | 41.66844 | 264 | 211.2 | 663.5 | 256.32 | 8c/c 260mm |
| b TO c | near b | 95.6 | 73.86184 | 264 | 211.2 | 374.3 | 256.32 | 8 c/c 260mm |
| | near c | 97.8 | 76.0618 | 264 | 211.2 | 363.5 | 256.32 | 8 c/c 260mm |
| c to d | near c | 98.84 | 76.8647 | 264 | 211.2 | 359.7 | 256.32 | 8 c/c 260mm |
| | near d | 96.67 | 74.6947 | 264 | 211.2 | 370.1 | 256.32 | 8c/c 260mm |
| d to e | near d | 90.15 | 78.0816 | 264 | 211.2 | 354.1 | 256.32 | 8 c/c 260mm |
| | near e | 97.15 | 79.9816 | 264 | 211.2 | 345.6 | 256.32 | 8 c/c 260mm |
| e to f | near e | 61.68 | 47.8143 | 264 | 211.2 | 578.2 | 256.32 | 8 c/c 260mm |
| | near f | 61.68 | 47.8143 | 264 | 211.2 | 578.2 | 256.32 | 8c/c 260mm |
| f to g | near f | 97.37 | 75.624 | 264 | 211.2 | 365.6 | 256.32 | 8 c/c 260mm |
| | near g | 96.1 | 74.354 | 264 | 211.2 | 371.8 | 256.32 | 8 c/c 260mm |
| g to h | near g | 90.09 | 75.7936 | 264 | 211.2 | 364.7 | 256.32 | 8 c/c 260mm |
| | near h | 96.8 | 77.7794 | 264 | 211.2 | 355.4 | 256.32 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| h to i | near h | 97.8 | 76.0562 | 264 | 211.2 | 363.5 | 256.32 | 8 c/c 260mm |
| | near i | 95.65 | 73.9062 | 264 | 211.2 | 374.1 | 256.32 | 8 c/c 260mm |
| I to j | near i | 52.58 | 42.0256 | 264 | 211.2 | 657.8 | 256.32 | 8 c/c 260mm |
| | near j | 41.32 | 30.7656 | 264 | 211.2 | 898.6 | 256.32 | 8 c/c 260mm |
| AXIS 2 | | | | | | | | |
| Story -2 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| a to b | near a | 42.24 | 31.68114 | 264 | 211.2 | 872.6 | 256.32 | 8 c/c 260mm |
| | near b | 51.7 | 41.14114 | 264 | 211.2 | 672.0 | 256.32 | 8c/c 260mm |
| b TO c | near b | 90.87 | 70.16592 | 264 | 211.2 | 394.0 | 256.32 | 8 c/c 260mm |
| | near c | 93.33 | 72.6259 | 264 | 211.2 | 380.7 | 256.32 | 8 c/c 260mm |
| c to d | near c | 92.15 | 71.4459 | 264 | 211.2 | 386.9 | 256.32 | 8 c/c 260mm |
| | near d | 92.05 | 71.3459 | 264 | 211.2 | 387.5 | 256.32 | 8c/c 260mm |
| d to e | near d | 92.22 | 71.517 | 264 | 211.2 | 386.6 | 256.32 | 8 c/c 260mm |
| | near e | 91.97 | 71.267 | 264 | 211.2 | 387.9 | 256.32 | 8 c/c 260mm |
| e to f | near e | 59.34 | 46.0004 | 264 | 211.2 | 601.0 | 256.32 | 8 c/c 260mm |
| | near f | 59.34 | 46.0004 | 264 | 211.2 | 601.0 | 256.32 | 8c/c 260mm |
| f to g | near f | 91.97 | 75.624 | 264 | 211.2 | 365.6 | 256.32 | 8 c/c 260mm |
| | near g | 92.22 | 74.354 | 264 | 211.2 | 371.8 | 256.32 | 8 c/c 260mm |
| g to h | near g | 92.04 | 71.267 | 264 | 211.2 | 387.9 | 256.32 | 8 c/c 260mm |
| | near h | 92.13 | 71.517 | 264 | 211.2 | 386.6 | 256.32 | 8 c/c 260mm |
| h to i | near h | 93.32 | 72.617 | 264 | 211.2 | 380.7 | 256.32 | 8 c/c 260mm |
| | near i | 90.87 | 70.167 | 264 | 211.2 | 394.0 | 256.32 | 8 c/c 260mm |
| I to j | near i | 51.76 | 41.1944 | 264 | 211.2 | 671.1 | 256.32 | 8 c/c 260mm |
| | near j | 42.24 | 31.6744 | 264 | 211.2 | 872.8 | 256.32 | 8 c/c 260mm |
| AXIS 2 | | | | | | | | |
| Story -1 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| a to b | near a | 28.4 | 21.51378 | 264 | 211.2 | 1285.0 | 213.6 | 8 c/c 260mm |
| | near b | 27.86 | 20.97378 | 264 | 211.2 | 1318.1 | 213.6 | 8c/c 260mm |
| b TO c | near b | 27.47 | 20.82858 | 264 | 211.2 | 1327.3 | 213.6 | 8 c/c 260mm |
| | near c | 26.79 | 20.1486 | 264 | 211.2 | 1372.1 | 213.6 | 8 c/c 260mm |
| c to d | near c | 27.16 | 20.5186 | 264 | 211.2 | 1347.3 | 213.6 | 8 c/c 260mm |
| | near d | 27.1 | 20.4586 | 264 | 211.2 | 1351.3 | 213.6 | 8c/c 260mm |
| d to e | near d | 26.5 | 19.8659 | 264 | 211.2 | 1391.6 | 213.6 | 8 c/c 260mm |
| | near e | 27.7 | 21.0659 | 264 | 211.2 | 1312.3 | 213.6 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| e to f | near e | 27.12 | 20.4786 | 264 | 211.2 | 1350.0 | 213.6 | 8 c/c 260mm |
| | near f | 27.14 | 20.4986 | 264 | 211.2 | 1348.7 | 213.6 | 8c/c 260mm |
| f to g | near f | 27.6 | 20.9684 | 264 | 211.2 | 1318.4 | 213.6 | 8 c/c 260mm |
| | near g | 26.58 | 19.9484 | 264 | 211.2 | 1385.9 | 213.6 | 8 c/c 260mm |
| g to h | near g | 27.09 | 20.4486 | 264 | 211.2 | 1352.0 | 213.6 | 8 c/c 260mm |
| | near h | 27.17 | 20.5286 | 264 | 211.2 | 1346.7 | 213.6 | 8 c/c 260mm |
| h to i | near h | 26.7 | 20.0757 | 264 | 211.2 | 1377.1 | 213.6 | 8 c/c 260mm |
| | near i | 27.42 | 20.7957 | 264 | 211.2 | 1329.4 | 213.6 | 8 c/c 260mm |
| I to j | near i | 27.84 | 21.1986 | 264 | 211.2 | 1304.1 | 213.6 | 8 c/c 260mm |
| | near j | 26.42 | 19.7786 | 264 | 211.2 | 1397.8 | 213.6 | 8 c/c 260mm |

Table G. 21: Shear Design for the beam on axis 3 for all story

AXIS 3

| Story -7 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 60.22 | 49.29185 | 190.05 | 152.3 | 560.9 | 256.32 | 8 c/c 250mm |
| | near c | 58.05 | 47.12185 | 190.05 | 152.3 | 586.7 | 256.32 | 8c/c 250mm |
| C TO D | near c | 59.19 | 48.26185 | 190.05 | 152.3 | 572.8 | 256.32 | 8 c/c 250mm |
| | near d | 59.08 | 48.1519 | 190.05 | 152.3 | 574.1 | 256.32 | 8 c/c 250mm |
| d to e | near d | 57.94 | 47.0109 | 190.05 | 152.3 | 588.1 | 256.32 | 8 c/c 250mm |
| | near e | 60.34 | 49.4109 | 190.05 | 152.3 | 559.5 | 256.32 | 8c/c 250mm |
| e to f | near e | 12.98 | 10.5813 | 190.05 | 152.3 | 2612.7 | 256.32 | 8 c/c 250mm |
| | near f | 12.98 | 10.5813 | 190.05 | 152.3 | 2612.7 | 256.32 | 8 c/c 250mm |
| f to g | near f | 60.3 | 49.3746 | 190.05 | 152.3 | 559.9 | 256.32 | 8 c/c 250mm |
| | near g | 57.94 | 47.0146 | 190.05 | 152.3 | 588.0 | 256.32 | 8c/c 250mm |
| g to h | near g | 59.07 | 48.1585 | 190.05 | 152.3 | 574.1 | 256.32 | 8 c/c 250mm |
| | near h | 59.02 | 48.1085 | 190.05 | 152.3 | 574.7 | 256.32 | 8 c/c 250mm |
| h to i | near h | 58.03 | 47.1019 | 190.05 | 152.3 | 586.9 | 256.32 | 8 c/c 250mm |
| | near i | 60.24 | 49.3119 | 190.05 | 152.3 | 560.6 | 256.32 | 8 c/c 250mm |
| AXIS 3 | | | | | | | | |
| Story -6 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 135.9 | 105.7543 | 264 | 211.2 | 261.4 | 256.32 | 8 c/c 260mm |
| | near c | 132.3 | 102.1543 | 264 | 211.2 | 270.6 | 256.32 | 8c/c 260mm |
| C TO D | near c | 134.3 | 104.1543 | 264 | 211.2 | 265.4 | 256.32 | 8 c/c 260mm |
| | near d | 133.9 | 103.754 | 264 | 211.2 | 266.5 | 256.32 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| d to e | near d | 131.8 | 101.649 | 264 | 211.2 | 272.0 | 256.32 | 8 c/c 260mm |
| | near e | 136.45 | 106.299 | 264 | 211.2 | 260.1 | 256.32 | 8c/c 260mm |
| e to f | near e | 31.41 | 24.3479 | 264 | 211.2 | 1135.4 | 256.32 | 8 c/c 260mm |
| | near f | 31.42 | 24.3579 | 264 | 211.2 | 1135.0 | 256.32 | 8 c/c 260mm |
| f to g | near f | 136.44 | 106.29 | 264 | 211.2 | 260.1 | 256.32 | 8 c/c 260mm |
| | near g | 131.8 | 101.65 | 264 | 211.2 | 272.0 | 256.32 | 8c/c 260mm |
| g to h | near g | 133.98 | 103.825 | 264 | 211.2 | 266.3 | 256.32 | 8 c/c 260mm |
| | near h | 134.3 | 104.145 | 264 | 211.2 | 265.5 | 256.32 | 8 c/c 260mm |
| h to i | near h | 132.9 | 102.732 | 264 | 211.2 | 269.1 | 256.32 | 8 c/c 260mm |
| | near i | 135.5 | 105.332 | 264 | 211.2 | 262.5 | 256.32 | 8 c/c 260mm |
| AXIS 3 | | | | | | | | |
| Story -5 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 143.3 | 111.4571 | 264 | 211.2 | 248.0 | 256.32 | 8 c/c 260mm |
| | near c | 140 | 108.1571 | 264 | 211.2 | 255.6 | 256.32 | 8c/c 260mm |
| C TO D | near c | 141 | 109.2358 | 264 | 211.2 | 253.1 | 256.32 | 8 c/c 260mm |
| | near d | 141.6 | 109.836 | 264 | 211.2 | 251.7 | 256.32 | 8 c/c 260mm |
| d to e | near d | 140 | 108.135 | 264 | 211.2 | 255.7 | 256.32 | 8 c/c 260mm |
| | near e | 143.5 | 111.635 | 264 | 211.2 | 247.6 | 256.32 | 8c/c 260mm |
| e to f | near e | 31.4 | 24.3479 | 264 | 211.2 | 1135.4 | 256.32 | 8 c/c 260mm |
| | near f | 31.42 | 24.3579 | 264 | 211.2 | 1135.0 | 256.32 | 8 c/c 260mm |
| f to g | near f | 143.49 | 111.616 | 264 | 211.2 | 247.7 | 256.32 | 8 c/c 260mm |
| | near g | 140.09 | 108.216 | 264 | 211.2 | 255.5 | 256.32 | 8c/c 260mm |
| g to h | near g | 141.67 | 109.797 | 264 | 211.2 | 251.8 | 256.32 | 8 c/c 260mm |
| | near h | 141.9 | 110.027 | 264 | 211.2 | 251.3 | 256.32 | 8 c/c 260mm |
| h to i | near h | 140.23 | 108.339 | 264 | 211.2 | 255.2 | 256.32 | 8 c/c 260mm |
| | near i | 143.5 | 111.609 | 264 | 211.2 | 247.7 | 256.32 | 8 c/c 260mm |
| AXIS 3 | | | | | | | | |
| Story -4 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 146.8 | 114.1366 | 264 | 211.2 | 242.2 | 256.32 | 8 c/c 260mm |
| | near c | 143.8 | 111.1366 | 264 | 211.2 | 248.8 | 256.32 | 8c/c 260mm |
| C TO D | near c | 145.25 | 112.5866 | 264 | 211.2 | 245.6 | 256.32 | 8 c/c 260mm |
| | near d | 145.35 | 112.687 | 264 | 211.2 | 245.3 | 256.32 | 8 c/c 260mm |
| d to e | near d | 144.34 | 111.683 | 264 | 211.2 | 247.5 | 256.32 | 8 c/c 260mm |
| | near e | 146.2 | 113.543 | 264 | 211.2 | 243.5 | 256.32 | 8c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| e to f | near e | 31.21 | 24.1715 | 264 | 211.2 | 1143.7 | 256.32 | 8 c/c 260mm |
| | near f | 31.41 | 24.3715 | 264 | 211.2 | 1134.3 | 256.32 | 8 c/c 260mm |
| f to g | near f | 146.27 | 113.607 | 264 | 211.2 | 243.3 | 256.32 | 8 c/c 260mm |
| | near g | 144.33 | 111.667 | 264 | 211.2 | 247.6 | 256.32 | 8c/c 260mm |
| g to h | near g | 145.25 | 112.592 | 264 | 211.2 | 245.5 | 256.32 | 8 c/c 260mm |
| | near h | 145.3 | 112.642 | 264 | 211.2 | 245.4 | 256.32 | 8 c/c 260mm |
| h to i | near h | 143.74 | 111.075 | 264 | 211.2 | 248.9 | 256.32 | 8 c/c 260mm |
| | near i | 146.87 | 114.205 | 264 | 211.2 | 242.1 | 256.32 | 8 c/c 260mm |
| AXIS 3 | | | | | | | | |
| Story -3 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 143.6 | 111.4424 | 264 | 211.2 | 248.1 | 256.32 | 8 c/c 260mm |
| | near c | 142.5 | 110.3424 | 264 | 211.2 | 250.5 | 256.32 | 8c/c 260mm |
| C TO D | near c | 142.7 | 110.6323 | 264 | 211.2 | 249.9 | 256.32 | 8 c/c 260mm |
| | near d | 142.6 | 110.532 | 264 | 211.2 | 250.1 | 256.32 | 8 c/c 260mm |
| d to e | near d | 143.8 | 111.642 | 264 | 211.2 | 247.6 | 256.32 | 8 c/c 260mm |
| | near e | 142.3 | 110.142 | 264 | 211.2 | 251.0 | 256.32 | 8c/c 260mm |
| e to f | near e | 31.42 | 24.3579 | 264 | 211.2 | 1135.0 | 256.32 | 8 c/c 260mm |
| | near f | 31.41 | 24.3479 | 264 | 211.2 | 1135.4 | 256.32 | 8 c/c 260mm |
| f to g | near f | 142.3 | 110.224 | 264 | 211.2 | 250.8 | 256.32 | 8 c/c 260mm |
| | near g | 143.07 | 110.994 | 264 | 211.2 | 249.1 | 256.32 | 8c/c 260mm |
| g to h | near g | 142.75 | 110.66 | 264 | 211.2 | 249.8 | 256.32 | 8 c/c 260mm |
| | near h | 142.75 | 110.66 | 264 | 211.2 | 249.8 | 256.32 | 8 c/c 260mm |
| h to i | near h | 142.32 | 110.243 | 264 | 211.2 | 250.8 | 256.32 | 8 c/c 260mm |
| | near i | 143.06 | 110.983 | 264 | 211.2 | 249.1 | 256.32 | 8 c/c 260mm |
| AXIS 3 | | | | | | | | |
| Story -2 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 68.37 | 53.7535 | 264 | 211.2 | 514.3 | 256.32 | 8 c/c 260mm |
| | near c | 61.67 | 47.0535 | 264 | 211.2 | 587.5 | 256.32 | 8c/c 260mm |
| C TO D | near c | 64.93 | 50.3135 | 264 | 211.2 | 549.5 | 256.32 | 8 c/c 260mm |
| | near d | 65.11 | 50.4935 | 264 | 211.2 | 547.5 | 256.32 | 8 c/c 260mm |
| d to e | near d | 63.84 | 49.2235 | 264 | 211.2 | 561.6 | 256.32 | 8 c/c 260mm |
| | near e | 66.2 | 51.5835 | 264 | 211.2 | 535.9 | 256.32 | 8c/c 260mm |
| e to f | near e | 32.26 | 25.008 | 264 | 211.2 | 1105.5 | 256.32 | 8 c/c 260mm |
| | near f | 32.26 | 25.008 | 264 | 211.2 | 1105.5 | 256.32 | 8 c/c 260mm |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| f to g | near f | 66.2 | 51.5824 | 264 | 211.2 | 536.0 | 256.32 | 8 c/c 260mm |
| | near g | 63.85 | 49.2324 | 264 | 211.2 | 561.5 | 256.32 | 8c/c 260mm |
| g to h | near g | 63.11 | 48.7183 | 264 | 211.2 | 567.5 | 256.32 | 8 c/c 260mm |
| | near h | 64.93 | 50.5383 | 264 | 211.2 | 547.0 | 256.32 | 8 c/c 260mm |
| h to i | near h | 61.64 | 47.0235 | 264 | 211.2 | 587.9 | 256.32 | 8 c/c 260mm |
| | near i | 68.4 | 53.7835 | 264 | 211.2 | 514.0 | 256.32 | 8 c/c 260mm |
| AXIS 3 | | | | | | | | |
| Story -1 | | | | | | | | |
| span | LOC | Vmax | Ved | Slmax | Sbmax | Scal | Smin | Spro |
| B to C | near b | 33.8 | 25.79871 | 264 | 211.2 | 1071.6 | 213.6 | 8 c/c 260mm |
| | near c | 31.57 | 23.56871 | 264 | 211.2 | 1173.0 | 213.6 | 8c/c 260mm |
| C TO D | near c | 32.6 | 43.82655 | 264 | 211.2 | 630.8 | 213.6 | 8 c/c 260mm |
| | near d | 32.69 | 45.0466 | 264 | 211.2 | 613.7 | 213.6 | 8 c/c 260mm |
| d to e | near d | 31.78 | 23.7787 | 264 | 211.2 | 1162.6 | 213.6 | 8 c/c 260mm |
| | near e | 33.59 | 25.5887 | 264 | 211.2 | 1080.4 | 213.6 | 8c/c 260mm |
| e to f | near e | 32.67 | 24.6687 | 264 | 211.2 | 1120.7 | 213.6 | 8 c/c 260mm |
| | near f | 32.7 | 24.6987 | 264 | 211.2 | 1119.3 | 213.6 | 8 c/c 260mm |
| f to g | near f | 33.57 | 25.5687 | 264 | 211.2 | 1081.2 | 213.6 | 8 c/c 260mm |
| | near g | 31.8 | 23.7987 | 264 | 211.2 | 1161.6 | 213.6 | 8c/c 260mm |
| g to h | near g | 32.66 | 24.6599 | 264 | 211.2 | 1121.1 | 213.6 | 8 c/c 260mm |
| | near h | 32.7 | 24.6999 | 264 | 211.2 | 1119.3 | 213.6 | 8 c/c 260mm |
| h to i | near h | 31.43 | 23.4275 | 264 | 211.2 | 1180.1 | 213.6 | 8 c/c 260mm |
| | near i | 33.95 | 25.9475 | 264 | 211.2 | 1065.4 | 213.6 | 8 c/c 260mm |

## Appendix F structural analysis and design of column

Table H 1: Effective length for foundation to roof column

| Lon. | column | bc | hc | bb | hb | Lc | Lbx left | lbx right | lby left | lby right | k1x | k2x | k1y | k2y | Lox | Loy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R | C1 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C2 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C3 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 5000 | 5000 | 3.16 | 3.16 | 3.16 | 3.16 | 2813.04 | 2813.04 |
| R | C4 | 400 | 400 | 250 | 300 | 3000 | 5000 | 0 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C5 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C6 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 5000 | 5000 | 3.16 | 3.16 | 3.16 | 3.16 | 2813.04 | 2813.04 |
| R | C7 | 400 | 400 | 250 | 300 | 3000 | 5000 | 0 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C8 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C9 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 5000 | 5000 | 3.16 | 3.16 | 3.16 | 3.16 | 2813.04 | 2813.04 |
| R | C10 | 400 | 400 | 250 | 300 | 3000 | 5000 | 0 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C11 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C12 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 5000 | 5000 | 3.16 | 3.16 | 3.16 | 3.16 | 2813.04 | 2813.04 |
| R | C13 | 400 | 400 | 250 | 300 | 3000 | 5000 | 0 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C14 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C15 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 5000 | 5000 | 3.16 | 3.16 | 3.16 | 3.16 | 2813.04 | 2813.04 |
| R | C16 | 400 | 400 | 250 | 300 | 3000 | 5000 | 0 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C17 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C18 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 5000 | 5000 | 3.16 | 3.16 | 3.16 | 3.16 | 2813.04 | 2813.04 |
| R | C19 | 400 | 400 | 250 | 300 | 3000 | 5000 | 0 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C20 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C21 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 5000 | 5000 | 3.16 | 3.16 | 3.16 | 3.16 | 2813.04 | 2813.04 |
| R | C22 | 400 | 400 | 250 | 300 | 3000 | 5000 | 0 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C23 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C24 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 5000 | 5000 | 3.16 | 3.16 | 3.16 | 3.16 | 2813.04 | 2813.04 |
| R | C29 | 400 | 400 | 250 | 300 | 3000 | 0 | 5000 | 5000 | 5000 | 6.32 | 6.32 | 3.16 | 3.16 | 2900.31 | 2813.04 |
| R | C30 | 400 | 400 | 250 | 300 | 3000 | 5000 | 5000 | 0 | 5000 | 3.16 | 3.16 | 6.32 | 6.32 | 2813.04 | 2900.31 |
| 4TH | C1 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C2 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C3 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 4TH | C4 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C5 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C6 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 4TH | C7 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C8 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C9 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 4TH | C10 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C11 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4TH | C12 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 4TH | C13 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C14 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C15 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 4TH | C16 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C17 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C18 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 0 | 1.33 | 1.33 | 2.67 | 2.67 | 2621.50 | 2783.42 |
| 4TH | C19 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C20 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C21 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 4TH | C22 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C23 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C24 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 4TH | C29 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 4TH | C30 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 0 | 5000 | 1.33 | 1.33 | 2.67 | 2.67 | 2621.50 | 2783.42 |
| 3RD | C1 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C2 | 400 | 400 | 250 | 400 | 3000 | 0 | 2000 | 5000 | 5000 | 1.07 | 1.07 | 1.33 | 1.33 | 2554.95 | 2621.50 |
| 3RD | C3 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 3RD | C4 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C5 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C6 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 3RD | C7 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C8 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C9 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 3RD | C10 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C11 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C12 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 3RD | C13 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C14 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C15 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 3RD | C16 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C17 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C18 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 3RD | C19 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C20 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C21 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 3RD | C22 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C23 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 3RD | C24 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 3RD | C29 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 0 | 5000 | 1.33 | 1.33 | 2.67 | 2.67 | 2621.50 | 2783.42 |
| 3RD | C30 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 0 | 5000 | 1.33 | 1.33 | 2.67 | 2.67 | 2621.50 | 2783.42 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2ND | C1 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C2 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C3 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C4 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C5 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C6 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C7 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C8 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C9 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C10 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C11 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C12 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C13 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C14 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C15 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C16 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C17 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C18 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C19 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C20 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C21 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C22 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 2ND | C23 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 2ND | C24 | 400 | 400 | 250 | 400 | 3000 | 500 | 5000 | 5000 | 5000 | 0.24 | 0.24 | 1.33 | 1.33 | 2025.16 | 2621.50 |
| 2ND | C29 | 400 | 400 | 250 | 400 | 3000 | 500 | 5000 | 0 | 5000 | 0.24 | 0.24 | 2.67 | 2.67 | 2025.16 | 2783.42 |
| 2ND | C30 | 400 | 400 | 250 | 400 | 3000 | 500 | 5000 | 0 | 5000 | 0.24 | 0.24 | 2.67 | 2.67 | 2025.16 | 2783.42 |
| 1ST | C1 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C2 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C3 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 1ST | C4 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C5 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C6 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 1ST | C7 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C8 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C9 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 1ST | C10 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C11 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C12 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 1ST | C13 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C14 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C15 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 3450 | 1.33 | 1.33 | 1.09 | 1.09 | 2621.50 | 2561.33 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1ST | C16 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C17 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C18 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 1ST | C19 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C20 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C21 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| 1ST | C22 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C23 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| 1ST | C24 | 400 | 400 | 250 | 400 | 3000 | 500 | 5000 | 5000 | 5000 | 0.24 | 0.24 | 1.33 | 1.33 | 2025.16 | 2621.50 |
| 1ST | C29 | 400 | 400 | 250 | 400 | 3000 | 500 | 5000 | 0 | 5000 | 0.24 | 0.24 | 2.67 | 2.67 | 2025.16 | 2783.42 |
| 1ST | C30 | 400 | 400 | 250 | 400 | 3000 | 500 | 5000 | 0 | 5000 | 0.24 | 0.24 | 2.67 | 2.67 | 2025.16 | 2783.42 |
| G | C1 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C2 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C3 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| G | C4 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C5 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C6 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 500 | 5000 | 1.33 | 1.33 | 0.24 | 0.24 | 2621.50 | 2025.16 |
| G | C7 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C8 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C9 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| G | C10 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C11 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C12 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| G | C13 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C14 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C15 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 3450 | 1.33 | 1.33 | 1.09 | 1.09 | 2621.50 | 2561.33 |
| G | C16 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C17 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C18 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| G | C19 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C20 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C21 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| G | C22 | 400 | 400 | 250 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C23 | 400 | 400 | 250 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 2.67 | 2.67 | 1.33 | 1.33 | 2783.42 | 2621.50 |
| G | C24 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 1.33 | 1.33 | 1.33 | 1.33 | 2621.50 | 2621.50 |
| G | C29 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 0 | 5000 | 1.33 | 1.33 | 2.67 | 2.67 | 2621.50 | 2783.42 |
| G | C30 | 400 | 400 | 250 | 400 | 3000 | 5000 | 5000 | 0 | 5000 | 1.33 | 1.33 | 2.67 | 2.67 | 2621.50 | 2783.42 |
| F | C1 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C2 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C3 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 2.71 | 2.71 | 2.71 | 2.71 | 2786.57 | 2786.57 |
| F | C4 | 500 | 500 | 300 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | C5 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C6 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 500 | 5000 | 2.71 | 2.71 | 0.49 | 0.49 | 2786.57 | 2284.36 |
| F | C7 | 500 | 500 | 300 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C8 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C9 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 2.71 | 2.71 | 2.71 | 2.71 | 2786.57 | 2786.57 |
| F | C10 | 500 | 500 | 300 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C11 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C12 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 2.71 | 2.71 | 2.71 | 2.71 | 2786.57 | 2786.57 |
| F | C13 | 500 | 500 | 300 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C14 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C15 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 5000 | 3450 | 2.71 | 2.71 | 2.22 | 2.22 | 2786.57 | 2746.72 |
| F | C16 | 500 | 500 | 300 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C17 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C18 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 2.71 | 2.71 | 2.71 | 2.71 | 2786.57 | 2786.57 |
| F | C19 | 500 | 500 | 300 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C20 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C21 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 2.71 | 2.71 | 2.71 | 2.71 | 2786.57 | 2786.57 |
| F | C22 | 500 | 500 | 300 | 400 | 3000 | 5000 | 0 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C23 | 500 | 500 | 300 | 400 | 3000 | 0 | 5000 | 5000 | 5000 | 5.43 | 5.43 | 2.71 | 2.71 | 2885.11 | 2786.57 |
| F | C24 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 5000 | 5000 | 2.71 | 2.71 | 2.71 | 2.71 | 2786.57 | 2786.57 |
| F | C25 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 0 | 5000 | 2.71 | 2.71 | 5.43 | 5.43 | 2786.57 | 2885.11 |
| F | C30 | 500 | 500 | 300 | 400 | 3000 | 5000 | 5000 | 0 | 5000 | 2.71 | 2.71 | 5.43 | 5.43 | 2786.57 | 2885.11 |

Table H 2:Check for short or long coulumn from foundation to roof

| loc | col. | Mx top | Mx bot | My top | My bot | NED | M01 x | M01 y | M02x | M02y | λx | λy | λxlim | λylim | S.L(x |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R | C1 | 47.25 | 52.82 | 4.67 | -2.09 | 173.84 | 3.48 | -2.09 | 52.82 | 4.67 | 25.12 | 24.36 | 89.04 | 117.01 | short |
| R | C2 | 49.26 | 55.27 | 5.08 | 0.35 | 174.90 | 3.50 | 0.35 | 55.27 | 5.08 | 25.12 | 24.36 | 88.91 | 88.64 | short |
| R | C3 | 1.36 | 1.91 | 15.56 | 19.31 | 229.83 | 1.36 | 4.60 | 4.60 | 19.31 | 24.36 | 24.36 | 66.54 | 69.28 | short |
| R | C4 | 47.51 | 52.82 | 4.71 | 2.14 | 173.80 | 3.48 | 2.14 | 52.82 | 4.71 | 25.12 | 24.36 | 89.05 | 67.84 | short |
| R | C5 | 42.61 | 46.75 | 2.73 | 2.49 | 189.23 | 3.78 | 2.49 | 46.75 | 3.78 | 25.12 | 24.36 | 84.55 | 54.42 | short |
| R | C6 | 1.22 | 16.67 | 0.35 | 0.24 | 236.60 | 1.22 | 0.24 | 16.67 | 4.73 | 24.36 | 24.36 | 75.97 | 77.08 | short |
| R | C7 | 41.29 | 44.95 | 1.89 | 2.32 | 188.13 | 3.76 | 1.89 | 44.95 | 3.76 | 25.12 | 24.36 | 84.65 | 62.73 | short |
| R | C8 | 41.99 | 44.80 | 0.93 | 1.32 | 188.70 | 3.77 | 0.93 | 44.80 | 3.77 | 25.12 | 24.36 | 84.50 | 75.99 | short |
| R | C9 | 0.32 | 0.23 | 1.49 | 2.20 | 235.90 | 0.23 | 1.49 | 4.72 | 4.72 | 24.36 | 24.36 | 77.23 | 64.76 | short |
| R | C10 | 40.05 | 44.39 | 2.95 | 3.79 | 187.05 | 3.74 | 2.95 | 44.39 | 3.79 | 25.12 | 24.36 | 84.87 | 48.41 | short |
| R | C11 | 39.68 | 42.29 | 0.50 | 0.45 | 188.90 | 3.78 | 0.45 | 42.29 | 3.78 | 25.12 | 24.36 | 84.19 | 82.63 | short |
| R | C12 | 18.74 | 20.89 | 17.24 | 18.60 | 194.70 | 3.89 | 3.89 | 20.89 | 18.60 | 24.36 | 24.36 | 77.93 | 76.74 | short |
| R | C13 | 27.13 | 30.97 | 35.23 | 45.47 | 122.84 | 2.46 | 2.46 | 30.97 | 45.47 | 25.12 | 24.36 | 105.04 | 106.68 | short |
| R | C14 | 39.69 | 42.39 | 0.51 | 0.47 | 188.60 | 3.77 | 0.47 | 42.39 | 3.77 | 25.12 | 24.36 | 84.27 | 82.41 | short |
| R | C15 | 16.74 | 20.89 | 17.23 | 18.85 | 194.78 | 3.90 | 3.90 | 20.89 | 18.85 | 24.36 | 24.36 | 77.91 | 76.87 | short |
| R | C16 | 27.13 | 30.97 | 35.20 | 45.77 | 122.84 | 2.46 | 2.46 | 30.97 | 45.77 | 25.12 | 24.36 | 105.04 | 106.71 | short |
| R | C17 | 41.99 | 44.80 | 0.94 | 1.32 | 188.70 | 3.77 | 0.94 | 44.80 | 3.77 | 25.12 | 24.36 | 84.50 | 75.90 | short |
| R | C18 | 0.38 | 0.23 | 1.49 | 2.20 | 235.92 | 0.23 | 1.49 | 4.72 | 4.72 | 24.36 | 24.36 | 77.23 | 64.76 | short |
| R | C19 | 40.05 | 44.39 | 2.95 | 3.79 | 187.05 | 3.74 | 2.95 | 44.39 | 3.79 | 25.12 | 24.36 | 84.87 | 48.41 | short |
| R | C20 | 42.62 | 46.75 | 2.73 | 2.49 | 189.23 | 3.78 | 2.49 | 46.75 | 3.78 | 25.12 | 24.36 | 84.55 | 54.42 | short |
| R | C21 | 1.22 | 1.67 | 0.35 | 0.23 | 236.60 | 1.22 | 0.23 | 4.73 | 4.73 | 24.36 | 24.36 | 67.35 | 77.12 | short |
| R | C22 | 41.29 | 44.95 | 1.89 | 2.32 | 188.13 | 3.76 | 1.89 | 44.95 | 3.76 | 25.12 | 24.36 | 84.65 | 62.73 | short |
| R | C23 | 49.26 | 55.37 | 5.08 | 0.35 | 174.98 | 3.50 | 0.35 | 55.37 | 5.08 | 25.12 | 24.36 | 88.89 | 88.62 | short |
| R | C24 | 1.37 | 1.91 | 18.56 | 19.31 | 229.83 | 1.37 | 4.60 | 4.60 | 19.31 | 24.36 | 24.36 | 66.44 | 69.28 | short |
| R | C29 | 0.53 | 1.06 | 20.60 | 23.86 | 161.90 | 0.53 | 3.24 | 3.24 | 23.86 | 25.12 | 24.36 | 86.76 | 88.32 | short |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R | C30 | 0.52 | 1.04 | 20.10 | 23.80 | 161.93 | 0.52 | 3.24 | 3.24 | 23.80 | 24.36 | 25.12 | 86.91 | 88.29 | short |
| 4TH | C1 | 35.83 | 50.56 | 4.67 | 2.09 | 510.50 | 10.21 | 2.09 | 50.56 | 10.21 | 24.11 | 22.70 | 47.63 | 47.54 | short |
| 4TH | C2 | 37.50 | 52.57 | 1.24 | 12.90 | 512.48 | 10.25 | 1.24 | 52.57 | 12.90 | 24.11 | 22.70 | 47.76 | 50.91 | short |
| 4TH | C3 | 1.38 | 1.91 | 10.72 | 22.71 | 609.74 | 1.38 | 10.72 | 12.19 | 22.71 | 22.70 | 22.70 | 46.16 | 35.72 | short |
| 4TH | C4 | 38.80 | 50.55 | 0.75 | 1.74 | 510.74 | 10.21 | 0.75 | 50.55 | 10.21 | 24.11 | 22.70 | 47.61 | 51.70 | short |
| 4TH | C5 | 31.26 | 44.40 | 3.10 | 8.04 | 575.10 | 11.50 | 3.10 | 44.40 | 11.50 | 24.11 | 22.70 | 43.16 | 42.85 | short |
| 4TH | C6 | 1.30 | 1.78 | 0.16 | 0.27 | 627.05 | 1.30 | 0.16 | 12.54 | 12.54 | 22.70 | 22.70 | 45.80 | 48.40 | short |
| 4TH | C7 | 29.85 | 42.47 | 1.39 | 1.79 | 571.60 | 11.43 | 1.39 | 42.47 | 11.43 | 24.11 | 22.70 | 42.99 | 47.43 | short |
| 4TH | C8 | 29.92 | 42.58 | 1.12 | 1.60 | 572.60 | 11.45 | 1.12 | 42.58 | 11.45 | 24.11 | 22.70 | 42.96 | 48.09 | short |
| 4TH | C9 | 0.06 | 0.01 | 1.81 | 2.20 | 624.93 | 0.01 | 1.81 | 12.50 | 12.50 | 22.70 | 22.70 | 48.82 | 44.69 | short |
| 4TH | C10 | 29.43 | 41.87 | 2.94 | 3.62 | 570.35 | 11.41 | 2.94 | 41.87 | 11.41 | 24.11 | 22.70 | 42.94 | 43.39 | short |
| 4TH | C11 | 28.08 | 40.23 | 0.25 | 0.45 | 572.21 | 11.44 | 0.25 | 40.23 | 11.44 | 24.11 | 22.70 | 42.51 | 50.40 | short |
| 4TH | C12 | 13.76 | 19.38 | 12.60 | 17.80 | 521.60 | 10.43 | 10.43 | 19.38 | 17.80 | 22.70 | 22.70 | 36.54 | 35.04 | short |
| 4TH | C13 | 21.07 | 29.45 | 35.45 | 49.31 | 373.10 | 7.46 | 7.46 | 29.45 | 49.31 | 24.11 | 22.70 | 53.80 | 57.60 | short |
| 4TH | C14 | 28.05 | 40.23 | 0.25 | 0.44 | 572.10 | 11.44 | 0.25 | 40.23 | 11.44 | 24.11 | 22.70 | 42.52 | 50.40 | short |
| 4TH | C15 | 13.76 | 19.37 | 12.59 | 17.82 | 521.16 | 10.42 | 10.42 | 19.37 | 17.82 | 22.70 | 22.70 | 36.56 | 35.09 | short |
| 4TH | C16 | 21.07 | 29.44 | 35.42 | 49.36 | 373.17 | 7.46 | 7.46 | 29.44 | 49.36 | 24.11 | 22.70 | 53.79 | 57.60 | short |
| 4TH | C17 | 29.92 | 42.58 | 1.12 | 1.60 | 194.52 | 3.89 | 1.12 | 42.58 | 3.89 | 24.11 | 22.70 | 82.86 | 72.69 | short |
| 4TH | C18 | 0.06 | 0.02 | 1.81 | 2.21 | 624.93 | 0.02 | 1.81 | 12.50 | 12.50 | 22.70 | 24.11 | 48.82 | 44.69 | short |
| 4TH | C19 | 29.43 | 41.87 | 2.94 | 3.67 | 570.35 | 11.41 | 2.94 | 41.87 | 11.41 | 24.11 | 22.70 | 42.94 | 43.39 | short |
| 4TH | C20 | 31.26 | 44.24 | 3.10 | 8.04 | 575.10 | 11.50 | 3.10 | 44.24 | 11.50 | 24.11 | 22.70 | 43.14 | 42.85 | short |
| 4TH | C21 | 1.30 | 1.78 | 0.16 | 0.27 | 627.05 | 1.30 | 0.16 | 12.54 | 12.54 | 22.70 | 22.70 | 45.80 | 48.40 | short |
| 4TH | C22 | 29.85 | 42.47 | 1.39 | 1.79 | 571.60 | 11.43 | 1.39 | 42.47 | 11.43 | 24.11 | 22.70 | 42.99 | 47.43 | short |
| 4TH | C23 | 37.50 | 52.57 | 5.08 | 0.35 | 512.49 | 10.25 | 0.35 | 52.57 | 10.25 | 24.11 | 22.70 | 47.76 | 52.87 | short |
| 4TH | C24 | 1.38 | 1.90 | 22.80 | 18.07 | 609.74 | 1.38 | 12.19 | 12.19 | 22.80 | 22.70 | 22.70 | 46.16 | 33.90 | short |
| 4TH | C29 | 0.59 | 0.23 | 16.88 | 23.43 | 453.30 | 0.23 | 9.07 | 9.07 | 23.43 | 24.11 | 22.70 | 56.50 | 44.30 | short |
| 4TH | C30 | 0.54 | 0.17 | 16.87 | 24.45 | 452.58 | 0.17 | 9.05 | 9.05 | 24.45 | 22.70 | 24.11 | 56.77 | 44.90 | short |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3RD | C1 | 39.07 | 55.22 | 1.05 | 2.50 | 859.00 | 17.18 | 1.05 | 55.22 | 17.18 | 24.11 | 22.70 | 34.04 | 40.17 | short |
| 3RD | C2 | 40.22 | 56.87 | 18.02 | 29.24 | 797.48 | 15.95 | 15.95 | 56.87 | 29.24 | 22.13 | 22.70 | 36.11 | 29.37 | short |
| 3RD | C3 | 1.35 | 1.83 | 13.99 | 19.89 | 1003.51 | 1.35 | 13.99 | 20.07 | 20.07 | 22.70 | 22.70 | 37.03 | 22.74 | short |
| 3RD | C4 | 39.01 | 55.19 | 1.07 | 0.35 | 859.19 | 17.18 | 0.35 | 55.19 | 17.18 | 24.11 | 22.70 | 34.03 | 41.16 | short |
| 3RD | C5 | 34.41 | 48.97 | 13.65 | ### | 963.50 | 19.27 | -30.69 | 48.97 | 19.27 | 24.11 | 22.70 | 30.24 | 76.20 | short |
| 3RD | C6 | 1.24 | 1.75 | 0.27 | 0.25 | 1031.30 | 1.24 | 0.25 | 20.63 | 20.63 | 22.70 | 22.70 | 36.68 | 37.76 | short |
| 3RD | C7 | 33.10 | 47.06 | 1.35 | 1.92 | 974.10 | 19.48 | 1.35 | 47.06 | 19.48 | 24.11 | 22.70 | 29.60 | 37.54 | short |
| 3RD | C8 | 33.07 | 47.17 | 0.11 | 1.73 | 976.60 | 19.53 | 0.11 | 47.17 | 19.53 | 24.11 | 22.70 | 29.56 | 38.95 | short |
| 3RD | C9 | 0.12 | 0.11 | 1.40 | 1.87 | 1028.24 | 0.11 | 1.40 | 20.56 | 20.56 | 22.70 | 22.70 | 37.96 | 36.56 | short |
| 3RD | C10 | 32.64 | 46.37 | 2.29 | 2.94 | 972.80 | 19.46 | 2.29 | 46.37 | 19.46 | 24.11 | 22.70 | 29.49 | 36.44 | short |
| 3RD | C11 | 31.54 | 45.32 | 0.28 | 0.12 | 974.98 | 19.50 | 0.12 | 45.32 | 19.50 | 24.11 | 22.70 | 29.21 | 38.97 | short |
| 3RD | C12 | 14.95 | 20.41 | 13.75 | 19.40 | 857.45 | 14.95 | 13.75 | 20.41 | 19.40 | 22.70 | 22.70 | 23.74 | 24.32 | short |
| 3RD | C13 | 22.43 | 31.26 | 36.76 | 50.05 | 631.74 | 12.63 | 12.63 | 31.26 | 50.05 | 24.11 | 22.70 | 37.04 | 41.37 | short |
| 3RD | C14 | 31.54 | 45.32 | 0.29 | 0.14 | 974.80 | 19.50 | 0.14 | 45.32 | 19.50 | 24.11 | 22.70 | 29.22 | 38.95 | short |
| 3RD | C15 | 14.94 | 20.90 | 13.74 | 19.37 | 857.81 | 14.94 | 13.74 | 20.90 | 19.37 | 22.70 | 22.70 | 24.16 | 24.30 | short |
| 3RD | C16 | 22.43 | 31.26 | 36.70 | 49.96 | 631.74 | 12.63 | 12.63 | 31.26 | 49.96 | 24.11 | 22.70 | 37.04 | 41.36 | short |
| 3RD | C17 | 33.07 | 47.17 | 0.11 | 1.72 | 976.00 | 19.52 | 0.11 | 47.17 | 19.52 | 24.11 | 22.70 | 29.58 | 38.96 | short |
| 3RD | C18 | 0.12 | 0.11 | 1.40 | 1.87 | 1028.34 | 0.11 | 1.40 | 20.57 | 20.57 | 22.70 | 22.70 | 37.96 | 36.56 | short |
| 3RD | C19 | 32.64 | 46.37 | 2.29 | 2.94 | 972.80 | 19.46 | 2.29 | 46.37 | 19.46 | 24.11 | 22.70 | 29.49 | 36.44 | short |
| 3RD | C20 | 34.41 | 48.97 | 13.65 | 30.69 | 963.50 | 19.27 | 13.65 | 48.97 | 30.69 | 24.11 | 22.70 | 30.24 | 29.05 | short |
| 3RD | C21 | 1.24 | 1.75 | 0.27 | 0.25 | 1031.66 | 1.24 | 0.25 | 20.63 | 20.63 | 22.70 | 22.70 | 36.68 | 37.75 | short |
| 3RD | C22 | 33.10 | 47.06 | 1.35 | 1.92 | 974.10 | 19.48 | 1.35 | 47.06 | 19.48 | 24.11 | 22.70 | 29.60 | 37.54 | short |
| 3RD | C23 | 40.22 | 56.80 | 15.02 | 29.24 | 797.90 | 15.96 | 15.02 | 56.80 | 29.24 | 24.11 | 22.70 | 36.09 | 30.17 | short |
| 3RD | C24 | 1.34 | 1.82 | 13.99 | 19.89 | 1003.51 | 1.34 | 13.99 | 20.07 | 20.07 | 22.70 | 22.70 | 37.04 | 22.74 | short |
| 3RD | C29 | 0.19 | 0.26 | 17.80 | 24.90 | 753.33 | 0.19 | 15.07 | 15.07 | 24.90 | 22.70 | 24.11 | 44.16 | 28.66 | short |
| 3RD | C30 | 0.23 | 0.26 | 17.81 | 25.03 | 753.58 | 0.23 | 15.07 | 15.07 | 25.03 | 22.70 | 24.11 | 44.09 | 28.73 | short |
| 2ND | C1 | 40.52 | 52.39 | 1.05 | 2.50 | 1221.00 | 24.4 | 1.05 | 52.39 | 24.42 | 24.11 | 22.70 | 25.3 | 34.0 | short |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2 | | | | | | 7 | 7 | |
| 2ND | C2 | 41.39 | 53.58 | 23.15 | 29.40 | 1078.96 | 21.58 | 21.58 | 53.58 | 29.40 | 24.11 | 22.70 | 28.37 | 21.13 | short |
| 2ND | C3 | 1.15 | 1.56 | 14.66 | 19.14 | 1426.51 | 1.15 | 14.66 | 28.53 | 28.53 | 22.70 | 22.70 | 31.57 | 22.56 | short |
| 2ND | C4 | 40.50 | 52.39 | 0.98 | 5.35 | 1221.20 | 24.42 | 0.98 | 52.39 | 24.42 | 22.70 | 22.70 | 25.36 | 34.12 | short |
| 2ND | C5 | 35.72 | 46.20 | 23.20 | 18.15 | 1300.01 | 26.00 | 18.15 | 46.20 | 26.00 | 24.11 | 22.70 | 22.66 | 19.96 | slender |
| 2ND | C6 | 1.14 | 1.60 | 0.26 | 0.26 | 1465.80 | 1.14 | 0.26 | 29.32 | 29.32 | 22.70 | 22.70 | 31.17 | 31.73 | short |
| 2ND | C7 | 34.56 | 44.39 | 1.10 | 0.67 | 1390.2 | 27.80 | 0.67 | 44.39 | 27.80 | 24.11 | 22.70 | 20.69 | 32.29 | slender |
| 2ND | C8 | 34.45 | 44.58 | 0.62 | 8.60 | 1395.37 | 27.91 | 0.62 | 44.58 | 27.91 | 24.11 | 22.70 | 20.65 | 32.26 | slender |
| 2ND | C9 | 0.18 | 0.05 | 1.11 | 1.08 | 1461.90 | 0.05 | 1.08 | 29.24 | 29.24 | 22.70 | 22.70 | 31.91 | 31.25 | short |
| 2ND | C10 | 34.07 | 43.79 | 1.59 | 1.30 | 1388.00 | 27.76 | 1.30 | 43.79 | 27.76 | 24.11 | 22.70 | 20.56 | 31.88 | slender |
| 2ND | C11 | 33.27 | 43.08 | 0.20 | 0.92 | 1391.20 | 27.82 | 0.20 | 43.08 | 27.82 | 24.11 | 22.70 | 20.30 | 32.60 | slender |
| 2ND | C12 | 15.13 | 19.01 | 14.14 | 18.30 | 1215.90 | 15.13 | 14.14 | 24.32 | 24.32 | 22.70 | 22.70 | 22.20 | 23.04 | slender |
| 2ND | C13 | 22.78 | 29.36 | 37.44 | 52.95 | 895.95 | 17.92 | 17.92 | 29.36 | 52.95 | 24.11 | 22.70 | 26.15 | 32.68 | short |
| 2ND | C14 | 33.27 | 43.08 | 0.27 | 0.88 | 1391.20 | 27.82 | 0.27 | 43.08 | 27.82 | 24.11 | 22.70 | 20.30 | 32.56 | slender |
| 2ND | C15 | 15.12 | 19.00 | 14.19 | 18.35 | 1215.90 | 15.12 | 14.19 | 24.32 | 24.32 | 22.70 | 22.70 | 22.21 | 23.00 | slender |
| 2ND | C16 | 22.78 | 29.35 | 37.48 | 52.98 | 895.95 | 17.92 | 17.92 | 29.35 | 52.98 | 24.11 | 22.70 | 26.15 | 32.68 | short |
| 2ND | C17 | 34.45 | 44.48 | 0.92 | 8.60 | 1395.37 | 27.91 | 0.92 | 44.48 | 27.91 | 24.11 | 22.70 | 20.63 | 32.06 | slender |
| 2ND | C18 | 0.30 | 0.39 | 0.41 | 0.37 | 1873.54 | 0.30 | 0.37 | 37.47 | 37.47 | 22.70 | 22.70 | 28.08 | 28.05 | short |
| 2ND | C19 | 32.23 | 47.13 | 0.70 | 1.60 | 1796.60 | 32.23 | 0.70 | 47.13 | 35.93 | 24.11 | 22.70 | 17.22 | 28.48 | slender |
| 2ND | C20 | 35.70 | 46.20 | 23.20 | 18.15 | 1300.00 | 26.00 | 18.15 | 46.20 | 26.00 | 24.11 | 22.70 | 22.66 | 19.96 | slender |
| 2ND | C21 | 1.14 | 1.60 | 0.27 | 0.27 | 1465.80 | 1.14 | 0.27 | 29.32 | 29.32 | 22.70 | 22.70 | 31.17 | 31.73 | short |
| 2ND | C22 | 34.56 | 44.39 | 1.10 | 0.67 | 1390.20 | 27.80 | 0.67 | 44.39 | 27.80 | 22.70 | 22.70 | 20.69 | 32.29 | slender |
| 2ND | C23 | 41.38 | 53.58 | 23.15 | 29.40 | 992.85 | 19.86 | 19.86 | 53.58 | 29.40 | 24.11 | 22.70 | 30.31 | 23.36 | short |
| 2ND | C24 | 1.15 | 1.56 | 14.66 | 19.14 | 1426.50 | 1.15 | 14.66 | 28.53 | 28.53 | 17.54 | 22.70 | 31.57 | 22.56 | short |
| 2ND | C29 | 0.40 | 0.78 | 18.39 | 24.18 | 1069.00 | 0.40 | 18.39 | 21.38 | 24.18 | 17.54 | 24.11 | 36.94 | 20.64 | short |
| 2ND | C30 | 0.47 | 1.16 | 18.31 | 24.14 | 1069.00 | 0.47 | 18.31 | 21.38 | 24.14 | 17.54 | 24.11 | 36.87 | 20.69 | short |
| 1ST | C1 | 38.24 | 54.46 | 1.49 | 22.59 | 1562.70 | 31.25 | 1.49 | 54.46 | 31.25 | 24.11 | 22.70 | 20.46 | 30.03 | slender |
| 1ST | C2 | 38.54 | 55.56 | 20.87 | 29.87 | 1351.10 | 27.0 | 20.8 | 55.56 | 29.87 | 24.11 | 22.70 | 23.7 | 19.5 | slender |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2 | 7 | | | | | 2 | 7 | |
| 1ST | C3 | 0.70 | 0.91 | 13.67 | 18.18 | 1828.87 | 0.70 | 13.67 | 36.58 | 36.58 | 22.70 | 22.70 | 28.24 | 22.28 | short |
| 1ST | C4 | 38.22 | 54.43 | 2.68 | 23.15 | 1572.20 | 31.44 | 2.68 | 54.43 | 31.44 | 24.11 | 22.70 | 20.33 | 29.26 | slender |
| 1ST | C5 | 33.49 | 48.80 | 4.60 | 4.36 | 1559.70 | 31.19 | 4.36 | 48.80 | 31.19 | 24.11 | 22.70 | 19.30 | 28.38 | slender |
| 1ST | C6 | 0.74 | 0.94 | 0.39 | 0.52 | 1878.38 | 0.74 | 0.39 | 37.57 | 37.57 | 22.70 | 22.70 | 27.85 | 28.01 | short |
| 1ST | C7 | 32.77 | 47.80 | 0.73 | 2.46 | 1797.10 | 32.77 | 0.73 | 47.80 | 35.94 | 24.11 | 22.70 | 17.19 | 28.46 | slender |
| 1ST | C8 | 32.45 | 47.17 | 7.50 | 3.64 | 1787.20 | 32.45 | 3.64 | 47.17 | 35.74 | 24.11 | 22.70 | 17.20 | 27.16 | slender |
| 1ST | C9 | 0.30 | 0.39 | 0.41 | 0.37 | 1873.54 | 0.30 | 0.37 | 37.47 | 37.47 | 22.70 | 22.70 | 28.08 | 28.05 | short |
| 1ST | C10 | 32.33 | 47.13 | 0.70 | 1.60 | 1796.60 | 32.33 | 0.70 | 47.13 | 35.93 | 24.11 | 22.70 | 17.19 | 28.48 | slender |
| 1ST | C11 | 31.62 | 47.06 | 0.78 | 0.50 | 1749.90 | 31.62 | 0.50 | 47.06 | 35.00 | 24.11 | 22.70 | 17.66 | 28.95 | slender |
| 1ST | C12 | 13.63 | 19.03 | 12.90 | 17.50 | 1557.20 | 13.63 | 12.90 | 31.14 | 31.14 | 22.70 | 22.70 | 22.98 | 23.41 | short |
| 1ST | C13 | 21.51 | 30.61 | 31.93 | 26.30 | 1153.43 | 21.51 | 23.07 | 30.61 | 31.93 | 24.11 | 22.70 | 21.09 | 20.68 | slender |
| 1ST | C14 | 31.62 | 47.06 | 0.73 | 0.57 | 1749.90 | 31.62 | 0.57 | 47.06 | 35.00 | 24.11 | 22.70 | 17.65 | 28.91 | slender |
| 1ST | C15 | 13.60 | 19.02 | 12.93 | 17.82 | 1557.20 | 13.60 | 12.93 | 31.14 | 31.14 | 22.70 | 22.18 | 23.00 | 23.39 | short |
| 1ST | C16 | 21.51 | 30.51 | 31.65 | 26.45 | 1153.43 | 21.51 | 23.07 | 30.51 | 31.65 | 24.11 | 22.70 | 21.05 | 20.54 | slender |
| 1ST | C17 | 32.45 | 47.15 | 7.50 | 3.64 | 1787.20 | 32.45 | 3.64 | 47.15 | 35.74 | 24.11 | 22.70 | 17.19 | 27.16 | slender |
| 1ST | C18 | 0.30 | 0.39 | 0.40 | 0.37 | 1873.54 | 0.30 | 0.37 | 37.47 | 37.47 | 22.70 | 22.70 | 28.08 | 28.05 | short |
| 1ST | C19 | 32.33 | 47.13 | 0.70 | 1.60 | 1796.60 | 32.33 | 0.70 | 47.13 | 35.93 | 24.11 | 22.70 | 17.19 | 28.48 | slender |
| 1ST | C20 | 33.49 | 48.80 | 4.67 | 4.36 | 1559.70 | 31.19 | 4.36 | 48.80 | 31.19 | 24.11 | 22.70 | 19.30 | 28.38 | slender |
| 1ST | C21 | 0.77 | 0.94 | 0.39 | 0.52 | 1878.38 | 0.77 | 0.39 | 37.57 | 37.57 | 22.70 | 22.70 | 27.84 | 28.00 | short |
| 1ST | C22 | 32.77 | 47.80 | 0.73 | 2.46 | 1797.10 | 32.77 | 0.73 | 47.80 | 35.94 | 24.11 | 22.70 | 17.19 | 28.46 | slender |
| 1ST | C23 | 38.54 | 55.56 | 20.87 | 29.87 | 1351.10 | 27.02 | 20.87 | 55.56 | 29.87 | 24.11 | 22.70 | 23.72 | 19.57 | slender |
| 1ST | C24 | 0.70 | 0.90 | 13.60 | 18.80 | 1828.87 | 0.70 | 13.60 | 36.58 | 36.58 | 17.54 | 22.70 | 28.24 | 22.31 | short |
| 1ST | C29 | 0.48 | 0.41 | 17.92 | 25.80 | 1373.90 | 0.41 | 17.92 | 27.48 | 27.48 | 17.54 | 24.11 | 32.66 | 20.31 | short |
| 1ST | C30 | 0.69 | 1.01 | 17.89 | 25.76 | 1828.87 | 0.69 | 17.89 | 36.58 | 36.58 | 17.54 | 24.11 | 28.24 | 20.34 | short |
| G | C1 | 31.22 | 21.12 | 23.17 | 20.50 | 1826.58 | 21.12 | 20.50 | 36.53 | 36.53 | 24.11 | 22.70 | 18.86 | 19.14 | slender |
| G | C2 | 31.76 | 21.34 | 19.61 | 19.03 | 1614.14 | 21.34 | 19.03 | 32.28 | 32.28 | 24.11 | 22.70 | 18.58 | 19.86 | slender |
| G | C3 | 0.32 | 0.16 | 9.16 | 3.42 | 2216.60 | 0.16 | 3.42 | 44.33 | 44.33 | 22.70 | 22.70 | 25.8 | 24.7 | short |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | 9 | 6 | |
| G | C4 | 31.22 | 21.13 | 22.84 | 21.47 | 1836.00 | 21.13 | 21.47 | 36.72 | 36.72 | 24.11 | 22.70 | 18.85 | 18.70 | slender |
| G | C5 | 27.70 | 17.60 | 1.31 | 0.83 | 1796.60 | 17.60 | 0.83 | 35.93 | 35.93 | 24.11 | 22.70 | 20.51 | 28.42 | slender |
| G | C6 | 0.35 | 0.22 | 0.58 | 0.52 | 1878.38 | 0.22 | 0.52 | 37.57 | 37.57 | 22.70 | 17.54 | 28.08 | 27.95 | short |
| G | C7 | 27.41 | 17.41 | 1.86 | 1.23 | 2032.10 | 17.41 | 1.23 | 40.64 | 40.64 | 24.11 | 22.70 | 20.26 | 26.61 | slender |
| G | C8 | 27.22 | 17.27 | 0.88 | 0.46 | 2025.00 | 17.27 | 0.46 | 40.50 | 40.50 | 24.11 | 22.70 | 20.33 | 26.96 | slender |
| G | C9 | 0.28 | 0.14 | 0.38 | 0.54 | 2269.06 | 0.14 | 0.38 | 45.38 | 45.38 | 22.70 | 22.70 | 25.59 | 25.51 | short |
| G | C10 | 26.99 | 17.20 | 1.38 | 1.05 | 2033.56 | 17.20 | 1.05 | 40.67 | 40.67 | 24.11 | 22.70 | 20.34 | 26.67 | slender |
| G | C11 | 27.13 | 16.95 | 0.01 | 0.07 | 2037.10 | 16.95 | 0.01 | 40.74 | 40.74 | 24.11 | 22.70 | 20.44 | 27.05 | slender |
| G | C12 | 10.27 | 5.37 | 9.41 | 4.78 | 1885.87 | 5.37 | 4.78 | 37.72 | 37.72 | 22.70 | 22.70 | 25.77 | 26.03 | short |
| G | C13 | 17.93 | 13.33 | 7.04 | 3.70 | 1328.08 | 13.33 | 3.70 | 26.56 | 26.56 | 24.11 | 22.70 | 23.62 | 30.77 | slender |
| G | C14 | 21.19 | 16.95 | 0.05 | 0.01 | 2037.10 | 16.95 | 0.01 | 40.74 | 40.74 | 24.11 | 22.70 | 20.44 | 27.05 | slender |
| G | C15 | 10.31 | 5.31 | 9.33 | 4.71 | 1885.87 | 5.31 | 4.71 | 37.72 | 37.72 | 22.70 | 22.18 | 25.79 | 26.06 | short |
| G | C16 | 17.90 | 13.33 | 6.98 | 3.78 | 1328.08 | 13.33 | 3.78 | 26.56 | 26.56 | 24.11 | 22.70 | 23.62 | 30.71 | slender |
| G | C17 | 27.27 | 17.27 | 0.88 | 0.46 | 2000.00 | 17.27 | 0.46 | 40.00 | 40.00 | 24.11 | 22.70 | 20.37 | 27.12 | slender |
| G | C18 | 0.28 | 0.14 | 0.38 | 0.54 | 2025.00 | 0.14 | 0.38 | 40.50 | 40.50 | 22.70 | 22.70 | 27.08 | 26.99 | short |
| G | C19 | 26.99 | 17.20 | 1.38 | 1.05 | 2033.00 | 17.20 | 1.05 | 40.66 | 40.66 | 24.11 | 22.70 | 20.35 | 26.67 | slender |
| G | C20 | 27.77 | 17.60 | 1.32 | 0.83 | 1796.68 | 17.60 | 0.83 | 35.93 | 35.93 | 24.11 | 22.70 | 20.51 | 28.42 | slender |
| G | C21 | 0.35 | 0.23 | 0.58 | 0.54 | 2274.40 | 0.23 | 0.54 | 45.49 | 45.49 | 22.70 | 22.70 | 25.53 | 25.43 | short |
| G | C22 | 27.41 | 17.41 | 1.86 | 1.23 | 2032.10 | 17.41 | 1.23 | 40.64 | 40.64 | 24.11 | 22.70 | 20.26 | 26.61 | slender |
| G | C23 | 31.76 | 21.34 | 19.61 | 19.03 | 1614.14 | 21.34 | 19.03 | 32.28 | 32.28 | 24.11 | 22.70 | 18.58 | 19.86 | slender |
| G | C24 | 0.32 | 0.16 | 9.16 | 3.43 | 2216.87 | 0.16 | 3.43 | 44.34 | 44.34 | 22.70 | 22.70 | 25.88 | 24.76 | short |
| G | C29 | 0.41 | 0.05 | 15.60 | 13.10 | 1671.10 | 0.05 | 13.10 | 33.42 | 33.42 | 22.70 | 24.11 | 29.85 | 22.99 | short |
| G | C30 | 0.46 | 0.13 | 15.66 | 13.17 | 1671.00 | 0.13 | 13.17 | 33.42 | 33.42 | 22.70 | 24.11 | 29.81 | 22.95 | short |
| F | C1 | 9.13 | 7.22 | 18.00 | 10.44 | 1967.60 | 7.22 | 10.44 | 39.35 | 39.35 | 19.99 | 19.31 | 30.70 | 29.04 | short |
| F | C2 | 9.41 | 7.46 | 18.94 | 10.23 | 1955.49 | 7.46 | 10.23 | 39.11 | 39.11 | 19.99 | 19.31 | 30.65 | 29.21 | short |
| F | C3 | 0.22 | 0.55 | 3.38 | 0.40 | 2359.22 | 0.22 | 0.40 | 47.18 | 47.18 | 19.31 | 19.31 | 31.34 | 31.27 | short |
| F | C4 | 9.08 | 7.23 | 16.34 | 9.97 | 1967.01 | 7.23 | 9.97 | 39.34 | 39.34 | 19.99 | 19.31 | 30.7 | 29.2 | short |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | 0 | 9 | |
| F | C5 | 5.63 | 5.24 | 1.26 | 1.49 | 1909.00 | 5.24 | 1.26 | 38.18 | 38.18 | 19.99 | 19.31 | 32.12 | 34.26 | short |
| F | C6 | 0.24 | 0.10 | 0.74 | 1.24 | 2403.00 | 0.10 | 0.74 | 48.06 | 48.06 | 19.31 | 15.83 | 31.10 | 30.86 | short |
| F | C7 | 5.33 | 5.17 | 0.47 | 0.23 | 2144.00 | 5.17 | 0.23 | 42.88 | 42.88 | 19.99 | 19.31 | 30.63 | 32.86 | short |
| F | C8 | 5.28 | 5.05 | 0.62 | 0.65 | 2138.25 | 5.05 | 0.62 | 42.77 | 42.77 | 19.99 | 19.31 | 30.72 | 32.73 | short |
| F | C9 | 0.16 | 0.06 | 0.43 | 0.09 | 2398.70 | 0.06 | 0.09 | 47.97 | 47.97 | 19.31 | 19.31 | 31.15 | 31.14 | short |
| F | C10 | 5.43 | 5.17 | 0.73 | 0.72 | 2145.90 | 5.17 | 0.72 | 42.92 | 42.92 | 19.99 | 19.31 | 30.62 | 32.63 | short |
| F | C11 | 4.63 | 4.67 | 0.10 | 0.10 | 2150.00 | 4.63 | 0.10 | 43.00 | 43.00 | 19.99 | 19.31 | 30.84 | 32.88 | short |
| F | C12 | 2.01 | 1.12 | 2.06 | 0.85 | 2016.60 | 1.12 | 0.85 | 40.33 | 40.33 | 19.31 | 19.31 | 33.44 | 33.57 | short |
| F | C13 | 8.39 | 5.78 | 1.02 | 0.14 | 1442.00 | 5.78 | 0.14 | 28.84 | 28.84 | 19.99 | 19.31 | 35.46 | 40.09 | short |
| F | C14 | 4.63 | 4.67 | 0.09 | 0.20 | 2150.00 | 4.63 | 0.09 | 43.00 | 43.00 | 19.99 | 19.31 | 30.84 | 32.88 | short |
| F | C15 | 2.10 | 1.10 | 2.05 | 0.98 | 2016.60 | 1.10 | 0.98 | 40.33 | 40.33 | 19.31 | 19.03 | 33.45 | 33.51 | short |
| F | C16 | 8.39 | 5.77 | 1.06 | 0.46 | 1442.00 | 5.77 | 0.46 | 28.84 | 28.84 | 19.99 | 19.31 | 35.47 | 39.82 | short |
| F | C17 | 5.28 | 5.05 | 0.62 | 0.64 | 2138.25 | 5.05 | 0.62 | 42.77 | 42.77 | 19.99 | 19.31 | 30.72 | 32.73 | short |
| F | C18 | 0.16 | 0.06 | 0.43 | 0.09 | 2398.70 | 0.06 | 0.09 | 47.97 | 47.97 | 19.31 | 19.31 | 31.15 | 31.14 | short |
| F | C19 | 5.43 | 5.17 | 0.73 | 0.71 | 2145.90 | 5.17 | 0.71 | 42.92 | 42.92 | 19.99 | 19.31 | 30.62 | 32.63 | short |
| F | C20 | 5.61 | 5.24 | 1.26 | 1.49 | 1909.01 | 5.24 | 1.26 | 38.18 | 38.18 | 19.99 | 19.31 | 32.12 | 34.26 | short |
| F | C21 | 0.24 | 0.10 | 0.74 | 1.24 | 2403.00 | 0.10 | 0.74 | 48.06 | 48.06 | 19.31 | 19.31 | 31.10 | 30.86 | short |
| F | C22 | 5.33 | 5.17 | 0.47 | 0.23 | 2144.00 | 5.17 | 0.23 | 42.88 | 42.88 | 19.99 | 19.31 | 30.63 | 32.86 | short |
| F | C23 | 9.41 | 7.46 | 18.94 | 10.23 | 1955.49 | 7.46 | 10.23 | 39.11 | 39.11 | 19.99 | 19.31 | 30.65 | 29.21 | short |
| F | C24 | 0.22 | 0.14 | 3.38 | 0.40 | 2359.92 | 0.14 | 0.40 | 47.20 | 47.20 | 19.31 | 19.31 | 31.37 | 31.27 | short |
| F | C29 | 0.11 | 0.20 | 12.02 | 8.49 | 1822.20 | 0.11 | 8.49 | 36.44 | 36.44 | 19.31 | 19.99 | 35.70 | 30.86 | short |
| F | C30 | 0.01 | 0.23 | 12.03 | 8.58 | 1822.20 | 0.01 | 8.58 | 36.44 | 36.44 | 19.31 | 19.99 | 35.76 | 30.81 | short |

Table H 3:Reinforcement calculation for column from founfation to roof floor

| lon | Col. | MEDx | MEDy | Vsd | μsdy | μsdx | ω | As | As, min | As, max | As, prov | as | NO | PROV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R | C1 | 52.82 | 4.67 | 0.1 | 0.01 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C2 | 55.27 | 5.08 | 0.1 | 0.01 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C3 | 4.60 | 19.31 | 0.1 | 0.02 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C4 | 52.82 | 4.71 | 0.1 | 0.01 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C5 | 46.75 | 3.78 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø4 |
| R | C6 | 16.67 | 4.73 | 0.1 | 0.01 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C7 | 44.95 | 3.76 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C8 | 44.80 | 3.77 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C9 | 4.72 | 4.72 | 0.1 | 0.01 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C10 | 44.39 | 3.79 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C11 | 42.29 | 3.78 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C12 | 20.89 | 18.60 | 0.1 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C13 | 30.97 | 45.47 | 0.1 | 0.05 | 0.04 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C14 | 42.39 | 3.77 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C15 | 20.89 | 18.85 | 0.1 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C16 | 30.97 | 45.77 | 0.1 | 0.05 | 0.04 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C17 | 44.80 | 3.77 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C18 | 4.72 | 4.72 | 0.1 | 0.01 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C19 | 44.39 | 3.79 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø4 |
| R | C20 | 46.75 | 3.78 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C21 | 4.73 | 4.73 | 0.1 | 0.01 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C22 | 44.95 | 3.76 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| R | C23 | 55.37 | 5.08 | 0.1 | 0.01 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| ROOF | C24 | 4.60 | 19.31 | 0.1 | 0.02 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| ROOF | C29 | 3.24 | 23.86 | 0.1 | 0.03 | 0.00 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| ROOF | C30 | 3.24 | 23.80 | 0.1 | 0.03 | 0.00 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C1 | 50.56 | 10.21 | 0.2 | 0.01 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C2 | 52.57 | 12.90 | 0.2 | 0.01 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C3 | 12.19 | 22.71 | 0.3 | 0.03 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C4 | 50.55 | 10.21 | 0.2 | 0.01 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 4TH | C5 | 44.40 | 11.50 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C6 | 12.54 | 12.54 | 0.3 | 0.01 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C7 | 42.47 | 11.43 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø4 |
| 4TH | C8 | 42.58 | 11.45 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C9 | 12.50 | 12.50 | 0.3 | 0.01 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C10 | 41.87 | 11.41 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C11 | 40.23 | 11.44 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4TH | C12 | 19.38 | 17.80 | 0.2 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C13 | 29.45 | 49.31 | 0.2 | 0.06 | 0.03 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 4TH | C14 | 40.23 | 11.44 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C15 | 19.37 | 17.82 | 0.2 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C16 | 29.44 | 49.36 | 0.2 | 0.06 | 0.03 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 4TH | C17 | 42.58 | 3.89 | 0.1 | 0.00 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C18 | 12.50 | 12.50 | 0.3 | 0.01 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C19 | 41.87 | 11.41 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C20 | 44.24 | 11.50 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C21 | 12.54 | 12.54 | 0.3 | 0.01 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø4 |
| 4TH | C22 | 42.47 | 11.43 | 0.3 | 0.01 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C23 | 52.57 | 10.25 | 0.2 | 0.01 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C24 | 12.19 | 22.80 | 0.3 | 0.03 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C29 | 9.07 | 23.43 | 0.2 | 0.03 | 0.01 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 4TH | C30 | 9.05 | 24.45 | 0.2 | 0.03 | 0.01 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C1 | 55.22 | 17.18 | 0.4 | 0.02 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C2 | 56.87 | 29.24 | 0.4 | 0.03 | 0.07 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C3 | 20.07 | 20.07 | 0.5 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C4 | 55.19 | 17.18 | 0.4 | 0.02 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C5 | 48.97 | 19.27 | 0.4 | 0.02 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C6 | 20.63 | 20.63 | 0.5 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C7 | 47.06 | 19.48 | 0.4 | 0.02 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C8 | 47.17 | 19.53 | 0.4 | 0.02 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C9 | 20.56 | 20.56 | 0.5 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø4 |
| 3RD | C10 | 46.37 | 19.46 | 0.4 | 0.02 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C11 | 45.32 | 19.50 | 0.4 | 0.02 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C12 | 20.41 | 19.40 | 0.4 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C13 | 31.26 | 50.05 | 0.3 | 0.06 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C14 | 45.32 | 19.50 | 0.4 | 0.02 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C15 | 20.90 | 19.37 | 0.4 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C16 | 31.26 | 49.96 | 0.3 | 0.06 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C17 | 47.17 | 19.52 | 0.4 | 0.02 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C18 | 20.57 | 20.57 | 0.5 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C19 | 46.37 | 19.46 | 0.4 | 0.02 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C20 | 48.97 | 30.69 | 0.4 | 0.04 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C21 | 20.63 | 20.63 | 0.5 | 0.02 | 0.02 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 3RD | C22 | 47.06 | 19.48 | 0.4 | 0.02 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C23 | 56.80 | 29.24 | 0.4 | 0.03 | 0.07 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø4 |
| 3RD | C24 | 20.07 | 20.07 | 0.5 | 0.02 | 0.02 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C29 | 15.07 | 24.90 | 0.3 | 0.03 | 0.02 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 3RD | C30 | 15.07 | 25.03 | 0.3 | 0.03 | 0.02 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2ND | C1 | 52.39 | 24.42 | 0.6 | 0.03 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C2 | 53.58 | 29.40 | 0.5 | 0.03 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C3 | 28.53 | 28.53 | 0.7 | 0.03 | 0.03 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 2ND | C4 | 52.39 | 24.42 | 0.6 | 0.03 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C5 | 46.20 | 26.00 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C6 | 29.32 | 29.32 | 0.7 | 0.03 | 0.03 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 2ND | C7 | 44.39 | 27.80 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C8 | 44.58 | 27.91 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C9 | 29.24 | 29.24 | 0.7 | 0.03 | 0.03 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 2ND | C10 | 43.79 | 27.76 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C11 | 43.08 | 27.82 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø4 |
| 2ND | C12 | 24.32 | 24.32 | 0.6 | 0.03 | 0.03 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C13 | 29.36 | 52.95 | 0.4 | 0.06 | 0.03 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C14 | 43.08 | 27.82 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C15 | 24.32 | 24.32 | 0.6 | 0.03 | 0.03 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C16 | 29.35 | 52.98 | 0.4 | 0.06 | 0.03 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C17 | 44.48 | 27.91 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C18 | 37.47 | 37.47 | 0.9 | 0.04 | 0.04 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 2ND | C19 | 47.13 | 35.93 | 0.8 | 0.04 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 2ND | C20 | 46.20 | 26.00 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C21 | 29.32 | 29.32 | 0.7 | 0.03 | 0.03 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 2ND | C22 | 44.39 | 27.80 | 0.6 | 0.03 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C23 | 53.58 | 29.40 | 0.5 | 0.03 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C24 | 28.53 | 28.53 | 0.7 | 0.03 | 0.03 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 2ND | C29 | 21.38 | 24.18 | 0.5 | 0.03 | 0.02 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø4 |
| 2ND | C30 | 21.38 | 24.14 | 0.5 | 0.03 | 0.02 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C1 | 54.46 | 31.25 | 0.7 | 0.04 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C2 | 55.56 | 29.87 | 0.6 | 0.03 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C3 | 36.58 | 36.58 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C4 | 54.43 | 31.44 | 0.7 | 0.04 | 0.06 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C5 | 48.80 | 31.19 | 0.7 | 0.04 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C6 | 37.57 | 37.57 | 0.9 | 0.04 | 0.04 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C7 | 47.80 | 35.94 | 0.8 | 0.04 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C8 | 47.17 | 35.74 | 0.8 | 0.04 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C9 | 37.47 | 37.47 | 0.9 | 0.04 | 0.04 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C10 | 47.13 | 35.93 | 0.8 | 0.04 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C11 | 47.06 | 35.00 | 0.8 | 0.04 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C12 | 31.14 | 31.14 | 0.7 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C13 | 30.61 | 31.93 | 0.5 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø4 |
| 1ST | C14 | 47.06 | 35.00 | 0.8 | 0.04 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C15 | 31.14 | 31.14 | 0.7 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1ST | C16 | 30.51 | 31.65 | 0.5 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C17 | 47.15 | 35.74 | 0.8 | 0.04 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C18 | 37.47 | 37.47 | 0.9 | 0.04 | 0.04 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C19 | 47.13 | 35.93 | 0.8 | 0.04 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C20 | 48.80 | 31.19 | 0.7 | 0.04 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C21 | 37.57 | 37.57 | 0.9 | 0.04 | 0.04 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C22 | 47.80 | 35.94 | 0.8 | 0.04 | 0.05 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| 1ST | C23 | 55.56 | 29.87 | 0.6 | 0.03 | 0.06 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C24 | 36.58 | 36.58 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C29 | 27.48 | 27.48 | 0.6 | 0.03 | 0.03 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| 1ST | C30 | 36.58 | 36.58 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C1 | 36.53 | 36.53 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø4 |
| G | C2 | 32.28 | 32.28 | 0.7 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C3 | 44.33 | 44.33 | 1.0 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C4 | 36.72 | 36.72 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C5 | 35.93 | 35.93 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C6 | 37.57 | 37.57 | 0.9 | 0.04 | 0.04 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| G | C7 | 40.64 | 40.64 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C8 | 40.50 | 40.50 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C9 | 45.38 | 45.38 | 1.0 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C10 | 40.67 | 40.67 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C11 | 40.74 | 40.74 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C12 | 37.72 | 37.72 | 0.9 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C13 | 26.56 | 26.56 | 0.6 | 0.03 | 0.03 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| G | C14 | 40.74 | 40.74 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C15 | 37.72 | 37.72 | 0.9 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø4 |
| G | C16 | 26.56 | 26.56 | 0.6 | 0.03 | 0.03 | 0.1 | 500.5 | 320 | 6400 | 500.48 | 452.16 | 1.11 | 4ø24 |
| G | C17 | 40.00 | 40.00 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C18 | 40.50 | 40.50 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C19 | 40.66 | 40.66 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C20 | 35.93 | 35.93 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C21 | 45.49 | 45.49 | 1.0 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C22 | 40.64 | 40.64 | 0.9 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C23 | 32.28 | 32.28 | 0.7 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C24 | 44.34 | 44.34 | 1.0 | 0.05 | 0.05 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C29 | 33.42 | 33.42 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| G | C30 | 33.42 | 33.42 | 0.8 | 0.04 | 0.04 | 0.2 | 1001 | 320 | 6400 | 1001 | 452.16 | 2.21 | 4ø24 |
| F | C1 | 39.35 | 39.35 | 0.6 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C2 | 39.11 | 39.11 | 0.6 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C3 | 47.18 | 47.18 | 0.7 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø4 |
| F | C4 | 39.34 | 39.34 | 0.6 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | C5 | 38.18 | 38.18 | 0.6 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C6 | 48.06 | 48.06 | 0.7 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C7 | 42.88 | 42.88 | 0.6 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C8 | 42.77 | 42.77 | 0.6 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C9 | 47.97 | 47.97 | 0.7 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C10 | 42.92 | 42.92 | 0.6 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C11 | 43.00 | 43.00 | 0.6 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C12 | 40.33 | 40.33 | 0.6 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C13 | 28.84 | 28.84 | 0.4 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C14 | 43.00 | 43.00 | 0.6 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C15 | 40.33 | 40.33 | 0.6 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C16 | 28.84 | 28.84 | 0.4 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C17 | 42.77 | 42.77 | 0.6 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø4 |
| F | C18 | 47.97 | 47.97 | 0.7 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C19 | 42.92 | 42.92 | 0.6 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C20 | 38.18 | 38.18 | 0.6 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C21 | 48.06 | 48.06 | 0.7 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C22 | 42.88 | 42.88 | 0.6 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C23 | 39.11 | 39.11 | 0.6 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C24 | 47.20 | 47.20 | 0.7 | 0.03 | 0.03 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C25 | 36.44 | 36.44 | 0.5 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |
| F | C30 | 36.44 | 36.44 | 0.5 | 0.02 | 0.02 | 0.1 | 782 | 500 | 10000 | 782 | 452.16 | 1.73 | 4ø24 |