"DESIGN & COST ESTIMATION OF HOSTEL BUILDING"

A PROJECT

Submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

DR. ASHISH KUMAR

PROFESSOR

By

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To

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

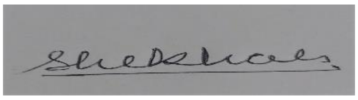
WAKNAGHAT, SOLAN – 173 234

HIMACHAL PRADESH, INDIA

June-2021

STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **"Design & Cost Estimation of Hostel Building"** submitted for partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** at is an authentic record of my work carried out under the supervision of Professor (Dr.) **Ashish Kumar** This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.



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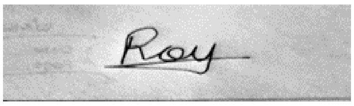

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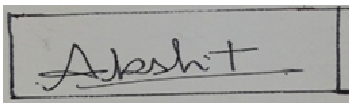

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12 MAY 2021

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **“DESIGN & COST ESTIMATION OF HOSTEL BUILDING”** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Shekhar Sharma (171606), Aviral Roy (171611),Akshit Thakur(171622)** during a period from July 2020 to May 2021 under the supervision of **DR. ASHISH KUMAR Professor** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

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ACKNOWLEDGEMENT

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The successful compilation of final year project depends on the knowledge and attitude inculcated in the total length of the course. So we want to express our sincere gratitude to all the faculties who taught us during the four years of B.Tech.

We would also like to thank my friends, library staff and several authors of various text books which have been referred in this project but have remained unmentioned in the list of references.

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ABSTRACT

In these modern times structures have more and more complex designs. The conventional methods of manual calculations and drawings have been outdated and cannot keep up with these new needs. To keep up with the modern structure requirements Construction companies have switched to modern software's such as AutoCAD, Staad Pro, Etab, SAP2000, Excel and many more.

Civil Engineers are now not only required to have knowledge on the field but the companies also require them to have proficiency in software's like Staad Pro, AutoCAD, Microsoft excel etc.

The Project titled "Design and cost estimation of Hostel building'' revolves around design and analysis of a hostel building on Staad Pro and cost estimation on Microsoft excel. The Floor plan with columns, beams and elevation of structure drawing was used.

The Hostel has following dimensions of 25460mm (Length) x 10300mm (Width) x 26100mm (Height) and is a G+7 building (Ground floor and 7 floors). The rooms have dimensions of 4100mm (Length) x 3200mm (Width), the washrooms have dimensions of 4100mm (Length) x 3800mm (Width), and the corridor has dimensions of 23600mm (Length) x 2100 mm (Width). The ground floor and the first floor have a height of 3600mm while all the other remaining floors have a height of 3150mm

The objective of this project is to design analyse and find cost estimation of the G+7 hostel building.

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CHAPTER 1: INTRODUCTION

We humans are surrounded by structures. The bridges, dams, even the houses we live, eat and sleep in are nothing else but structures. Even in structures humans have achieved great feats for example Qutab Minar a famous structure known for its height another example is Pyramid of Giza known for being colossal.

The structures have always been an important part of human life and it serves a bunch of purposes. An example would be for transportations we use bridges, another example is to store water for various purposes we build a tank, to control flow of rivers we use dams. Workplaces, educational institutes, Hospitals, Houses all are structures which have a regular use in human society.

As easy it may look but to build a structure is a challenge. A structure requires material like bricks, concrete, steel etc. Structure compromises of foundation, beams, columns and slabs. To build a structure first an architectural drawing is prepared which is given to a structural engineer that prepares a structural drawing and an electrical drawing as well. With all these drawings estimations of quantities of various components are determined.

A lot of calculations are required to build structure. With modern times and this age of technology luckily for civil engineers some structure designing software's are making rounds in the market some of them which are widely use these days are Etabs, Staad Pro, Sap 2000.

These software's have reduced the stress of manual calculations for structural designers and made it easier to design the modern structures. Staad Pro is being widely used around the world because of its user friendly interface, easiness with which it allows design and analysis and accuracy in its results.

The Project titled "Design and cost estimation of Hostel building'' revolves around design and analysis of a hostel building on Staad Pro and finally cost estimation on Microsoft excel.

1.1 OBJECTIVES

The objectives of this project are as follows:

To Design and analyse hostel building on Staad Pro V8i.

To compare the Staad Pro results for structures with/without specifications.

To estimate the cost of structure.

1.2 INTRODUCTION TO STAAD PRO

Staad Pro will be used for the design and analysis of the hostel building. The version of the Staad Pro that will be used is Staad Pro V8i Select Series 6. Inputs will be given in Staad Pro like assigning beam columns properties etc. Outputs like Beam design and Column design will be considered

Staad Pro was developed by researchers international at Yorba Linda, CA in 1997 later in 2005 it was sold to Bentley Systems. Bentley has developed the software till this date. The latest being Staad Pro Connect edition version 22. Staad Pro is used for design and analysis of structures comprising of steel, concrete, Aluminium etc.

Architects give their structure drawings to Structural Designers. Structural Designers use Staad Pro to analyse and design a 3D model of the structure. Staad Pro will give the Structural Designer reinforcements in Beams and Columns. The Structure Designer after designing the Beams, Columns, Slabs, Stairs and footing will give his work to draft person which will further give the details to quantity estimators.

1.3 COST ESTIMATION

Cost estimation would be performed on Microsoft excel on the latest version available. In the project Detailed estimate will be used which mainly includes working out quantities of different work and calculating cost of each work.

CHAPTER 2: LITERATURE REVIEW

Adhiraj A. Wadekar, Ajay G. Dahake (2020): Analysis and Design of multi storey using Staad Pro

Conclusion

The journal involved a review of a high rise building that was analysed and designed using staad pro. Dead, imposed and wind loads with their combination were applied to the structure. The building was high rise which is more than 15metre in height so shear walls and brace frames were also applied to the structure. The accuracy of Staad Pro while giving results like Shear force and bending moment were noted.

Dhanavath Seva, Bhukya Chandrashekar, Faria Aseem (2017): Design of Residential Building using Staad Pro

Conclusion

The project consisted of analysis of multi storey residential building of G+6 consisting of 5 apartments on each floor. The dead and live loads were applied. Design for the beams columns and footings were obtained. The software was noted for being fast, accurate and effective.

Mahesh Ram Patel, RC Singh (2017): Analysis of tall structure using Staad Pro providing different wind intensities as per IS875 part 3

Conclusion

In this research high rise building of 10, 14 and 18 storeys were tested in five wind zones of 33, 39, 44, 47and 55 m/s. The results were compared for the maximum shear force, maximum bending and displacement. Max shear force and bending was seen in zone 4 compared to zone 1. In terms of displacement maximum was shown in zone 4.

CHAPTER 3: METHODOLOGY

In this chapter we focus on a step by step description of how we designed our structure on Staad Pro. We will also be calculating manually the different loads that are to be applied on our structure. Further we will move to cost estimation its procedure after which we will be finally designing the slab and stairs manually.

The Hostel has following dimensions of 25460mm (Length) x 10300mm (Width) x 26100mm (Height) and is a G+7 building (Ground floor and 7 floors). The rooms have dimensions of 4100mm (Length) x 3200mm (Width), the washrooms have dimensions of 4100mm (Length) x 3800mm (Width), and the corridor has dimensions of 23600mm (Length) x 2100 mm (Width). The ground floor and the first floor have a height of 3600mm while all the other remaining floors have a height of 3150mm. This building is designed to accommodate a number of 150 students with 10 rooms, 4 bathrooms, a store and office on each floor. Floor plan is given in Annexure 1.

3.1 Working on Staad Pro

3.1.1 Nodes

To start a structure on Staad Pro we first make nodes. The first node used in structure has coordinates of 0,0,0 moving on to the second node with coordinates as 4,1,0,0 the third node has the coordinates of 6,2,0,0 while the fourth node has coordinates of 10,3,0,0 the units being in metric. The distance between these nodes can be displayed by node to node distance a tool in Staad Pro.

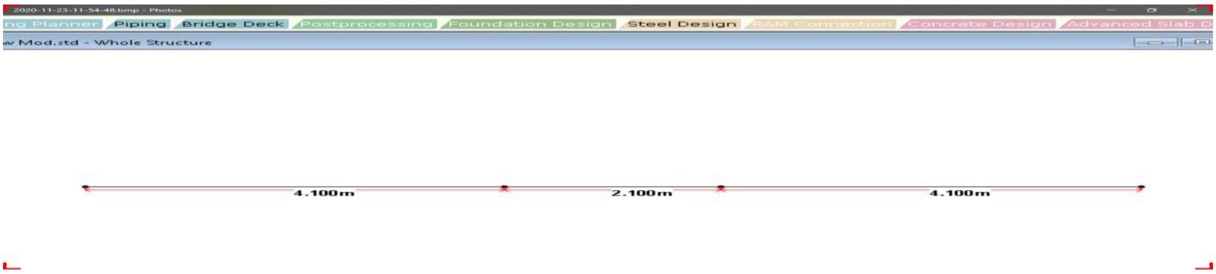


FIGURE 3.1 Initial nodes

3.1.2 Ground floor plan

The beams that were made previously are selected now and a tool named translational repeat is used to replicate the beams to form a floor. The distance between each of the beams were taken as 1.86metre, 3.2metre, 3.8metre, 3.2metre, 3.2metre, 3.8metre, 3.2metre, 3.2metre.

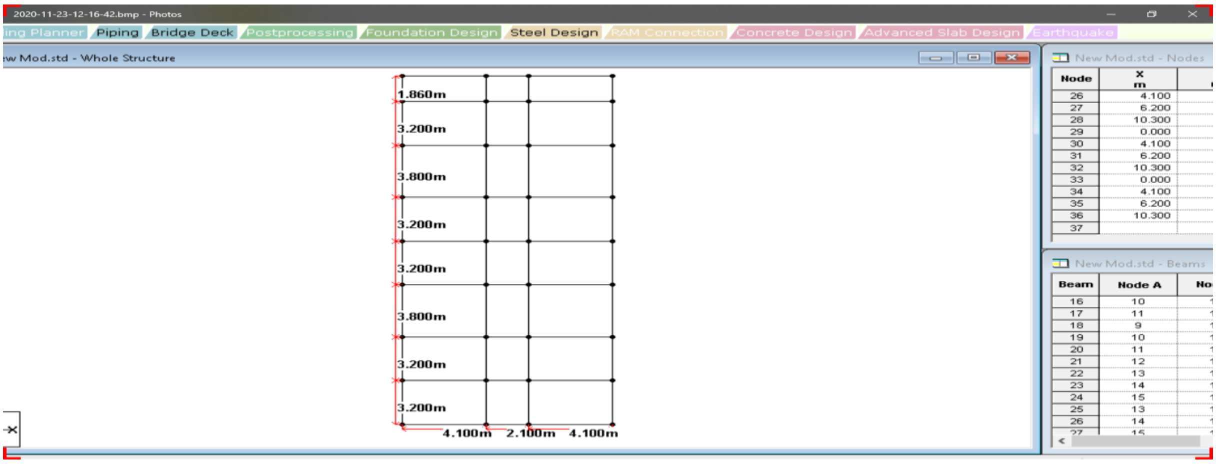


FIGURE 3.2 Floor Plan

3.1.3 Structure in 3D

Now select the entire ground floor using the geometry cursor. Again use the translational tool but this time in the y direction. The structure is a G+7 so the ground floor has a height of 3.6metre, similarly the first floor has a height of 3.6metre while all the remaining floors have a height of 3.15metres.

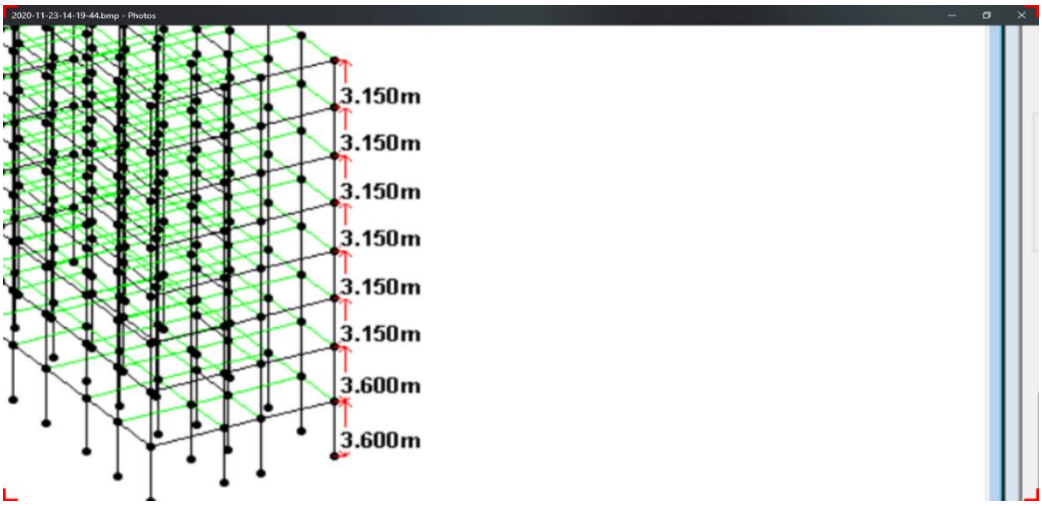


FIGURE 3.3 Floor Elevations

3.1.4 Define Beams Columns and Supports

The beams dimensions were taken as 0.23metre width by 0.45metre depth from the provided data.

The columns dimensions were taken as 0.3metre width by 0.6metre depth from the provided data.

The column specifically attached to the stair had dimensions of 0.3metre width by 3.3metre depth. This column had an unusual amount of depth because of a staircase that was attached to this column. The staircase had to transfer all the loads using the big column available.

Fixed supports were created in the software and applied in the structure.

3.1.5 Assigning Beams Columns and Supports

Using the select tool all the beams in the x and the z directions are selected and assigned with the dimensions similarly all the columns in the y direction are selected and assigned.

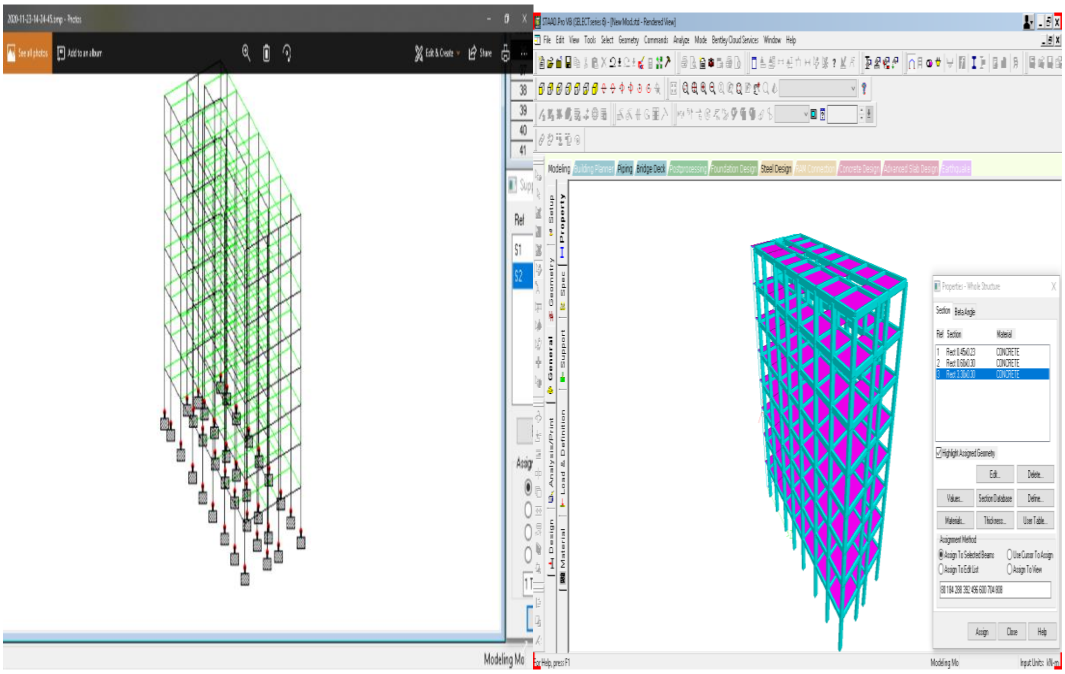


FIGURE 3.4 Beams Columns and Supports

3.1.6 Specifications

Staad Pro tends to design structure with every member being ideal in nature. So when a moment is generated in one member it completely transfers to the next member without facing any loss or distribution. Which implies that the moment generated on the top of the structure is completely transferred to the bottom. In real life our structure is not ideal hence in real structures moment is released or redistributed and similar should be achieved in Staad Pro. To release the moment in Staad Pro we go to moment release option in specification tab. We further are asked to choose between a partial or a full moment release option.

Full moment release is used for the secondary beams. Primary beams have columns attached to them which do not allow rotation because of a counter moment generated in their junction on the contrary rotation happens in secondary beam as they have no column support available. So the moment is 0 in secondary beams and primary beams junction.

Partial moment release is used for the columns. According to Indian standards about 30 percent of moment is released in the columns

Another specification is member offset. In Staad Pro when we see a 3D render view of our beam column junction we see that the beam has gone in width of depth of column similarly the beam goes in half of depth of column. This anomaly causes the beam length and column length to increase. Though the increment is of around 80milimetre but considering the fact that there are a lot of beams and columns in the structure this small anomaly affects the output results. To economise our section by using member offset which rectifies this length increase.

Another specification is cracked sections. In Structures with time we know that certain micro cracks are formed specifically in the tension zone. We know concrete is bad in tension and good in compression. We use a specification of property reduction factor to involve this future possibility of micro cracks in the tension zone. To columns we use moment of inertia of 0.7 as for beams the it is 0.35 noted from Indian standards code 1893 part 1 (6.4.3.1).

Another specification is Plate mesh. In structures slabs and beams are monolithic in nature but to replicate that same in Staad Pro we have to use plate mesh command. The command is important because it allows the plate to have uniform stress on it. The more the divisions we select for the plate the more accurate the stress distribution becomes. The plate mesh command should always be used when we are using a slab in our structure.

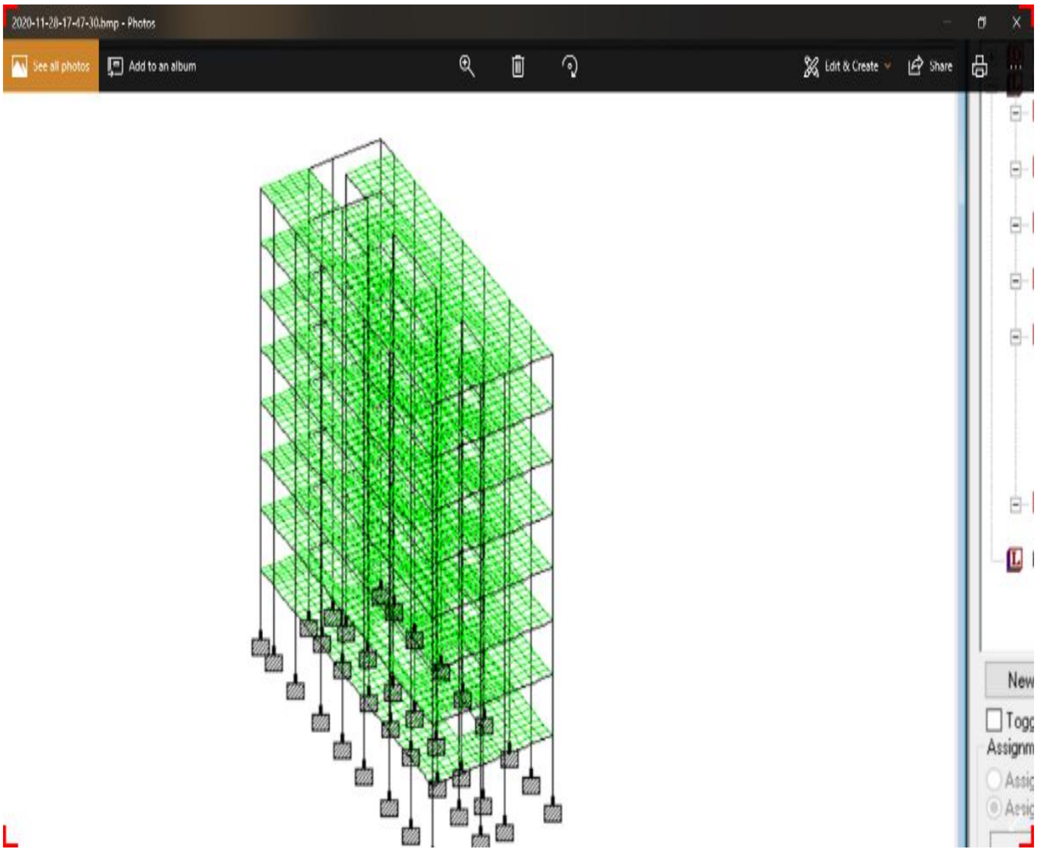


FIGURE 3.5 Plate Mesh

3.2 Loads Calculations

3.2.1 Dead Loads

3.2.1.1 SELF WEIGHT

Loads in a structure that cannot be moved and are permanent in nature. An example of a dead load is wall load, slab load etc.

Self-weight of the structure is typically calculated using

Self-weight = unit weight of concrete x volume of section

= 25kn/m^3 x volume

Staad pro has a direct option to apply the self-weight of the structure under dead load in -y direction towards ground.

3.2.1.2 WALL LOADS

The ground floor and first floor have a height of 3.6metre while other floors have a height of 3.15metre while the terrace will have a parapet wall. Calculations of wall load will go as follows.

Ground and First floor

Outer Walls;

Wall Thickness = 9 inches or 0.23metre

Floor height = 3.6metre

Beam Depth = 0.45metre

Wall Height = Floor Height – Beam Depth

= 3.6 – 0.45

= 3.15 metre

Wall Load = Unit weight of brick x Wall thickness x Wall height

= 19 x 0.23 x 3.15

= 13.7655 or 13.8kn/m

Inner Walls

Wall Thickness = 4 inches or 0.11metre

Floor Height = 3.6metre

Beam Depth = 0.45metre

Wall Height = 3.15metre

Wall Load = 19k x 0.11 x 3.15

= 6.5835m or 6.6kn/m

Second floor to seventh floor

Outer Walls;

Wall Thickness = 9 inches or 0.23m

Floor height = 3.15m

Beam Depth = 0.45m

Wall Height = Floor Height – Beam Depth

= 3.15 – 0.45m

= 2.7metre

Wall Load = Unit weight of brick x Wall thickness x Wall height

= 19 x 0.23 x 2.7

= 11.799 or 11.8kn/m

Inner Walls;

Wall Thickness = 4 inches or 0.11m

Floor Height = 3.15m

Beam Depth = 0.45m

Wall Height = 2.7m

Wall Load = Unit weight of brick x Wall thickness x Wall height

= 19kn/m^3 x 0.11m x 2.7m

= 5.643 or 5.6kn/m

Terrace Walls

Outer Walls only;

Wall Load = 3kn/m

3.2.1.3 FLOOR LOADS

We will consider the load of the slab as 1kn/m^2. With that floor finish load of 1.5kn/m^2 will also be taken.

So floor load = 1.5 + 1

= 2.5kn/m^2

3.2.2 Live Loads

The live loads also known as the imposed loads includes all the loads that can be moved in the structure like human load, furniture loads, fan load etc. The code followed for applying imposed loads is INDIAN STANDARD CODE 875 PART2: IMPOSED LOADS.

3.2.2.1 FLOOR FINISH LOADS

We take the floor finish load as = 1.5kn/m^2

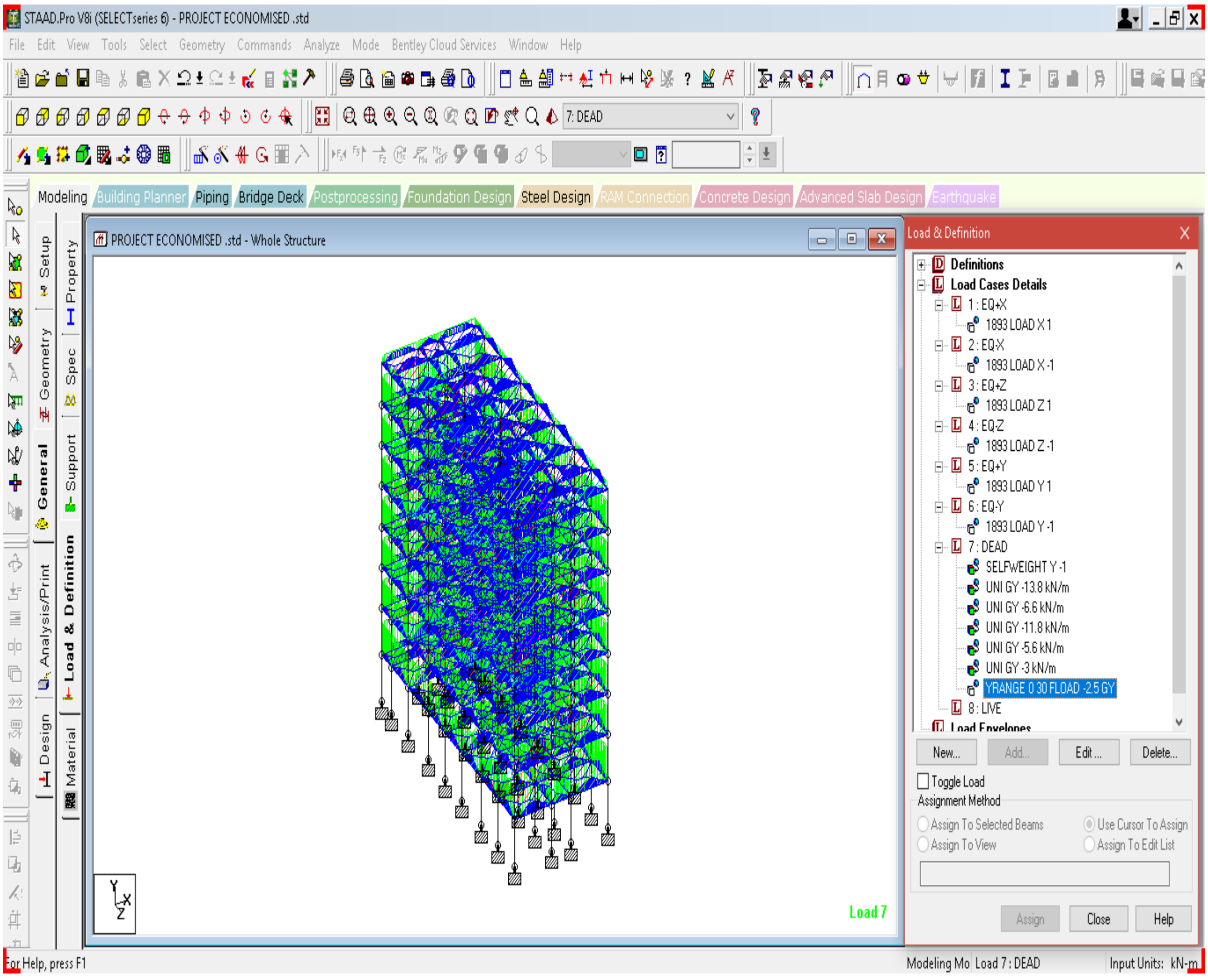
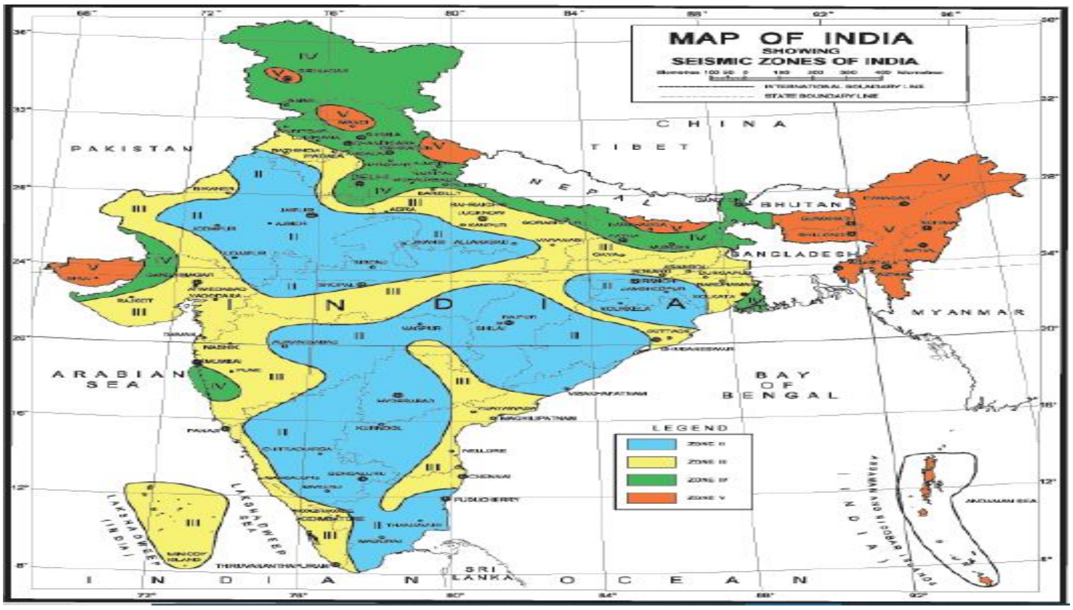


FIGURE 3.6 Floor finish load

3.2.3 Seismic Loads

Seismic loads also known as the Earth quake loads are applied to the structure using the INDIAN STANDARD CODE 1893: PART1 EARTHQUAKE RESISTANT. To apply the Seismic loads, we need to refer the map to determine the earthquake zone of the location where the structure is to be made.



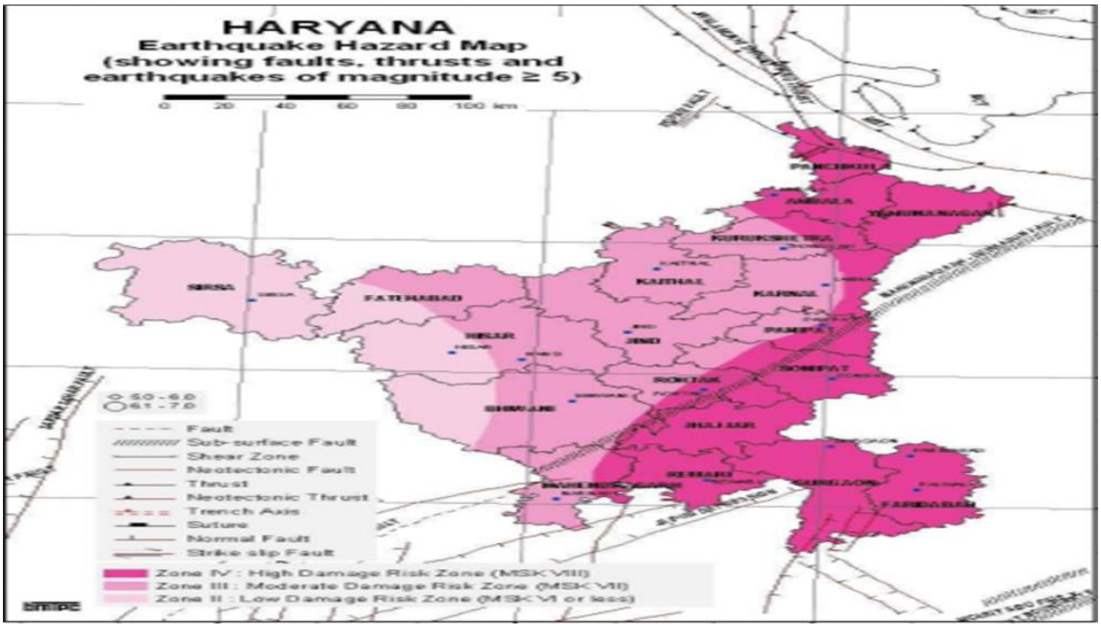


FIGURE 3.7 Earthquake Zones India(Haryana)

Using the map, it was determined that our project location came under earthquake zone 4.

3.2.4 Wind Loads

The wind loads are considered using the Indian code IS 875 part 3 Loads other than earthquake loads. The wind loads were considered from Staad Pro itself.

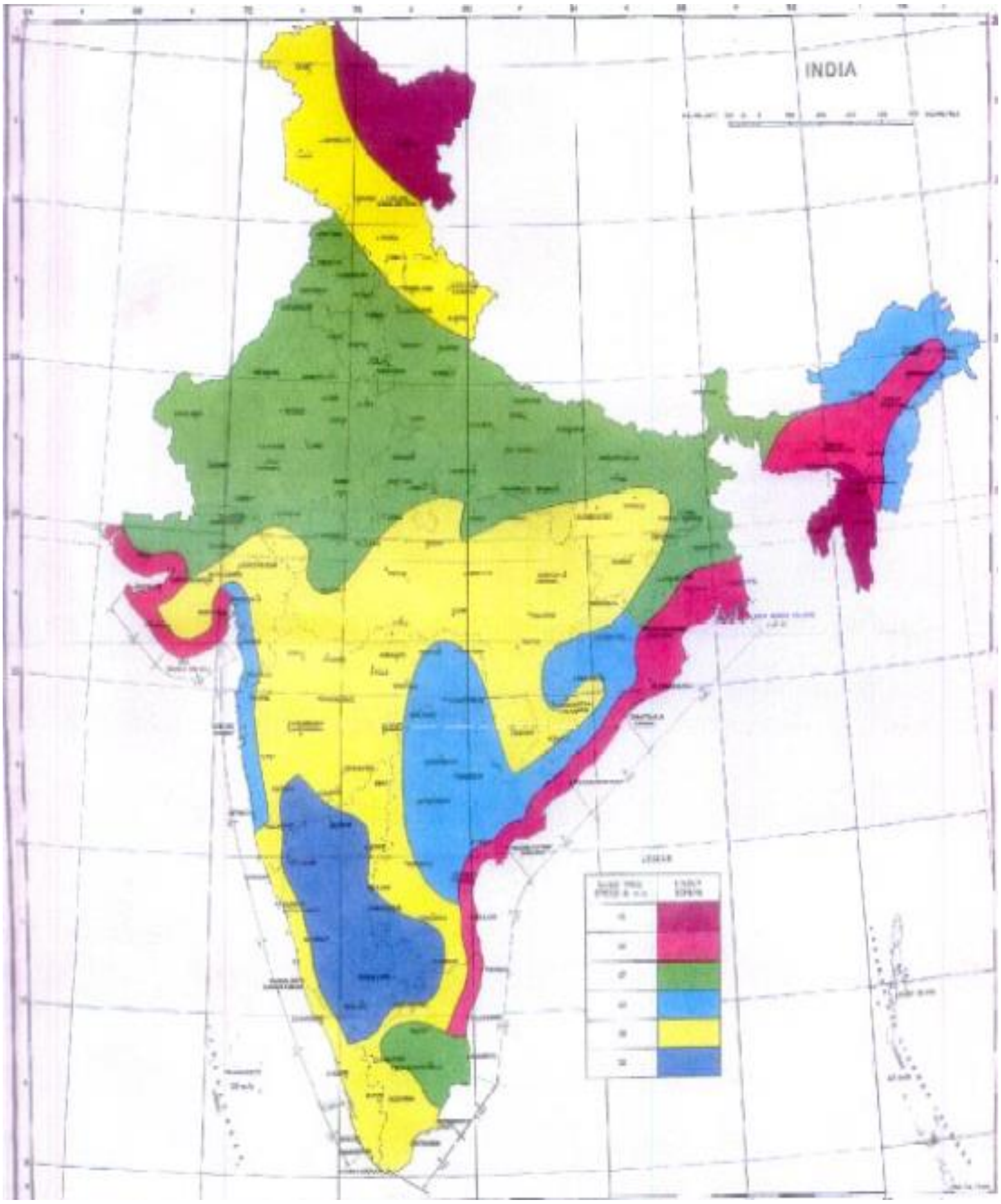
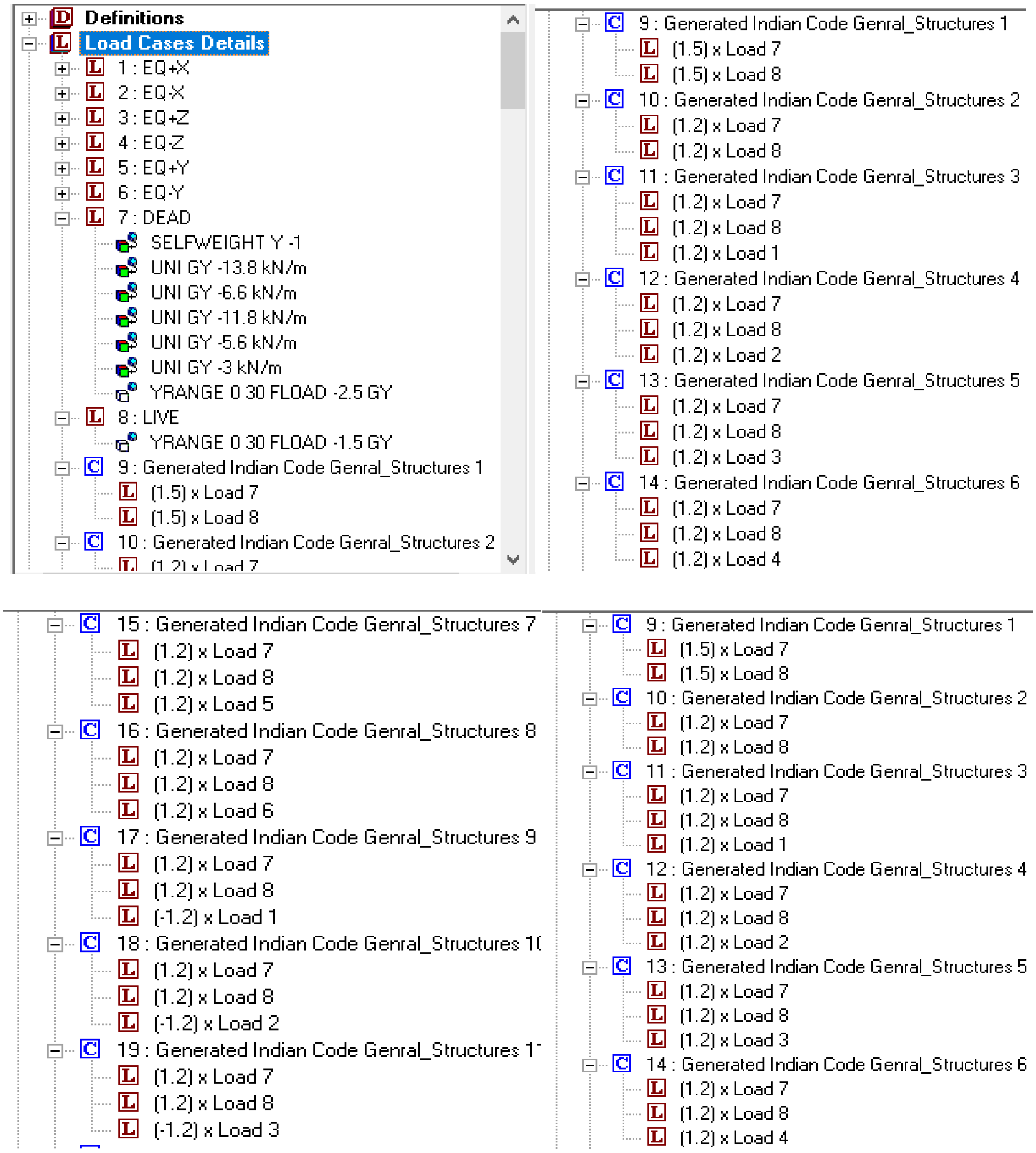


FIGURE 3.8 Wind Map India

3.2.5 Load Combinations

The load combinations were generated via the Staad Pro itself. The Dead Live and Seismic loads are applied in a certain combination via also taking into account the safety factors of 1.25 and 1.5.



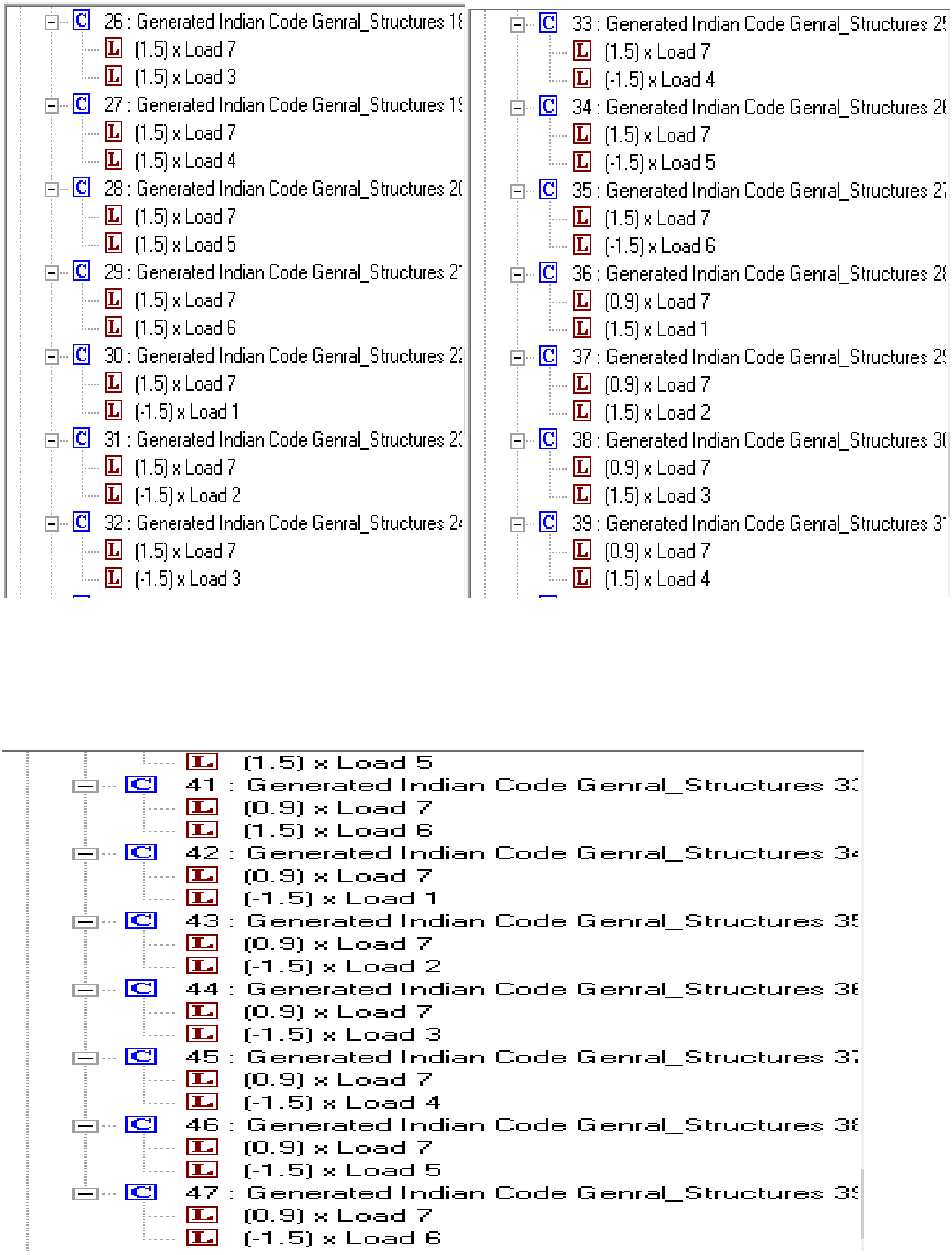


FIGURE 3.9 Load Combinations

3.3 Cost Estimation

Cost estimation is a process of predicting the cost required to build a structure. Project owners can determine the feasibility and scope of project via cost estimation. Following paragraphs give insight to steps involved in cost estimation and we have used DSR 2016 for material rates

3.3.1 Interpretation of Drawing

Check the dimensions for each block if provided or not.

Check if the schedule of opening is there or not.

Check the specification of work.

Check whether the thickness of wall remains same or changes.

Check rise and tread dimension of stairs.

Check type of foundation and its detailing.

3.3.2 Preparing an estimation sheet

QUANTITY SHEET

Sr. No.	Item Description	No.	Length (m)	Widht/ Breadth (m)	Height/ Depth (m)	Quantity	
1	Earthwork in Excavation in Foundation:						

FIGURE 3.10 Quantity Sheet example

3.3.3 Calculating Quantity

In our project we are using detailed estimate an example is given below

QUANTITY SHEET

Sr. No.	Item Description	No.	Length (m)	Widht/ Breadth (m)	Height/ Depth (m)	Quantity	
1	Earthwork in Excavation in Foundation:						
	Footing (1m x 1m)	12	1.50	1.50	1.50	40.50	cu m
	Depth From GL = 1.5 m						
2	P.P.C. in Foundation						
	Footing (1m x 1m)	12	1.3	1.3	0.1	2.03	cu m
	Thickness = 0.10						

FIGURE 3.11 Quantity Sheet example 2

STEEL REINFORCEMENT

Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.		
Mild steel and Medium Tensile steel bars	Kg	55.30
Hard drawn steel wire	Kg	66.70
Cold twisted bars	Kg	56.60
Hot rolled deformed bars	Kg	56.60
Hard drawn steel wire fabric	Kg	71.30
Thermo-Mechanically Treated bars of grade Fe-500D or more.	Kg	56.60
Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level.		
Mild steel and Medium Tensile steel bars	Kg	55.30
Hard drawn steel wire	Kg	66.70

Description	Unit	Rate ₹
Cold twisted bars	Kg	56.60
Hot rolled deformed bars	Kg	56.60
Hard drawn steel wire fabric	Kg	71.30
Thermo-Mechanically Treated bars of grade Fe-500 D or more.	Kg	56.60

FIGURE 3.12 Rate for Steel

DESIGN MIX CONCRETE

Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge."(Note :- Cement content considered in this item is @ 330 kg/cum."Excess/ less cement used as per design mix is payable/recoverable separately).

All works upto plinth level	cum	6446.45
All works above plinth level upto floor V level	cum	7250.05
Extra for R.C.C./ B.M.C/ R.M.C. work above floor V level for each four floors or part thereof.	cum	232.30

FIGURE 3.13 Rate of concrete

3.4 Manual Design Slab

A slab is a flat two dimensional planar structural element having thickness small compared to its other two dimensions. It provides a working flat surface or a covering shelter in buildings. It primarily transfers the load by bending in one or two directions. Reinforced concrete slabs are used in floors, roofs and walls of buildings and as the decks of bridges.

3.4.1 Slab 1

3.4.1.1 MATERIAL CONSTANT SLAB 1

Concrete, f_{ck} or compressive strength of concrete =25N/mm^2

Steel, f_y or compressive strength of steel =500 N/mm^2

3.4.2.1 DIMENSION SLAB 1

Clear span distance in shorter direction, lx =3.2metre

Clear span distance in longer direction, ly =4.1metre

Thickness of slab =125milimetre

Clear cover =20milimetre

Diameter of bar used in reinforcement =8milimetre

Effective depth, d =450milimetre

3.4.2.2 EFFECTIVE SPAN SLAB 1

As per IS 456:2000 clause 22.2

Effective span along short and long spans are computed as:

Lex1= Centre to centre of support

=3.2+0.230/2+0.230/2 =3.43metre

Lex2= Clear span+ eff. Depth

=3.2+0.450 =3.65metre

Ley1= Centre to centre of support

=4.1+0.23/2+0.43/2 =4.33metre

Ley2= Clear span+ eff. Depth

=4.1+0.450 =4.55metre

Effective span along short span in our case, Lex=3.43m

Effective span along long span in our case, Ley=4.33m

3.4.2.3 LOAD CALCULATION SLAB 1

Dead load on slab=0.125*25 =3.125 Kn/m^2

Live load on slab=2 Kn/m^2

Floor finish=0.75 Kn/m^2

Total load=5.875 Kn/m^2

Factored load=1.5*5.875=8.8125 Kn/m^2

3.4.2.4 TYPE OF SLAB 1

Effective span along short span in our case, Lex=3.43m

Effective span along long span in our case, Ley=4.33m

Ley/Lex = 4.33/3.43 =1.262 < 2

Hence it is a two-way slab determined.

3.4.2.5 CALCULATION OF BENDING MOMENT SLAB 1

TABLE 27 IS456:2000 considered from

Mx = αx W lx2 =0.0885 x 8.8125 x 3.432 =9.1755KN/m

My = αy W lx2=0.057 x 8.8125 x 3.432=5.909KN/m

3.4.2.6 CHECK FOR EFFECTIVE DEPTH SLAB 1

D required=√ (Mu/0.138 x f_{ck} x b)

=47mm<D Provided under reinforced section

3.4.2.7 CALCULATION OF REINFORCEMENTS IN SLAB 1

Along shorter span of slab 1

Width of middle strip= (3 x ly)/4 = 3.24m

Astx=0.5f_{ck}/f_y x 1-(√(1-4.5 x Mu)/(fck x bd2)) x b x d

Astx=0.5 x 30/415 x 1-(√ (1-4.5 x 9.17 x 106)/(30 x 1000 x 4502)) x 1000 x 450

Area of 8mm bar = 50.24mm^2

Spacing=Area of 8mm bar/Astx x 1000

Provide 8mm diameter bars @150c/c top reinforcement at supports and 175c/c bottom reinforcement at mid span.

Along the longer span of slab 1

Width of middle strip= (3 x ly)/4 = 3.24m

Asty=0.5f_{ck}/f_y x 1-(√(1-4.5 x Mu)/(fck x bd2)) x b x d

Asty=0.5 x 30/415 x 1-(√ (1-4.5 x 5.909 x 106)/ (30 x 1000 x 4502)) x 1000 x450

Area of 8mm bar = 50.24mm^2

3.4.2 Slab 2

3.4.2.1 MATERIAL CONSTANTS OF SLAB 2

Concrete, f_{ck} =25N/mm^2

Steel, f_y = 500 N/mm^2

3.4.2.2 DIMENSIONS OF SLAB 2

Clear span distance in shorter direction, lx =1.9m

Clear span distance in longer direction, ly =2.7m

Thickness of slab =125mm

Clear cover =20mm

Diameter of bar used in reinforcement =8mm

Effective depth, d =450mm

3.4.2.3 EFFECTIVE SPAN OF SLAB 2

As in IS 456:2000 clause 22.2 we consider

Effective span along short and long spans are computed as:

Lex1= Centre to centre of support

=1.9+0.230/2+0.230/2 =2.13metre

Lex2= Clear span+ eff. Depth

=1.9+0.450 =2.35metre

Ley1= Centre to centre of support

=2.7+0.23/2+0.43/2 =2.93metre

Ley2= Clear span+ eff. Depth

=2.7+0.450 =3.15m

Effective span along short span, Lex=2.13metre

Effective span along long span, Ley=2.93metre

3.4.2.4 LOAD CALCULATIONS OF SLAB 2

Dead load on slab=0.125 x 25 =3.125 KN/m^2

Live load on slab=2 KN/m^2

Floor finish=0.75 KN/m^2

Total load=5.875 KN/m^2

Factored load=1.5 x 5.875=8.8125 KN/m^2

3.4.2.5 TYPE OF SLAB 2

Effective span along short span, Lex=2.13m

Effective span along long span, Ley=2.93m

Ley/Lex = 2.93/2.13 =1.37 < 2

Hence it is a two-way slab.

3.4.2.6 CALCULATION OF BENDING SLAB 2

TABLE 27 IS456:2000

Mx = αx W lx2 =0.0972 x 8.8125 x 2.132 =3.88KN/m

My = αy W lx2=0.0578 x 8.8125 x 2.132=2.31KN/m

3.4.2.7 CHECK FOR EFFECTIVE DEPTH SLAB 2

D required=√ (Mu/0.138 x f_{ck} x b)

=39mm<D Provided under reinforced section

3.4.2.8 CALCULATION OF REINFORCEMENT OF SLAB 2

Along the shorter span of slab 2

Width of middle strip= (3 x ly)/4 = 2.197m

Astx=0.5f_{ck}/f_y x 1-(√(1-4.5 x Mu)/(f_{ck} x bd^2)) x b x d

Astx=0.5 x 30/415 x 1-(√ (1-4.5 x 3.88 x 106)/ (30 x 1000 x 4502)) x 1000 x 450

Area of 8mm bar = 50.24mm^2

Spacing=Area of 8mm bar/Astx x 1000

Provide 8mm diameter bars @150c/c top reinforcement at supports and 150c/c bottom reinforcement at mid span.

Along the longer span of slab 2

Width of middle strip= (3 x lx)/4 = 1.59m

Asty=0.5f_{ck}/F_y x 1-(√(1-4.5 x Mu)/(f_{ck} xbd ^{2})) x b x d

Asty=0.5 x 30/415 x 1-(√(1-4.5 x 2.31 x 106)/(30 x 1000 x 4502)) x 1000 x 450

Area of 8mm bar = 50.24mm^2

Spacing=Area of 8mm bar/Astx x 1000

Provide 8mm diameter bars @175c/c top reinforcement at supports and 175c/c bottom reinforcement at mid span.

3.4.3 Slab 3

3.4.3.1 MATERIAL CONSTANTS OF SLAB 3

Concrete, f_{ck} =25N/mm^2

Steel, f_y = 500 N/mm^2

3.4.3.2 DIMENSIONS OF SLAB 3

Clear span distance in shorter direction, lx =1.9m

Clear span distance in longer direction, ly =2.1m

Thickness of slab =125mm

Clear cover =20mm

Diameter of bar used in reinforcement =8mm

Effective depth, d =450mm

3.4.3.3 EFFECTIVE SPAN OF SLAB 3

As per IS 456:2000 clause 22.2

Effective span along short and long spans are computed as:

Lex1= Centre to centre of support

=1.9+0.230/2+0.230/2 =2.13m

Lex2= Clear span+ eff. Depth

=1.9+0.450 =2.35m

Ley1= Centre to centre of support

=2.1+0.23/2+0.23/2 =2.33m

Ley2= Clear span+ eff. Depth

=2.1+0.450 =2.55m

Effective span along short span, Lex=2.13m

Effective span along long span, Ley=2.33m

3.4.3.4 LOAD CALCULATIONS OF SLAB 3

Dead load on slab=0.125 x 25 =3.125 KN/m^2

Live load on slab=2 KN/m^2

Floor finish=0.75 KN/m^2

Total load=5.875 KN/m^2

Factored load=1.5 x 5.875=8.8125 KN/m^2

3.4.3.5 TYPE OF SLAB 3

Effective span along short span, Lex=2.13m

Effective span along long span, Ley=2.33m

Ley/Lex = 2.33/2.13 =1.09< 2

Hence it is a two-way slab.

3.4.3.6 CALCULATION OF BENDING MOMENT SLAB 3

TABLE 27 IS456:2000

Mx = αx W lx2 =0.072 x 8.8125 x 2.132 =2.87KN/m

My = αy W lx2=0.061 x 8.8125 x 2.132=2.43KN/m

3.4.3.7 CHECK FOR EFFECTIVE DEPTH SLAB 3

D required=√ (Mu/0.138 x fck x b)

=25mm<D provided   under reinforced section

3.4.3.8 CALCULATIONS OF REINFORCEMENTS SLAB 3

Along the shorter span of slab 3

Width of middle strip= (3 x ly)/4 = 1.74m

Astx=0.5fck/fy x 1-(√(1-4.5 x Mu)/(fck x bd2)) x b x d

Astx=0.5 x 30/415 x 1-(√(1-4.5 x 2.87 x 106)/(30 x 1000 x 4502)) x 1000 x 450

Area of 8mm bar = 50.24mm2

Spacing=Area of 8mm bar/Astx x 1000

Provide 8mm diameter bars @175c/c top reinforcement at supports and 175c/c bottom reinforcement at mid span.

Along the longer span of slab 3

Width of middle strip= (3 x lx)/4 = 1.59m

Asty=0.5fck/fy x 1-(√(1-4.5 x Mu)/(fck x bd2)) x b x d

Asty=0.5 x 30/415 x 1-(√(1-4.5 x 2.43 x 106)/(30 x 1000 x 4502)) x 1000 x 450

Area of 8mm bar = 50.24mm^2

Spacing=Area of 8mm bar/Astx x 1000

Provide 8mm diameter bars @175c/c top reinforcement at supports and 175c/c bottom reinforcement at mid span.

3.4.4 Slab 4

3.4.4.1 MATERIAL CONSTANTS SLAB 4

Concrete, f_{ck} =25N/mm^2

Steel, f_y = 500 N/mm^2

3.4.4.2 DIMENSIONS OF SLAB 4

Clear span distance in shorter direction, lx =2.1m

Clear span distance in longer direction, ly =3.2m

Thickness of slab =125mm

Clear cover =20mm

Diameter of bar used in reinforcement =8mm

Effective depth, d =450mm

3.4.4.3 EFFECTIVE SPAN OF SLAB 4

As per IS 456:2000 clause 22.2

Effective span along short and long spans are computed as:

Lex1= Centre to centre of support

=2.1+0.230/2+0.230/2 =2.33m

Lex2= Clear span+ eff. Depth

=2.1+0.450 =2.55m

Ley1= Centre to centre of support

=3.2+0.23/2+0.23/2 =3.43m

Ley2= Clear span+ eff. Depth

=3.2+0.450 =3.65m

Effective span along short span, Lex=2.33m

Effective span along long span, Ley=3.43m

3.4.4.4 LOAD CALCULATION SLAB 4

Dead load on slab=0.125*25 =3.125 KN/m^2

Live load on slab=2 KN/m^2

Floor finish=0.75 KN/m^2

Total load=5.875 KN/m^2

Factored load=1.5*5.875=8.8125 KN/m^2

3.4.4.5 TYPE OF SLAB 4

Effective span along short span, Lex=2.33m

Effective span along long span, Ley=3.43m

Ley/Lex = 3.43/2.33 =1.47< 2

Hence it is a two-way slab.

3.4.4.6 CALCULATION OF BENDING MOMENT SLAB 4

TABLE 27 IS456:2000

Mx = αx W lx2 =0.1025*8.8125*2.332 =4.90KN/m

My = αy W lx2=0.0475*8.8125*2.332=2.27KN/m

3.4.4.7 CHECK FOR EFFECTIVE DEPTH SLAB 4

D required=√ (Mu/0.138 x fck x b)

=43mm<D provided   under reinforced section

3.4.4.8 CALCULATION OF REINFORCEMENTS SLAB 4

Along the shorter span slab 4

Width of middle strip= (3 x ly)/4 = 1.74m

Astx=0.5fck/fy x 1-(√(1-4.5 x Mu)/(fck x bd2)) x b x d

Astx=0.5 x 30/415 x 1-(√(1-4.5 x 4.90 x 106)/(30 x 1000 x 4502)) x 1000 x 450

Area of 8mm bar = 50.24mm^2

Spacing=Area of 8mm bar/Astx x 1000

Provide 8mm diameter bars @150c/c top reinforcement at supports and 175c/c bottom reinforcement at mid span.

Along the longer span slab 4

Width of middle strip= (3*lx)/4 = 1.59m

Asty=0.5fck/fy x 1-(√(1-4.5 x Mu)/(fck x bd2)) x b x d

Asty=0.5 x 30/415 x 1-(√(1-4.5 x 2.27 x 106)/(30 x 1000 x 4502)) x 1000 x 450

Area of 8mm bar = 50.24mm^2

Spacing=Area of 8mm bar/Astx x 1000

Provide 8mm diameter bars @175c/c top reinforcement at supports and 175c/c bottom reinforcement at mid span.

3.5 Manual Design of Stairs

3.5.1 Design of Stair case 1

Design of staircase from ground floor and first floor of heights 3.6m.

3.5.1.1 MATERIAL CONSTANTS STAIRS 1

Concrete =25 N/mm^2

Steel=500 N/mm^2

3.5.1.2 PRELIMINARY DIMENSIONING STAIRS 1

Riser of stair R=150mm

Tread of stair T=300mm

Effective span=4.2m

No. of riser=24

No. of riser per flight=12

No. of tread per flight=12-1=11

Total going=11*0.3=3.3m

Clear cover=20mm

The depth of waist slab = 4200/20 = 210 mm.

Total depth =210+4+20=234mm approx. 235 mm

Effective depth = 235– 4-20 = 211 approx. 200mm (assuming cover = 20 mm and diameter of main reinforcing bar =8 mm).

3.5.1.3 LOAD CALCULATIONS STAIRS 1

Self-weight of landing slab=0.2 x 25=5kN/m^2

Live load of landing slab=5kN/m^2

Floor finish load=1kN/m^2

Total load on finishing slab= 11kN/m^2

Self-weight of waist slab=Thickness of waist slab x 25 x $\sqrt{}(R^2+T^2)/T$

=0.235 x 25 x $\sqrt{}$ (150^2+300^2)/300

=6.8kN/m^2

The self-weight of steps is calculated by treating the steps to be equivalent horizontal slab of thickness equal to half the riser

Self-weight of step=0.5 x 0.150 x 25=1.8kN/m^2

Live load=5kN/m^2

Floor finish load=0.75kN/m^2

Total load on slab=14.53kN/m^2

Width of waist slab=1.5m

Total load on slab=14.53*1.5=21.79kN/m^2

Total ultimate load Wu=1.5*21.79=32.69kN/m^2

3.5.1.4 ULTIMATE DESIGN MOMENT STAIRS 1

MU=WU x LEFF2/8=72.08kN/m

3.5.1.5 CHECK FOR THE DEPTH OF WAIST SLAB STAIRS 1

d required=√Mu/0.138 x b x fc

=36mm<d provided

Hence the effective depth selected is sufficient to resist the ultimate moment

3.5.1.6 REINFORCEMENTS STAIRS 1

MU/b x d2=72.08 x 106/1500 x 2002=1.2

From table 4 of SP16

Pt=0.350

Ast/b x d =0.350

Ast=1050mm^2

Spacing= ((3.14/4) x 1500 x 8 x 8)/1080

=71.7mm

Provide 8mm bars @72 mm c/c spacing

3.5.1.7 CHECK FOR SPACING STAIRS 1

- 3 x d provided
- 300mm Spacing provided<spacing maximum safe

3.5.1.8 CHECK FOR AREA OF STEEL STAIRS 1

Ast min. =0.12%cross sectional area

= (0.12 x 1500 x 235)/100

Ast min. =423mm^2

Ast min. < Ast provided

Hence ok

3.5.1.9 DISTRIBUTION OF REINFORCEMENTS STAIRS 1

Area of distribution reinforcement=0.12%cross sectional area

$423mm^2$

Use 8mm diameter of bars

Spacing= (3.14/4 x 1500 x 82)/area of distribution reinforcement

=178.18mm

3.5.1.10 CHECK FOR SPACING STAIRS 1

- 5 x d provided
- 450mm

Spacing provided<spacing maximum safe

3.5.1.11 DEVELOPMENT LENGTH OF STAIRS 1

L d = (0.87 x fy x 8)/4 x τbd

IS456:2000 for M25 concrete τbd=1.5

L d=481.4mm

Provide 8mm bar 480mmas development length

3.5.2 Design of Staircase 2

Staircase 2 includes design of stairs for floors excluding ground and first floor with height of 3.15m.

3.5.2.1 MATERIAL CONSTANTS

Concrete =25N/mm^2

Steel=500N/mm^2

3.5.2.2 PRELIMINARY DESIGN OF STAIRS 2

Riser of stair R=150mm

Tread of stair T=300mm

Effective span=4.1m

No. of riser=22

No. of riser per flight=11

No. of tread per flight=11-1=10

Total going=10*0.3=3.0m

Clear cover=20mm

The depth of waist slab = 4200/20 = 210 mm.

Total depth =210+4+20=234mm approx. 235 mm

Effective depth = 235– 4-20 = 211mm approx. 200mm (assuming cover = 20 mm and diameter of main reinforcing bar =8 mm).

3.5.2.3 LOAD CALCULATIONS STAIRS 2

Self-weight of landing slab=0.2*25=5kN/m^2

Live load of landing slab=5kN/m^2

Floor finish load=1kN/m^2

Total load on finishing slab= 11kN/m^2

Self-weight of waist slab=Thickness of waist slab x 25 x $\sqrt{}(R^2+T^2)/T$

=0.235 x 25 x $\sqrt{}$ (150^2+300^2)/300

=6.8kN/m^2

The self-weight of steps is calculated by treating the steps to be equivalent horizontal slab of thickness equal to half the riser

Self-weight of step=0.5 x 0.150 x 25=1.8kN/m^2

Live load=5kN/m^2

Floor finish load=0.75kN/m^2

Total load on slab=14.53kN/m^2

Width of waist slab=1.5m

Total load on slab=14.53*1.5=21.79kN/m^2

Total ultimate load Wu=1.5*21.79=32.69kN/m^2

3.5.2.4 ULTIMATE DESIGN MOMENT OF STAIRS 2

MU=WU*LEFF2/8=68.6kn/m

3.5.2.5 CHECK FOR DEPTH OF WAIST SLAB STAIRS 2

d required=$\sqrt{}$(Mu/0.138 x b x fc)

=33.2mm<d provided

Hence the effective depth selected is sufficient to resist the ultimate moment

3.5.2.6 REINFORCEMENTS STAIRS 2

MU/b x d2=68.6 x 106/1500 x 2002=1.14

From table 4 of SP16

Pt=0.330

Ast/b x d =0.330

Ast=990mm2

Spacing= ((3.14/4) x 1500 x 8 x 8)/1080

=76.1mm

Provide 8mm bars @76 mm c/c spacing

3.5.2.7 CHECK FOR SPACING STAIRS 2

- 3 x d provided
- 300mm

Spacing provided<spacing maximum safe

3.5.2.8 CHECK FOR AREA OF STEEL STAIRS 2

ASTMIN=0.12%cross sectional area

= (0.12 x 1500 x 235)/100

Ast min. =423mm^2

Ast min. < Ast provided

Hence ok

3.5.2.9 DISTRIBUTION OF REINFORCEMENTS SLAB STAIRS 2

Area of distribution reinforcement=0.12%cross sectional area

= 423mm^2

Use 8mm diameter of bars

Spacing= (3.14/4 x 1500 x 82)/area of distribution reinforcement

=178.18mm

3.5.2.10 CHECK FOR SPACING

- 5 x d provided
- 450mm

Spacing provided<spacing maximum safe

3.5.2.11 DEVELOPMENT LENGTH STAIRS 2

L d= (0.87 x fy x 8)/4 x τbd

IS456:2000 for M25 concrete τbd=1.5

L d=481.4mm

Provide 8mm bar 480mmas development length

CHAPTER 4: RESULTS

4.1 Staad Pro Outputs

4.1.1 Staad Pro Outputs with / without Specifications

4.1.1.1 DEAD LOADS

With specifications in Structure

```
***TOTAL APPLIED LOAD ( KN    METE ) SUMMARY (LOADING      7 )
    SUMMATION FORCE-X =            0.00
    SUMMATION FORCE-Y =       -22798.54
    SUMMATION FORCE-Z =            0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=       277822.86  MY=            0.00  MZ=      -117559.84

***TOTAL REACTION LOAD( KN    METE ) SUMMARY (LOADING      7 )
    SUMMATION FORCE-X =           -0.00
    SUMMATION FORCE-Y =        22798.54
    SUMMATION FORCE-Z =           -0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=      -277822.86  MY=            0.00  MZ=       117559.84

MAXIMUM DISPLACEMENTS (   CM  /RADIANS) (LOADING       7)
          MAXIMUMS     AT NODE
   X =  5.34369E-02      321
   Y = -2.87892E-01      297
   Z =  1.22536E-01      291
   RX=  5.47811E-04      295
   RY=  9.33937E-05      300
```

Without specifications in Structure

```
***TOTAL APPLIED LOAD ( KN    METE ) SUMMARY (LOADING      7 )
    SUMMATION FORCE-X =            0.00
    SUMMATION FORCE-Y =       -24733.64
    SUMMATION FORCE-Z =            0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=       303557.25  MY=            0.00  MZ=      -127901.26

***TOTAL REACTION LOAD( KN    METE ) SUMMARY (LOADING      7 )
    SUMMATION FORCE-X =           -0.00
    SUMMATION FORCE-Y =        24733.64
    SUMMATION FORCE-Z =           -0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=      -303557.25  MY=            0.00  MZ=       127901.26

MAXIMUM DISPLACEMENTS (   CM  /RADIANS) (LOADING       7)
          MAXIMUMS     AT NODE
   X = -6.76295E-02      290
   Y = -2.66438E-01      309
   Z =  1.07033E-01      291
   RX=  3.72423E-04      295
   RY=  6.16384E-05      300
   RZ=  1.63537E-04      290
```

As we can see total force in the y direction for with specification results is -22798.54 kn while for without specification it is -24733.64 kn. It can be seen that due to added specifications some forces might have been lost for with specification structure.

4.1.1.2 LIVE LOADS

With specifications in Structure

```
    SUMMATION OF MOMENTS AROUND THE ORIGIN-
    MX=        34726.36   MY=            0.00   MZ=       -13797.11


 ***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING      8 )
     SUMMATION FORCE-X =           -0.00
     SUMMATION FORCE-Y =         2744.12
     SUMMATION FORCE-Z =           -0.00

    SUMMATION OF MOMENTS AROUND THE ORIGIN-
    MX=       -34726.36   MY=            0.00   MZ=        13797.11


 MAXIMUM DISPLACEMENTS (   CM   /RADIANS) (LOADING       8)
            MAXIMUMS    AT NODE
    X =  3.11212E-02     313
    Y = -5.04111E-02     299
    Z =  3.26630E-02     291
    RX=  1.35161E-04     295
    RY=  2.11500E-05     300
    RZ= -8.94687E-05     309
```

Without specifications in Structure

```
    SUMMATION OF MOMENTS AROUND THE ORIGIN-
    MX=        40059.47   MY=            0.00   MZ=       -16206.31


 ***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING      8 )
     SUMMATION FORCE-X =           -0.00
     SUMMATION FORCE-Y =         3146.86
     SUMMATION FORCE-Z =           -0.00

    SUMMATION OF MOMENTS AROUND THE ORIGIN-
    MX=       -40059.47   MY=           -0.00   MZ=        16206.31


 MAXIMUM DISPLACEMENTS (   CM   /RADIANS) (LOADING       8)
            MAXIMUMS    AT NODE
    X = -7.89816E-03     292
    Y = -4.81245E-02     310
    Z =  2.11843E-02     291
    RX=  9.25478E-05     295
    RY=  8.24231E-06     300
    RZ=  4.07941E-05     300
```

Total forces for with specifications is 2744.12 kn and without specification is 3146.86. The resulted has a variation due to the added specifications.

4.1.1.3 BEAM – NUMBER 96

With specifications--Beam number 96 CONCRETE GRADE (M25), STEEL (Fe500)

```
              IS-456    L I M I T    S T A T E    D E S I G N
             B E A M  N O.     96   D E S I G N  R E S U L T S


    LENGTH:  3500.0 mm      SIZE:   230.0 mm X  450.0 mm   COVER: 25.0 mm


                  SUMMARY OF REINF. AREA (Sq.mm)
 ----------------------------------------------------------------------------
 SECTION      0.0 mm      875.0 mm     1750.0 mm     2625.0 mm     3500.0 mm
 ----------------------------------------------------------------------------
  TOP          376.84       197.86         0.00        197.86        373.36
 REINF.      (Sq. mm)     (Sq. mm)     (Sq. mm)      (Sq. mm)      (Sq. mm)

 BOTTOM       197.38        197.38       197.38        197.38        197.38
 REINF.      (Sq. mm)     (Sq. mm)     (Sq. mm)      (Sq. mm)      (Sq. mm)
 ----------------------------------------------------------------------------
```

```
                  SUMMARY OF PROVIDED REINF. AREA
 ----------------------------------------------------------------------------
 SECTION      0.0 mm      875.0 mm     1750.0 mm     2625.0 mm     3500.0 mm
 ----------------------------------------------------------------------------
  TOP        5-10í         3-10í         3-10í         3-10í         5-10í
 REINF.   1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)

 BOTTOM      2-12í         2-12í         2-12í         2-12í         2-12í
 REINF.   1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)    1 layer(s)

 SHEAR   2 legged  8í  2 legged  8í  2 legged  8í  2 legged  8í  2 legged  8í
 REINF.  @ 145 mm c/c  @ 145 mm c/c  @ 145 mm c/c  @ 145 mm c/c  @ 145 mm c/c
 ----------------------------------------------------------------------------


 SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT
 ----------------------------------------------------------------------------

 SHEAR DESIGN RESULTS AT   720.0 mm AWAY FROM START SUPPORT
   VY =    44.37 MX =     -0.17 LD=   30
   Provide 2 Legged  8í  @ 145 mm c/c

 SHEAR DESIGN RESULTS AT   720.0 mm AWAY FROM END SUPPORT
   VY =   -45.12 MX =      0.32 LD=   31
   Provide 2 Legged  8í  @ 145 mm c/c
```

Without specifications--Beam number 96 CONCRETE GRADE (M25) STEEL (Fe500)

```
              IS-456    L I M I T    S T A T E    D E S I G N
             B E A M  N O.      96   D E S I G N  R E S U L T S


    LENGTH:  4100.0 mm      SIZE:   230.0 mm X  450.0 mm   COVER: 25.0 mm
```

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1025.0 mm	2050.0 mm	3075.0 mm	4100.0 mm
TOP REINF.	543.52 (Sq. mm)	197.86 (Sq. mm)	0.00 (Sq. mm)	197.86 (Sq. mm)	531.81 (Sq. mm)
BOTTOM REINF.	197.38 (Sq. mm)	197.38 (Sq. mm)	197.38 (Sq. mm)	197.38 (Sq. mm)	197.38 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	1025.0 mm	2050.0 mm	3075.0 mm	4100.0 mm
TOP REINF.	7-10í 2 layer(s)	3-10í 1 layer(s)	3-10í 1 layer(s)	3-10í 1 layer(s)	7-10í 2 layer(s)
BOTTOM REINF.	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c

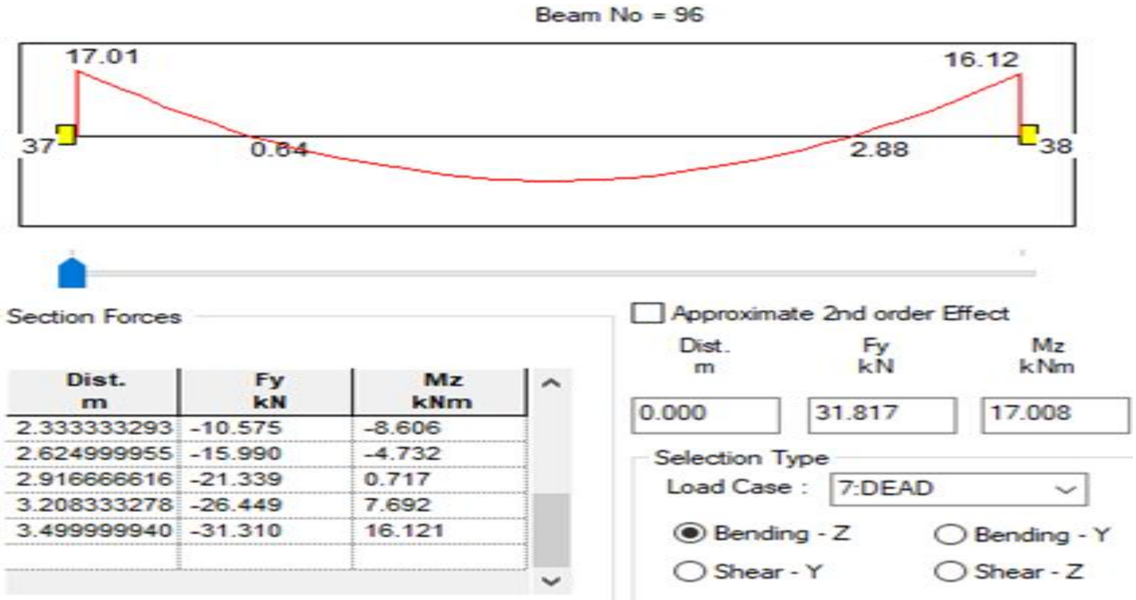
```
SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT
-----------------------------------------------------------------------------

SHEAR DESIGN RESULTS AT   712.9 mm AWAY FROM START SUPPORT
  VY =    54.86 MX =    -0.30 LD=    30
  Provide 2 Legged  8í  @ 145 mm c/c

SHEAR DESIGN RESULTS AT   712.9 mm AWAY FROM END SUPPORT
  VY =   -55.24 MX =     0.44 LD=    31
  Provide 2 Legged  8í  @ 145 mm c/c
```

The span of beam for with specs is 3500mm which is smaller to 4100mm without specs due to the member offset.

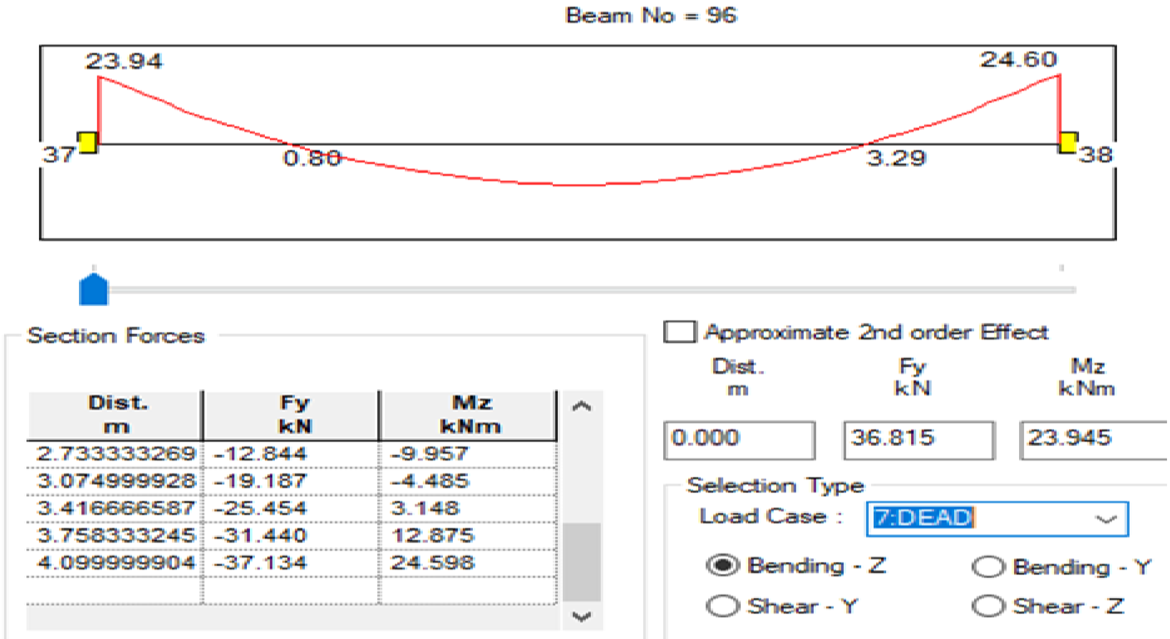
In both cases the end reinforcements are higher which is because of the uniform load which is applied to a continuous beam.

4.1.1.4 BENDING – BEAM NUMBER 96

With Specification in structure-- Dead load considered



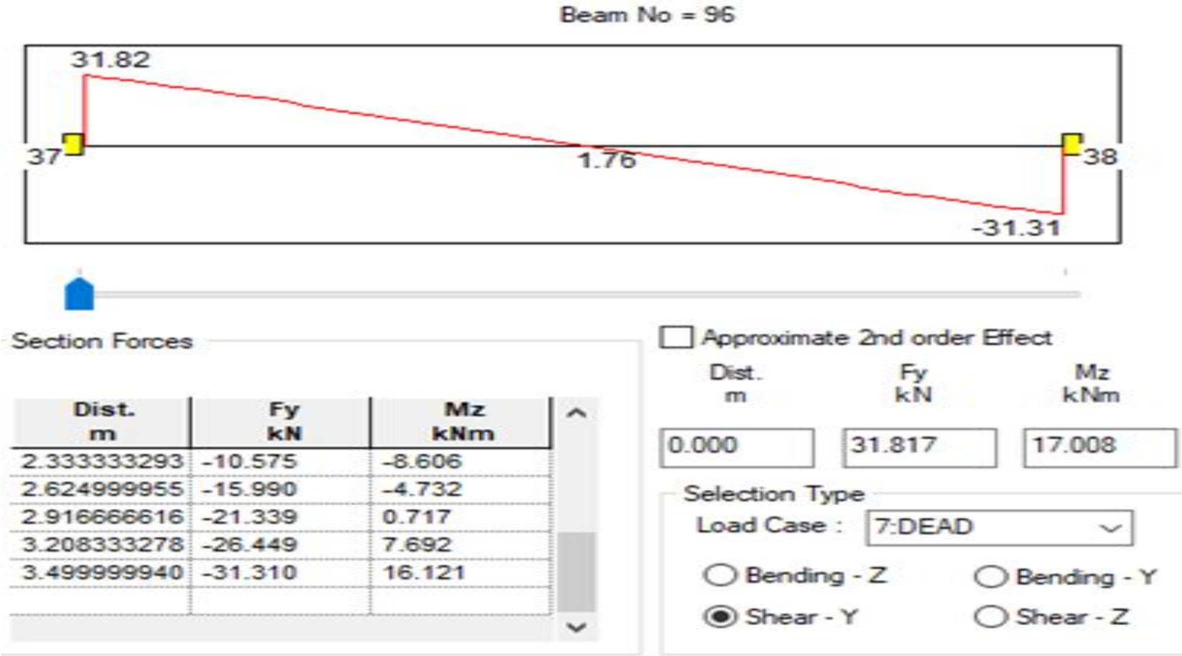
Without Specs Dead load considered



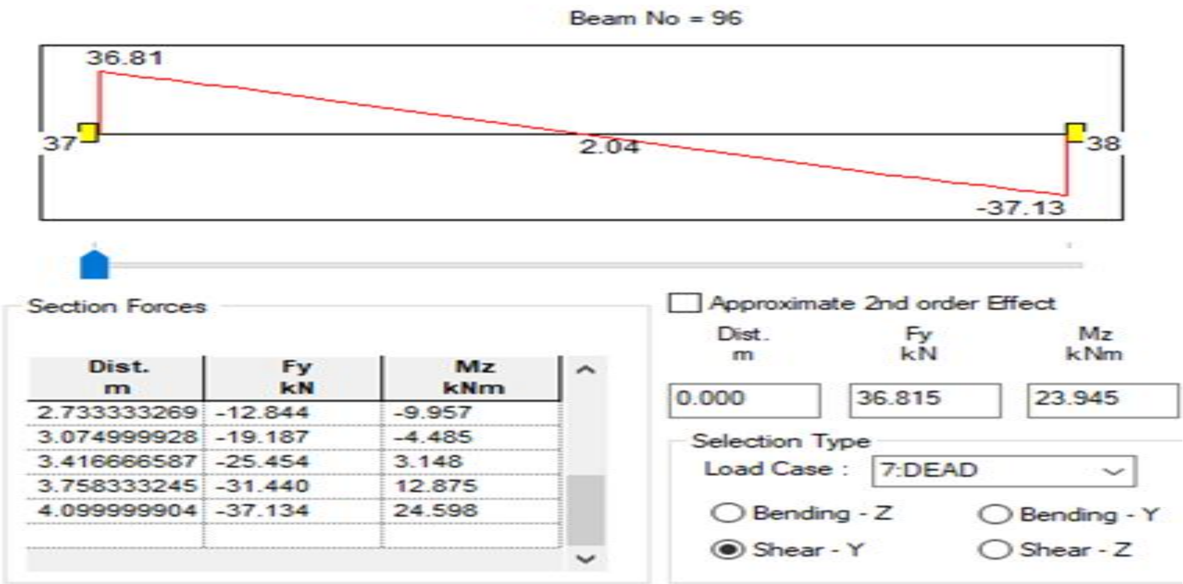
Bending is more in without specs rather than with specs because of the longer span and more applied force as discussed before.

4.1.1.5 SHEAR FORCE – BEAM NUMBER 96

With Specifications in structure



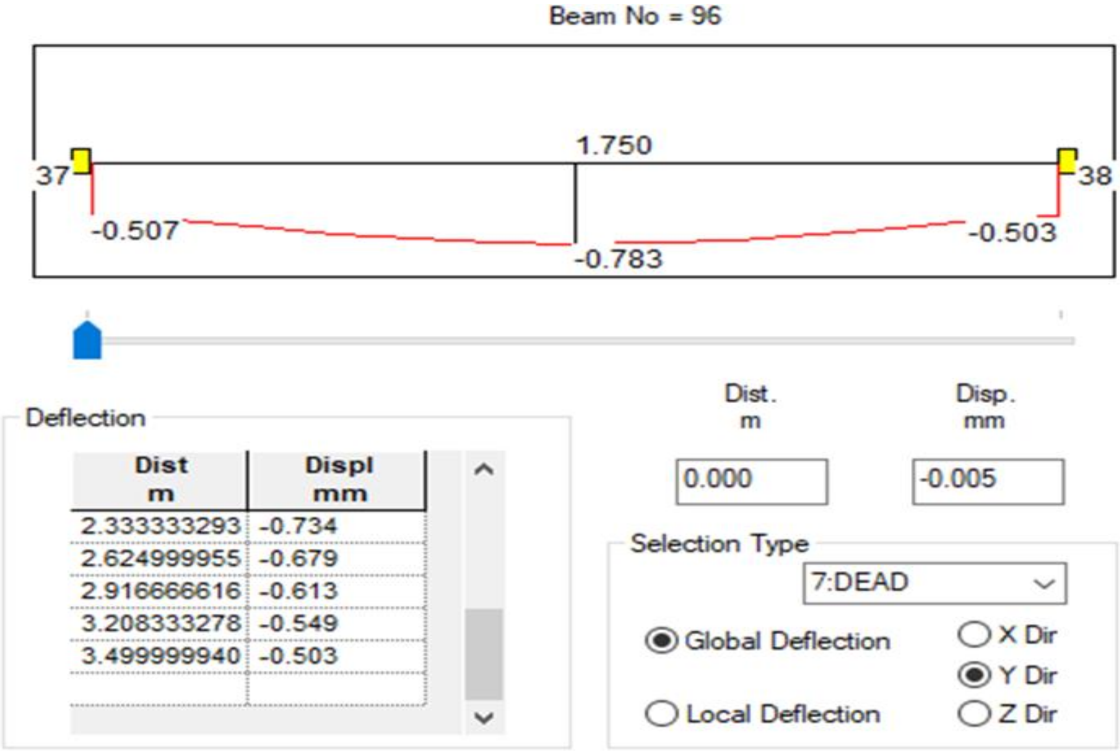
Without Specifications in structure



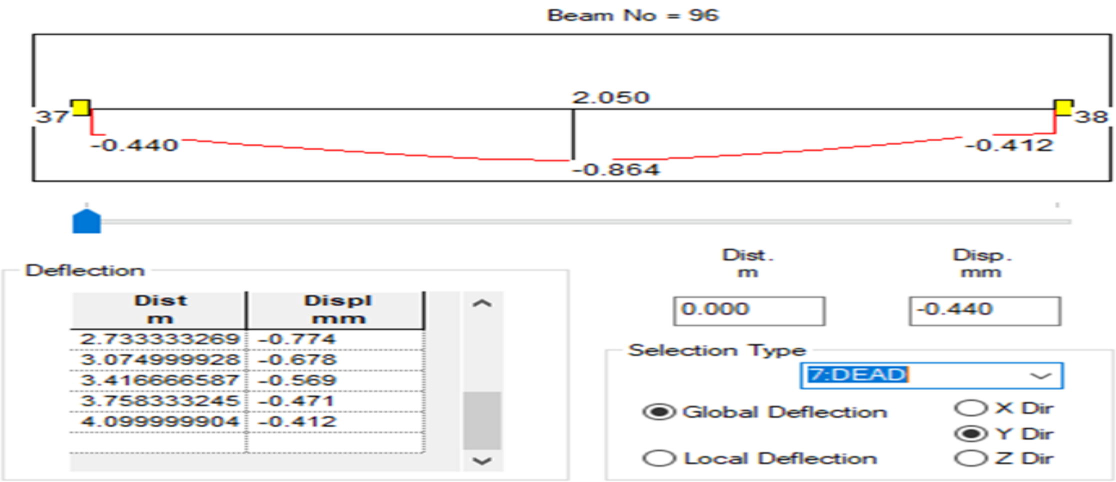
The values for without specs are little higher because of a longer span and higher force applied.

4.1.1.6 DEFLECTION – BEAM NUMBER 96

With specifications in structure



Without specs



Without specs has higher deflection because of a longer span and higher force applied.

4.1.1.7 COLUMN – NUMBER 60 CONCRETE GRADE (M25) STEEL (Fe500)

With specifications in structure

```
              IS-456   L I M I T   S T A T E   D E S I G N
          C O L U M N  N O.    60  D E S I G N  R E S U L T S


  LENGTH:  4060.0 mm   CROSS SECTION:  300.0 mm X  600.0 mm  COVER: 40.0 mm

  ** GUIDING LOAD CASE:   38 END JOINT:     1  TENSION COLUMN


  REQD. STEEL AREA   :     4176.00 Sq.mm.
  REQD. CONCRETE AREA:   175824.00 Sq.mm.
  MAIN REINFORCEMENT : Provide  16 - 20 dia. (2.79%,   5026.55 Sq.mm.)
                       (Equally distributed)
  TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 300 mm c/c

  SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
  ----------------------------------------------------------
  Puz :   3673.40   Muz1 :    289.20   Muy1 :    122.71

  INTERACTION RATIO: 0.99 (as per Cl. 39.6, IS456:2000)

  SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
  ----------------------------------------------------------
  WORST LOAD CASE:    45
  END JOINT:    37 Puz :   3926.65   Muz :    357.59   Muy :    148.09   IR: 0.83
```

Without Specs

```
               IS-456   L I M I T   S T A T E   D E S I G N
            C O L U M N  N O.    60 D E S I G N  R E S U L T S



LENGTH:  3600.0 mm   CROSS SECTION:  300.0 mm X  600.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:   38 END JOINT:     1  TENSION COLUMN


REQD. STEEL AREA    :     3888.00 Sq.mm.
REQD. CONCRETE AREA:   176112.00 Sq.mm.
MAIN REINFORCEMENT : Provide   8 - 25 dia. (2.18%,   3926.99 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 300 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
----------------------------------------------------------
Puz :   3587.65   Muz1 :    294.59   Muy1 :    125.90

INTERACTION RATIO: 0.99 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:    45
END JOINT:    37 Puz :   3599.26   Muz :    297.65   Muy :    126.20   IR: 1.00
```

Without specs has a shorter length compared to with specs due to member offset command.

More reinforcements are seen in with specs compared to without specs because of the property reduction factor which was taken 75 percent for column according to Indian standards.

4.1.1.8 Volume of Concrete and Steel

With Specifications in structure

TOTAL VOLUME OF CONCRETE = 323.2 CU.METER

BAR DIA (in mm)	WEIGHT (in New)
8	67301
10	26220
12	100316
16	86135
20	45561
25	4436
32	2664
*** TOTAL=	332634

Without Specifications in structure

TOTAL VOLUME OF CONCRETE = 320.4 CU.METER

BAR DIA (in mm)	WEIGHT (in New)
8	71186
10	24083
12	111880
16	75555
20	32183
25	11042
32	518
*** TOTAL=	326447

With Specifications has higher values for both Concrete and Steel because it depicts a more accurate real structure as compared to without specs which has a more ideal structure.

4.1.2 Staad Pro outputs with Earthquake load

4.1.2.1 MAX BENDING

Earthquake Load

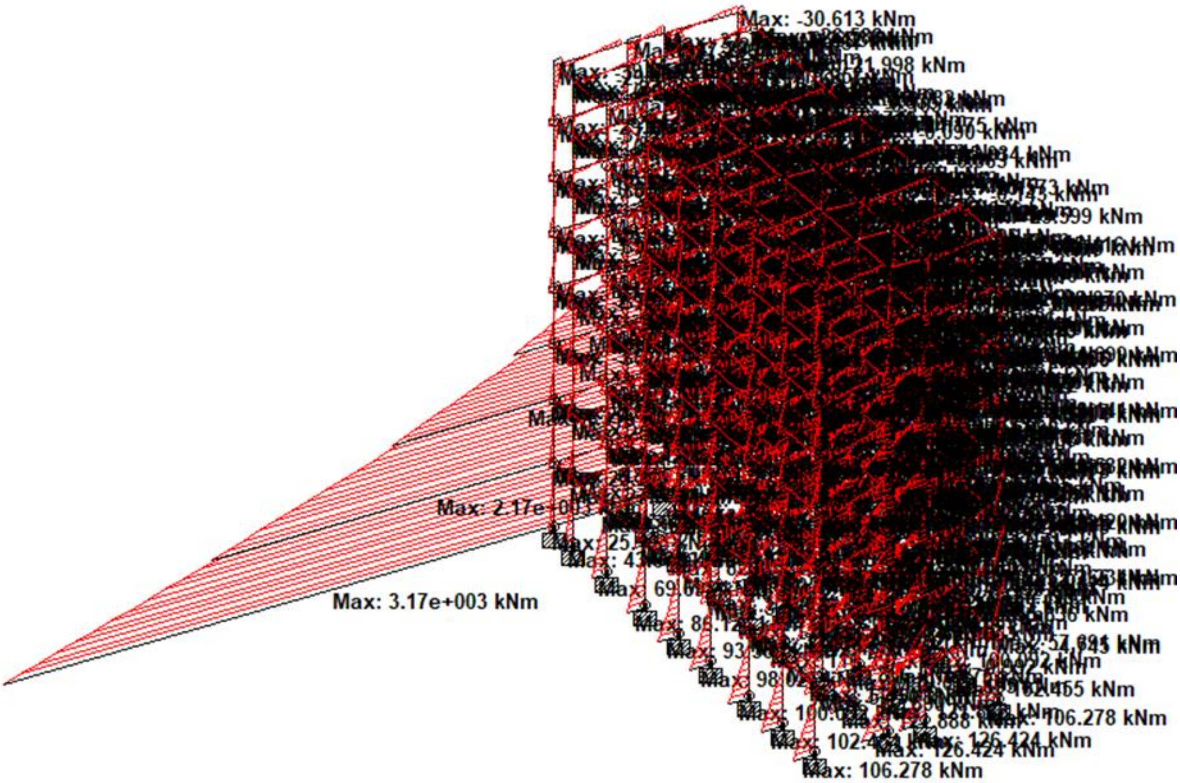


FIGURE 4.1 Maximum Bending Earthquake Load

4.1.2.2 MAX SHEAR FORCE

Earthquake Load

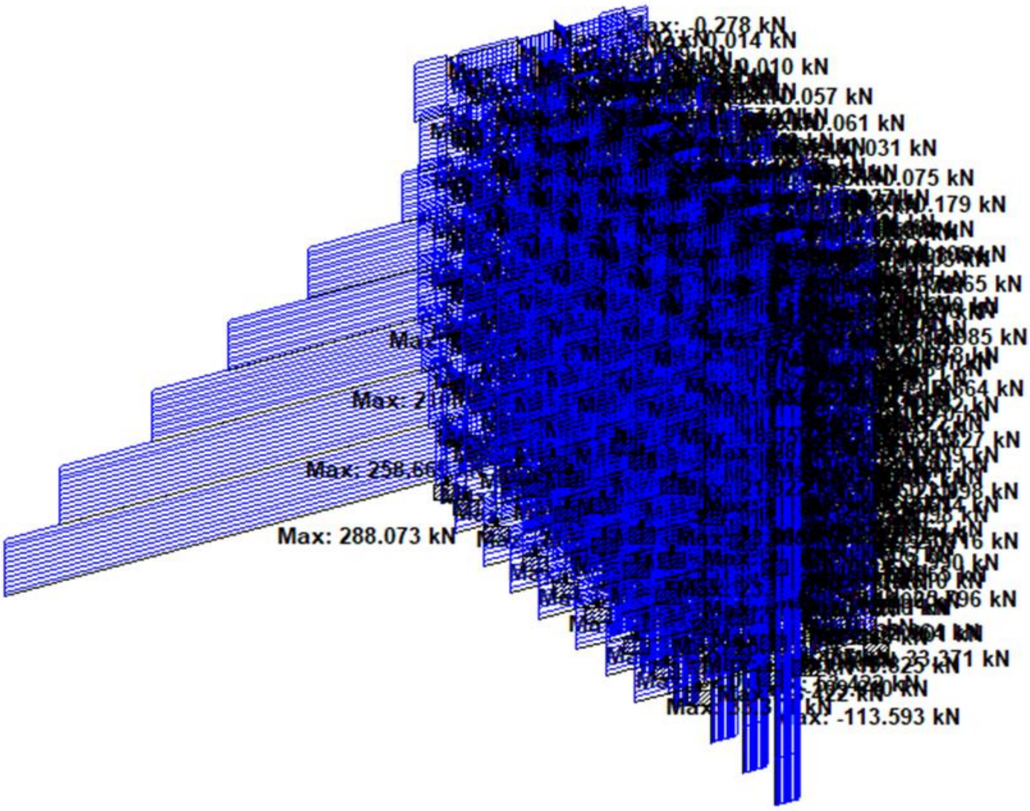


FIGURE 4.2 Maximum Shear Force Earthquake Load

4.2 Staad Foundation Output

4.2.1 Foundation Geometry

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
1	1	2.050 m	2.050 m	0.305 m
2	2	2.050 m	2.050 m	0.305 m
3	3	0.000 m	0.000 m	0.000 m
4	4	2.050 m	2.050 m	0.305 m
5	5	2.300 m	2.300 m	0.355 m
6	6	2.200 m	2.200 m	0.355 m
7	7	2.100 m	2.100 m	0.305 m
8	8	2.250 m	2.250 m	0.355 m
9	9	2.550 m	2.550 m	0.355 m
10	10	2.450 m	2.450 m	0.355 m
11	11	2.500 m	2.500 m	0.355 m
12	12	2.500 m	2.500 m	0.355 m
13	13	2.550 m	2.550 m	0.355 m
14	14	2.450 m	2.450 m	0.355 m
15	15	2.500 m	2.500 m	0.355 m
16	16	2.500 m	2.500 m	0.355 m
17	17	2.450 m	2.450 m	0.355 m
18	18	2.400 m	2.400 m	0.355 m
19	19	2.400 m	2.400 m	0.355 m
20	20	2.450 m	2.450 m	0.355 m
21	21	2.550 m	2.550 m	0.355 m
22	22	2.450 m	2.450 m	0.355 m
23	23	2.500 m	2.500 m	0.355 m
24	24	2.500 m	2.500 m	0.355 m
25	25	2.550 m	2.550 m	0.355 m
26	26	2.450 m	2.450 m	0.355 m
27	27	2.500 m	2.500 m	0.355 m
28	28	2.500 m	2.500 m	0.355 m
29	29	2.450 m	2.450 m	0.355 m
30	30	2.400 m	2.400 m	0.355 m
31	31	2.400 m	2.400 m	0.355 m
32	32	2.450 m	2.450 m	0.355 m
33	33	2.250 m	2.250 m	0.355 m
34	34	2.300 m	2.300 m	0.355 m
35	35	2.300 m	2.300 m	0.355 m
36	36	2.200 m	2.200 m	0.355 m

TABLE 4.1: Foundation Geometry

4.2.2 Footing Reinforcements

Footing No.	Footing Reinforcement			
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)
1	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
2	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
3	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c	Ø0 @ 0 mm c/c
4	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
5	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
6	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
7	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
8	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
9	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
10	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
11	Ø10 @ 150 mm c/c	Ø10 @ 125 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
12	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
13	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
14	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
15	Ø10 @ 150 mm c/c	Ø10 @ 125 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
16	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
17	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
18	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
19	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
20	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
21	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
22	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
23	Ø10 @ 150 mm c/c	Ø10 @ 125 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
24	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
25	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
26	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
27	Ø10 @ 150 mm c/c	Ø10 @ 125 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
28	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
29	Ø10 @ 150 mm c/c	Ø12 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
30	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
31	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
32	Ø10 @ 150 mm c/c	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
33	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
34	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
35	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c
36	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c	Ø10 @ 150 mm c/c

TABLE 4.2: Footing Reinforcements

4.2.3 Footing Plan

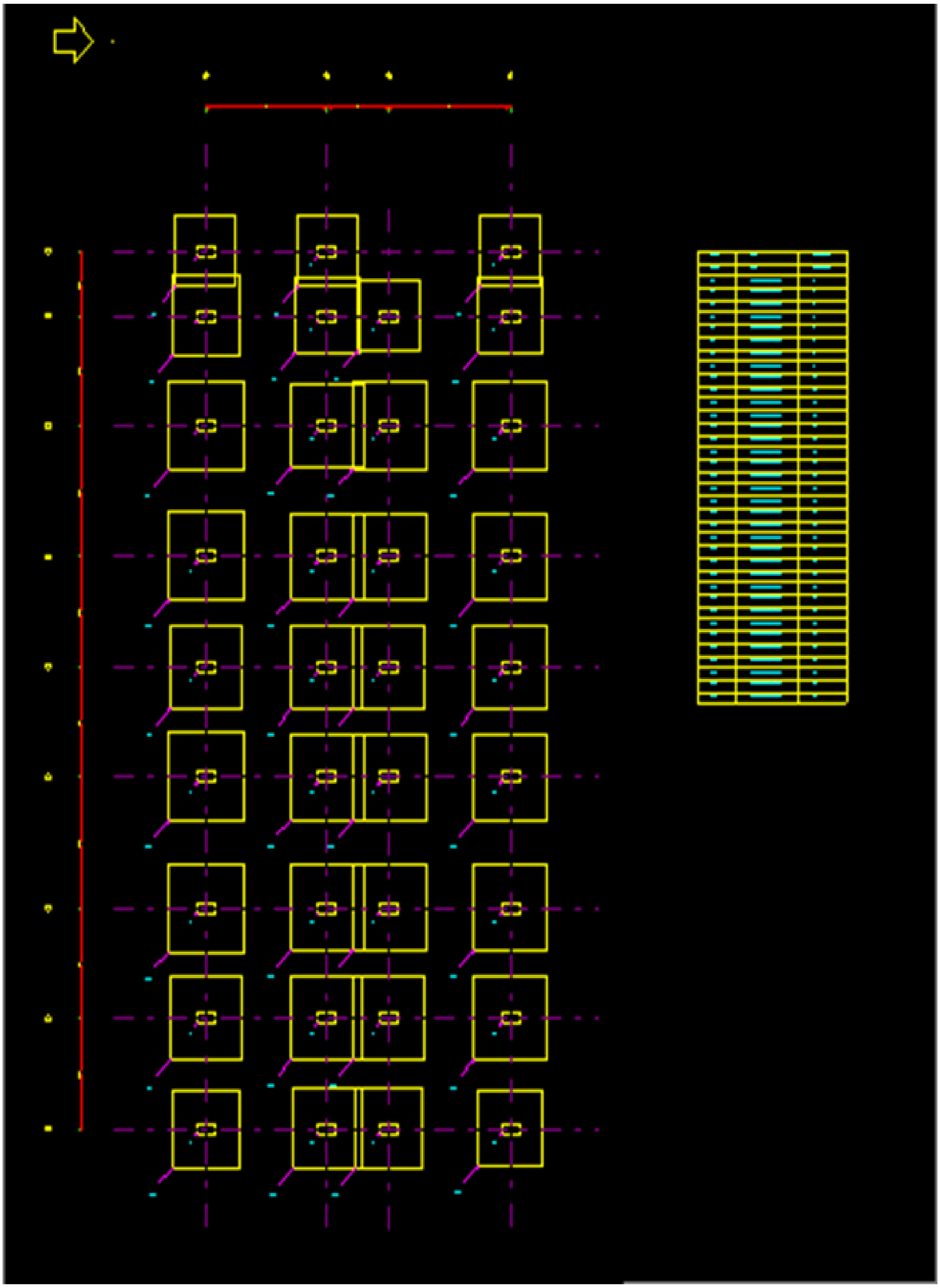


FIGURE 4.3 Footing

4.3 Cost Estimation

4.3.1 Beams

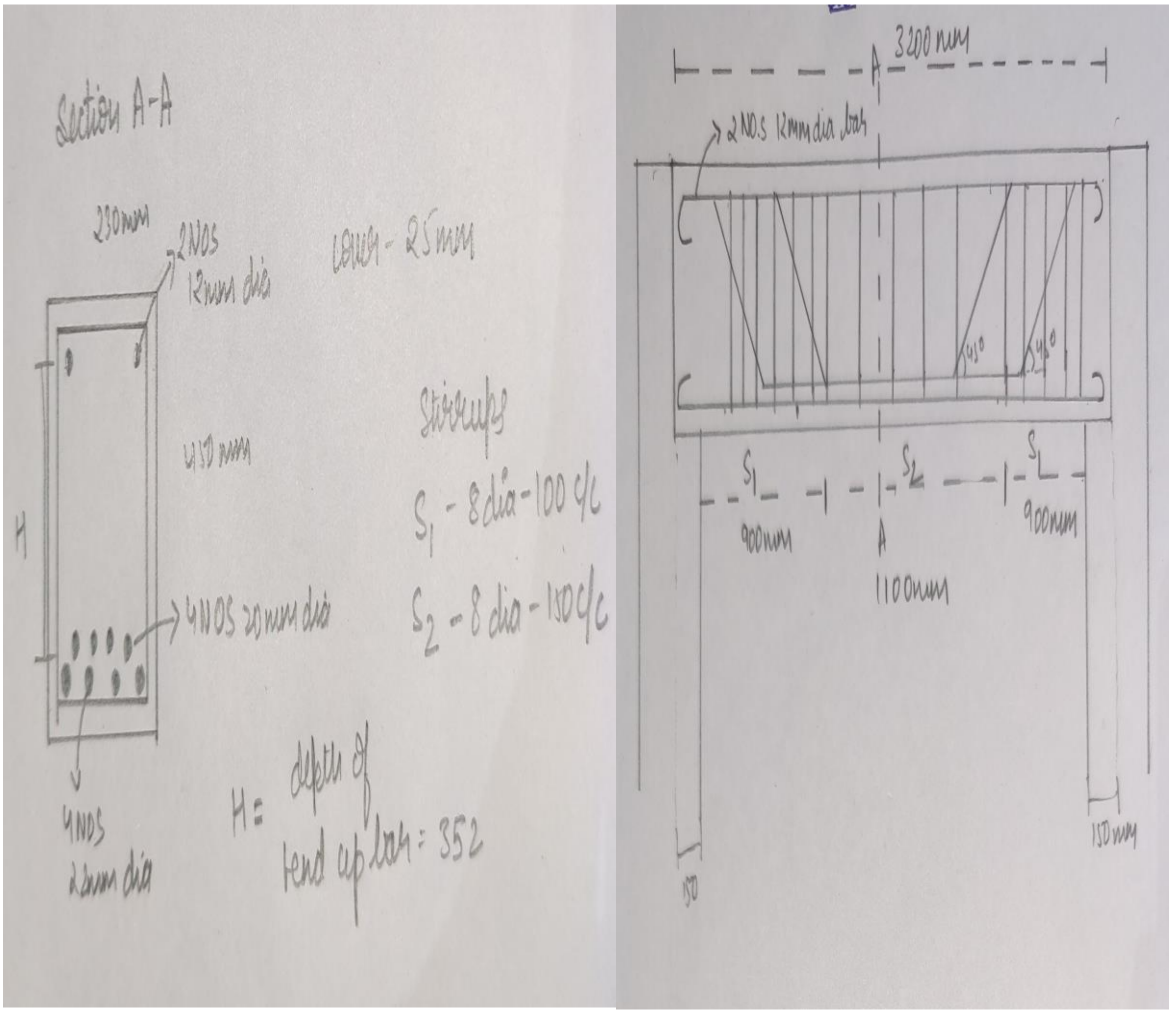


FIGURE 4.4 Cross section of Beam

		BEAM(230*450)						
	SPAN OF BEAM (CLEAR SPAN)	3200MM						
	WIDTH	230MM						
	DEPTH	450MM						
	COVER	25MM						
	EFFECTIVE DEPTH	400MM						
	DIA OF MAIN BAR	22MM						
	DIA OF BENT UP BAR	20MM						
	DIA OF TOP BAR	12MM						
	DIA OF STIRRUPS	8MM						
		LENGTH(M)	HEIGHT(M)	WIDTH(M)	TOTAL VOLUME (M^3)			
	RCC WORK	3.2	0.45	0.23	0.3312			
NO	ITEM	NOS	LENGTH(mm)	TOTAL LENGTH(mm)	UNIT WEIGHT (kg/mm)	TOTAL WEIGHT (KG)		REMARKS
	BARS							
1	22mm dia straight bars	4	3546	14184	0.00298	42.26832		3200-25-25+2*9(22)
2	20mm dia bent up bars	4	3826	15304	0.00247	37.80088		3200-25-25+2*9(20)+352
3	12mm dia top bars	2	3826	7652	0.00089	6.81028		3200-25-25+2*9(12)
	STIRRUPS							
1	8mm dia with 100 c\c	18	1208	21744	0.000395	8.58888		400*2+180*2+18(8)-12(8)
2	8mm dia with 150 c\c	8	1208	9664	0.000395	3.81728		400*2+180*2+18(8)-12(8)
					TOTAL	99.28564	KG	
	TOTAL NO OF BEAM (230*450) IN THIS STRUCTURE		821					
	CONCRETE QUANTITY WHICH WILL BE USED	271.9152	M^3		COST OF CONCRETE IN BEAM	1971398.796	₹	
	STEEL QUANTITY WHICH WILL BE USED	81513.5104	KG		COST OF STEEL IN BEAM	4613664.691	₹	
	RATE OF CONCRETE AS PER DSR (2016)	7250.05	₹ PER CUM		TOTAL COST FOR BEAMS	6585063.487	₹	
	RATE OF STEEL AS PER DSR (2016)	56.6	₹ PER KG					

TABLE 4.3: Beam Estimation

Total Cost of Beams = 65,85,063.487 INR

4.3.2 Columns

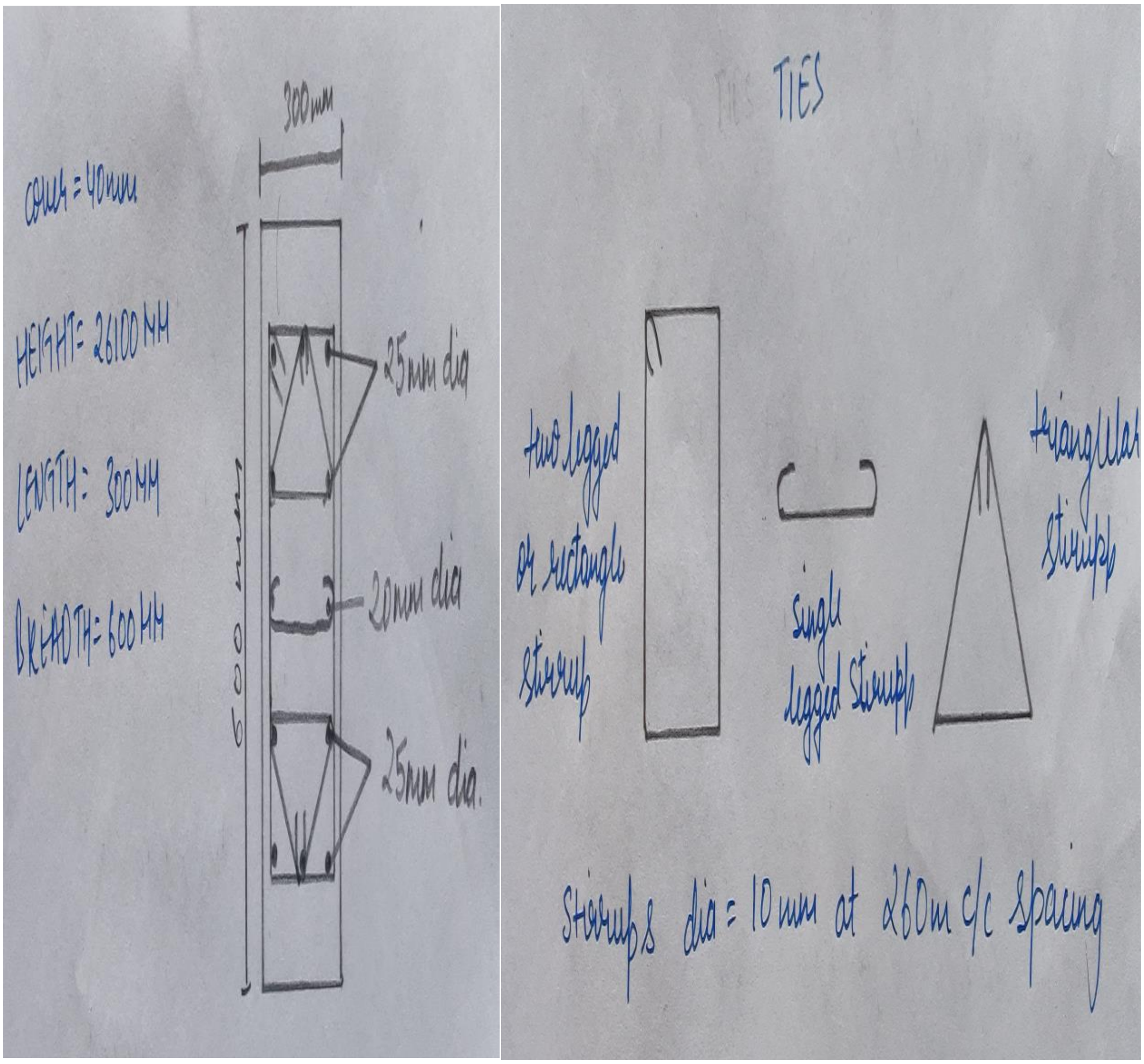


FIGURE 4.5 Bar Bending Schedule

		COLUMN(300*600)					
	HEIGHT OF COLUMN	26100MM					
	LENGTH	300MM					
	BREADTH	600MM					
	COVER	40MM					
	DIA OF MAIN BAR	25 mm and 20 mm					
	DIA OF STIRRUPS	10MM					
		LENGTH(M)	HEIGHT(M)	BREADTH(M)	TOTAL VOLUME (M^3)		
	RCC WORK	0.3	2.61	0.6	0.4698		
NO	**ITEM**	**NOS**	**LENGTH(mm)**	**TOTAL LENGTH(mm)**	**UNIT WEIGHT (kg/mm)**	**TOTAL WEIGHT (KG)**	**REMARKS**
	STEEL						
	BARS						
1	25mm main dowel bar	6	26400	158400	0.00385	609.84	26100+2(9*25)-2(3*25)
2	25mm main dowel bar	4	26400	105600	0.00385	406.56	26100+2(9*25)-2(3*25)
3	20mm dia main dowel bar	2	26340	52680	0.00247	130.1196	26100+2(9*20)-2(3*20)
	STIRRUPS(ONE SET)						
1	SINGLE LEGGED STIRRUPS (10MM DIA 100C/C)	1	340	340	0.000617	0.20978	220+2(9*10)-2(3*10)
2	DOUBLE LEGGED STIRRUPS (10MM DIA 100C/C)	1	800	800	0.000617	0.4936	520+220+2(9*10)-3(2*10)-2(3*10)
3	TRAINGULAR STIRRUPS (10MM DIA 100C/C)	2	620.58	1241.16	0.000617	0.76579572	170.29+170.29+220+2*(9*10)-4*(3*10)
					TOTAL(ONE SET)	1.46917572	
	TOTAL NO OF TIES (ONE SINGLE LEGGED + ONE DOUBLE LEGGED + 2 TRAINGULAR STIRRUPS)	261					
	TOTAL QUANTITY OF 261 TIES (KGS)	383.4548629					
					TOTAL	1529.974463	KG
	TOTAL NO OF COLOMUN(300*600) IN THIS STRUCTURE	35					
	CONCRETE QUANTITY WHICH WILL BE USED	16.443	M^3		COST OF CONCRETE IN BEAM	119212.5722	₹
	STEEL QUANTITY WHICH WILL BE USED	53549.1062	KG		COST OF STEEL IN BEAM	3030879.411	₹
	RATE OF CONCRETE AS PER DSR (2016)	7250.05	₹ PER CUM		TOTAL COST FOR BEAM	3150091.983	₹
	RATE OF STEEL AS PER DSR (2016)	56.6	₹ PER KG				

TABLE 4.4: Column Estimation

Total Cost of Columns = 31,50,091.983 INR

4.3.3 Foundation

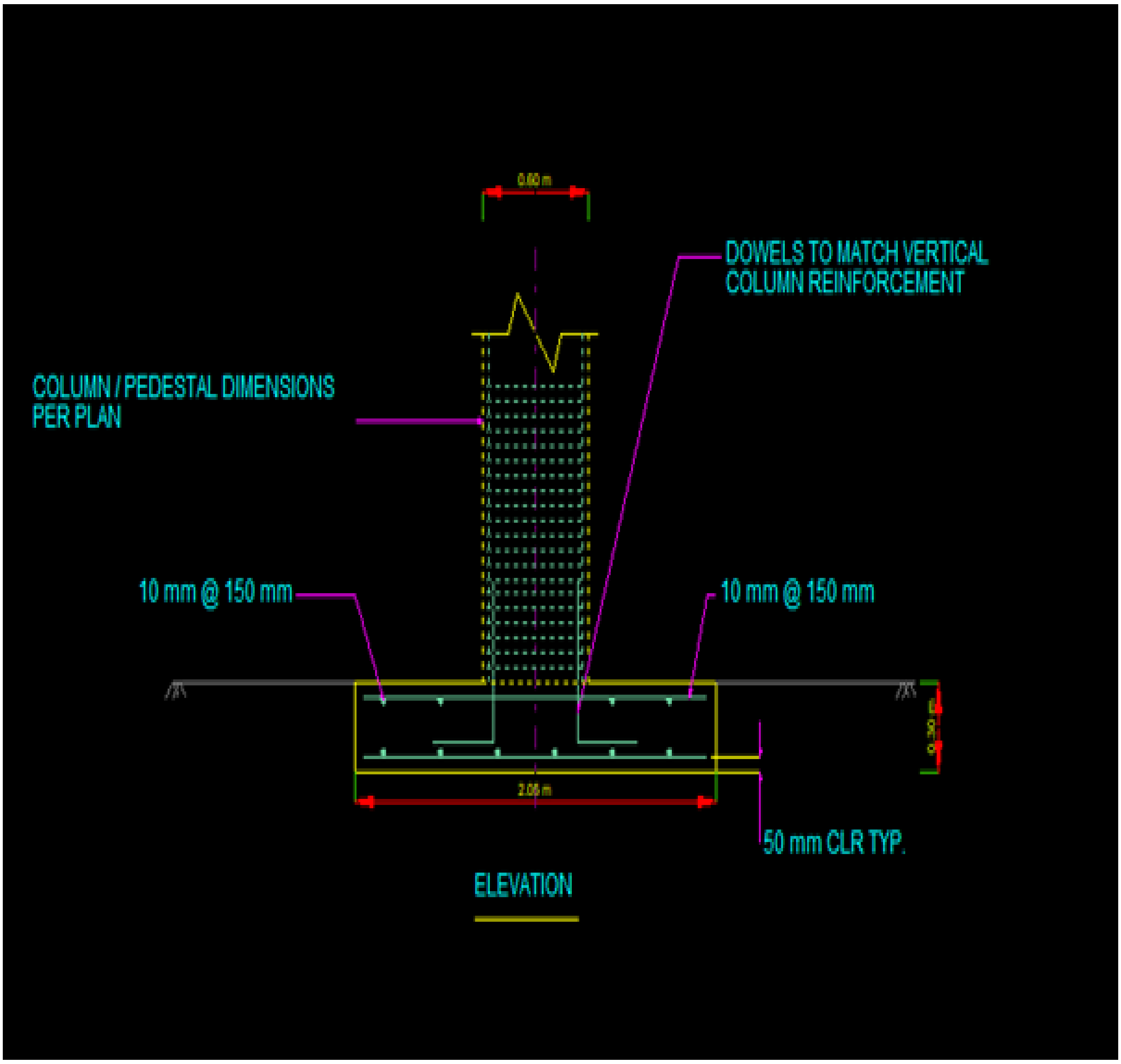


FIGURE 4.6 Footing no 1 reference for figure

FOOTING NO 1

NO	RCC		HEIGHT	LENGTH	BREADTH	TOTAL VOLUMNE	
1	PEDESTIAL		1.5	0.3	0.6	0.27	CUM
2	FOOTING		0.3	2.05	2.05	1.26075	CUM
	TOTAL RCC WORK	1.53075	CUM				

NO	ITEM	NOS	LENGTH(mm)	TOTAL LENGTH(mm)	UNIT WEIGHT (kg/mm)	TOTAL WEIGHT (KG)		REMARKS
	STEEL							
	Pedestial							
1	25mm main dowel bar	6	2505	15030	0.00385	57.8655		(24*25)+1500+300-50-10-10+(9*25)-2*25
2	25mm main dowel bar	4	2505	10020	0.00385	38.577		(24*25)+1500+300-50-10-10+(9*25)-2*25
3	20mm dia main dowel bar	2	2350	4700	0.00247	11.609		(24*20)+1500+300-50-10-10+(9*20)-(2*20)
	Footing							
	10MM DIA 150MM C/C (TO	80	2130	170400	0.000617	105.1368		2050-50-50+(18*10)
	10MM DIA 150MM C/C (BO	80	2130	170400	0.000617	105.1368		2050-50-50+(18*10)
	STIRRUPS(ONE SET)							
1	SINGLE LEGGED STIRRUPS (10MM DIA 100C/C)	1	340	340	0.000617	0.20978		220+2(9*10)-2(3*10)
2	DOUBLE LEGGED STIRRUPS (10MM DIA 100C/C)	1	800	800	0.000617	0.4936		520+220+2(9*10)-3(2*10)-2(3*10)
3	TRAINGULAR STIRRUPS (10MM DIA 100C/C)	2	620.58	1241.16	0.000617	0.76579572		170.29+170.29+220+2*(9*10)-4*(3*10)
					TOTAL(ONE SET)	1.46917572		
	TOTAL NUMBER OF STIRRUPS BELOW PLINTH LEVEL	15						
	TOTAL QUANTITY OF 261 TIES (KGS)	22.03764	KG					
	TOTAL STEEL	340.3627	KG					
	COST OF FOOTING							
	CONCRETE QUANTITY WHICH WILL BE USED	1.53075	M^3					
	STEEL QUANTITY WHICH WILL BE USED	340.3627	KG					
	RATE OF CONCRETE AS PER DSR (2016)	6446.45	₹ PER CUM					
	RATE OF STEEL AS PER DSR (2016)	56.6	₹ PER KG					
	TOTAL COST OF FOOTING	29132.43	₹					

TABLE 4.5: Footing 1 Estimation

Cost of footing no 1 = 29,132.43 INR

Total Cost of all 35 footings = 10,19,635.05 INR

The Total Cost of Structure = 1,07,54,790.52 INR

CHAPTER 5: CONCLUSION

The structure was designed and analysed on Staad Pro and a detailed cost estimation was prepared for the structure on excel.

Staad Pro had certain specification that allowed the structure to be replicated more realistically like an actual structure. To test these specifications two structures one with specifications and the other without specifications were created.

The specifications that were taken are member offset, property reduction, moment distribution.

The one without specification would be an ideal structure that Staad Pro tends to design on contrary the other structure would be slightly more realistic.

The structure with specification required more concrete and steel as compared to the one without specifications which was expected as a real structure would have more requirements of material as compared to an ideal one.

After completing the cost estimation, it was determined the total cost of our structure came out to Rs. 1,07,54,790.52.

The structure is safe and sound.

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(4) KUMAR SUJIT, GARG V. & SHARMA A. "Effect of Sloping Ground On Structural Performance of RCC Building Under Seismic Load", International journal of sciences, engineering and technology, ISSN: 2348-4098, Volume 2, Issue 6, 2014

(5) The DSR (Delhi schedule of rate) by CPWD (central public work department) Here is the link for DSR which I will be using in this project - https://www.pdf-book-search.com/schedule/delhi-schedule-of-rates-e-m-cpwd.html

(6) https://civiconcepts.com/2019/09/estimation-of-a-building-with-plan/

(7) https://basiccivilengineering.com/2018/07/types-estimate-types-estimates-prepared-various-stages-project.html

(8) IS 875 1987 (Part 1, 2 & 3)

(9) STAAD Pro User Manual 4

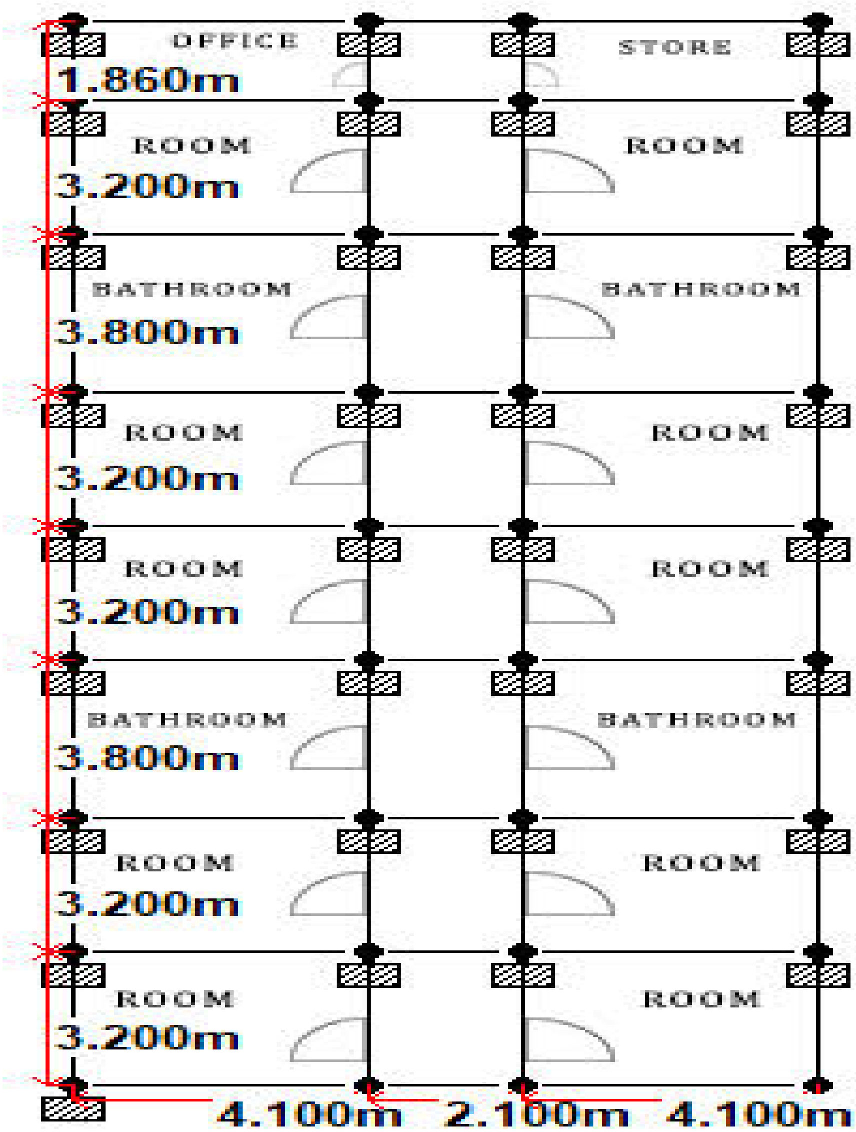
(10) http://en.wikipedia.org/wiki/STAAD

(11) https://structuralbd.com/staad-pro-software-features-and-download

APPENDIX

ANNEXURE 1

Floor plan is diagrammatic representation of positioning of rooms. The following floor plan is our proposed plan.



ANNEXURE 2

BEAM DESIGN RESULTS FOR STRUCTURE WITH SPECIFICATIONS

BEAM NO 99

CONCRETE GRADE = M25, STEEL GRADE = Fe500

I S - 4 5 6 L I M I T S T A T E D E S I G N

B E A M N O. 99 D E S I G N R E S U L T S

LENGTH: 1560.0 mm SIZE: 230.0 mm X 450.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	390.0 mm	780.0 mm	1170.0 mm	1560.0 mm
TOP REINF.	1222.73 (Sq. mm)	589.53 (Sq. mm)	196.44 (Sq. mm)	382.88 (Sq. mm)	1010.18 (Sq. mm)
BOTTOM REINF.	1208.21 (Sq. mm)	615.23 (Sq. mm)	196.44 (Sq. mm)	352.12 (Sq. mm)	848.75 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	390.0 mm	780.0 mm	1170.0 mm	1560.0 mm
TOP REINF.	4-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	4-20í 1 layer(s)
BOTTOM REINF.	4-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	3-20í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 120 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 565.0 mm AWAY FROM START SUPPORT
VY = 171.06 MX = -0.19 LD= 32
Provide 2 Legged 8í @ 125 mm c/c

SHEAR DESIGN RESULTS AT 565.0 mm AWAY FROM END SUPPORT
VY = -182.76 MX = -0.17 LD= 33
Provide 2 Legged 8í @ 115 mm c/c

BEAM NO 100

CONCRETE GRADE = M 25, STEEL GRADE = Fe 500

IS-456 L I M I T S T A T E D E S I G N

B E A M N O. 100 D E S I G N R E S U L T S

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	390.0 mm	780.0 mm	1170.0 mm	1560.0 mm
TOP REINF.	1222.86 (Sq. mm)	602.17 (Sq. mm)	195.50 (Sq. mm)	368.44 (Sq. mm)	965.58 (Sq. mm)
BOTTOM REINF.	1207.38 (Sq. mm)	623.53 (Sq. mm)	195.50 (Sq. mm)	339.24 (Sq. mm)	846.39 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	390.0 mm	780.0 mm	1170.0 mm	1560.0 mm
TOP REINF.	4-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	4-20í 1 layer(s)
BOTTOM REINF.	4-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	3-20í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 125 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 565.0 mm AWAY FROM START SUPPORT
VY = -170.40 MX = 0.22 LD= 33
Provide 2 Legged 8í @ 125 mm c/c

SHEAR DESIGN RESULTS AT 565.0 mm AWAY FROM END SUPPORT
VY = -179.27 MX = 0.22 LD= 33
Provide 2 Legged 8í @ 115 mm c/c

BEAM NO 101

CONCRETE GRADE = M 25, STEEL GRADE = Fe 500

IS-456 LIMIT STATE DESIGN
BEAM NO. 101 DESIGN RESULTS

LENGTH: 1560.0 mm SIZE: 230.0 mm X 450.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	390.0 mm	780.0 mm	1170.0 mm	1560.0 mm
TOP REINF.	2359.95 (Sq. mm)	1480.60 (Sq. mm)	457.60 (Sq. mm)	356.64 (Sq. mm)	1375.12 (Sq. mm)
BOTTOM REINF.	2247.42 (Sq. mm)	1439.67 (Sq. mm)	456.04 (Sq. mm)	352.55 (Sq. mm)	1340.09 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	390.0 mm	780.0 mm	1170.0 mm	1560.0 mm
TOP REINF.	3-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)
BOTTOM REINF.	3-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)
SHEAR REINF.	2 legged 10í @ 145 mm c/c	2 legged 10í @ 105 mm c/c	2 legged 10í @ 70 mm c/c	2 legged 10í @ 110 mm c/c	2 legged 10í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 559.0 mm AWAY FROM START SUPPORT
VY = 292.94 MX = 0.37 LD= 32
Provide 2 Legged 10í @ 105 mm c/c

SHEAR DESIGN RESULTS AT 559.0 mm AWAY FROM END SUPPORT
VY = -284.60 MX = 0.54 LD= 33
Provide 2 Legged 10í @ 105 mm c/c

BEAM NO 102

CONCRETE GRADE= M25 STEEL GRADE= Fe500

IS-456 LIMIT STATE DESIGN
BEAM NO. 102 DESIGN RESULTS

LENGTH: 1560.0 mm SIZE: 230.0 mm X 450.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	390.0 mm	780.0 mm	1170.0 mm	1560.0 mm
TOP REINF.	1232.85 (Sq. mm)	597.05 (Sq. mm)	196.44 (Sq. mm)	378.40 (Sq. mm)	1006.92 (Sq. mm)
BOTTOM REINF.	1220.35 (Sq. mm)	622.55 (Sq. mm)	196.44 (Sq. mm)	346.04 (Sq. mm)	842.56 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	390.0 mm	780.0 mm	1170.0 mm	1560.0 mm
TOP REINF.	3-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)
BOTTOM REINF.	3-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)
SHEAR REINF.	2 legged 10í @ 145 mm c/c	2 legged 10í @ 105 mm c/c	2 legged 10í @ 70 mm c/c	2 legged 10í @ 110 mm c/c	2 legged 10í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 559.0 mm AWAY FROM START SUPPORT
VY = 292.94 MX = 0.37 LD= 32
Provide 2 Legged 10í @ 105 mm c/c

SHEAR DESIGN RESULTS AT 559.0 mm AWAY FROM END SUPPORT
VY = -284.60 MX = 0.54 LD= 33
Provide 2 Legged 10í @ 105 mm c/c

BEAM NO 103

CONCRETE GRADE = M25, STEEL GRADE = Fe 500

IS-456 LIMIT STATE DESIGN
BEAM NO. 103 DESIGN RESULTS

LENGTH: 3500.0 mm SIZE: 230.0 mm X 450.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	875.0 mm	1750.0 mm	2625.0 mm	3500.0 mm
TOP REINF.	415.32 (Sq. mm)	197.38 (Sq. mm)	0.00 (Sq. mm)	197.38 (Sq. mm)	393.57 (Sq. mm)
BOTTOM REINF.	197.38 (Sq. mm)	197.38 (Sq. mm)	197.38 (Sq. mm)	197.38 (Sq. mm)	197.38 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	875.0 mm	1750.0 mm	2625.0 mm	3500.0 mm
TOP REINF.	4-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	4-12í 1 layer(s)
BOTTOM REINF.	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 719.0 mm AWAY FROM START SUPPORT
VY = 44.73 MX = -0.08 LD= 30
Provide 2 Legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT 719.0 mm AWAY FROM END SUPPORT
VY = -44.98 MX = 0.20 LD= 31
Provide 2 Legged 8í @ 145 mm c/c

BEAM DESIGN RESULTS STRUCTURE WITHOUT ADDED OF SPECIFICATIONS

BEAM NO 99

CONCRETE GRADE = M25, STEEL GRADE = Fe500

IS-456 L I M I T S T A T E D E S I G N
B E A M N O. 99 D E S I G N R E S U L T S

LENGTH: 1860.0 mm SIZE: 230.0 mm X 450.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	465.0 mm	930.0 mm	1395.0 mm	1860.0 mm
TOP REINF.	1502.80 (Sq. mm)	709.74 (Sq. mm)	195.50 (Sq. mm)	433.75 (Sq. mm)	1203.49 (Sq. mm)
BOTTOM REINF.	1423.71 (Sq. mm)	738.96 (Sq. mm)	194.32 (Sq. mm)	418.17 (Sq. mm)	1027.66 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	465.0 mm	930.0 mm	1395.0 mm	1860.0 mm
TOP REINF.	5-20í 2 layer(s)	3-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	4-20í 1 layer(s)
BOTTOM REINF.	3-25í 1 layer(s)	2-25í 1 layer(s)	2-25í 1 layer(s)	2-25í 1 layer(s)	3-25í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 135 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 557.0 mm AWAY FROM START SUPPORT
VY = 173.58 MX = -0.19 LD= 32
Provide 2 Legged 8í @ 120 mm c/c

SHEAR DESIGN RESULTS AT 565.0 mm AWAY FROM END SUPPORT
VY = -180.29 MX = -0.16 LD= 33
Provide 2 Legged 8í @ 110 mm c/c

BEAM NO 100

CONCRETE GRADE= M25, STEEL GRADE= Fe500

IS-456 L I M I T S T A T E D E S I G N
B E A M N O. 100 D E S I G N R E S U L T S

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	465.0 mm	930.0 mm	1395.0 mm	1860.0 mm
TOP REINF.	1520.27 (Sq. mm)	735.51 (Sq. mm)	195.50 (Sq. mm)	423.07 (Sq. mm)	1157.74 (Sq. mm)
BOTTOM REINF.	1445.95 (Sq. mm)	744.76 (Sq. mm)	194.32 (Sq. mm)	415.00 (Sq. mm)	1051.33 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	465.0 mm	930.0 mm	1395.0 mm	1860.0 mm
TOP REINF.	5-20í 2 layer(s)	3-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	4-20í 1 layer(s)
BOTTOM REINF.	3-25í 1 layer(s)	2-25í 1 layer(s)	2-25í 1 layer(s)	2-25í 1 layer(s)	3-25í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 135 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 557.0 mm AWAY FROM START SUPPORT
VY = 174.16 MX = 0.28 LD= 32
Provide 2 Legged 8í @ 120 mm c/c

SHEAR DESIGN RESULTS AT 565.0 mm AWAY FROM END SUPPORT
VY = -176.84 MX = 0.12 LD= 33
Provide 2 Legged 8í @ 110 mm c/c

BEAM NO 101

CONCRETE GRADE = M25, STEEL GRADE = Fe500

I S - 4 5 6 L I M I T S T A T E D E S I G N
B E A M N O. 101 D E S I G N R E S U L T S

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	465.0 mm	930.0 mm	1395.0 mm	1860.0 mm
TOP REINF.	5-25í 2 layer(s)	4-25í 2 layer(s)	2-25í 1 layer(s)	2-25í 1 layer(s)	3-25í 1 layer(s)
BOTTOM REINF.	3-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)	2-32í 1 layer(s)
SHEAR REINF.	2 legged 10í @ 145 mm c/c	2 legged 10í @ 110 mm c/c	2 legged 10í @ 120 mm c/c	2 legged 10í @ 125 mm c/c	2 legged 10í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 542.5 mm AWAY FROM START SUPPORT
VY = 260.41 MX = 0.37 LD= 32
Provide 2 Legged 8í @ 80 mm c/c

SHEAR DESIGN RESULTS AT 562.5 mm AWAY FROM END SUPPORT
VY = 245.90 MX = 0.37 LD= 32
Provide 2 Legged 8í @ 85 mm c/c

LENGTH: 1860.0 mm SIZE: 230.0 mm X 450.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	465.0 mm	930.0 mm	1395.0 mm	1860.0 mm
TOP REINF.	2439.39 (Sq. mm)	1477.94 (Sq. mm)	409.56 (Sq. mm)	405.44 (Sq. mm)	1430.20 (Sq. mm)
BOTTOM REINF.	2258.45 (Sq. mm)	1401.73 (Sq. mm)	402.84 (Sq. mm)	427.75 (Sq. mm)	1448.34 (Sq. mm)

BEAM NO 102

CONCRETE GRADE = M25, STEEL GRADE = Fe500

IS-456 L I M I T S T A T E D E S I G N
B E A M N O. 102 D E S I G N R E S U L T S

LENGTH: 1860.0 mm SIZE: 230.0 mm X 450.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	465.0 mm	930.0 mm	1395.0 mm	1860.0 mm
TOP REINF.	1521.89 (Sq. mm)	721.82 (Sq. mm)	195.50 (Sq. mm)	427.77 (Sq. mm)	1194.68 (Sq. mm)
BOTTOM REINF.	1431.23 (Sq. mm)	744.00 (Sq. mm)	194.32 (Sq. mm)	415.70 (Sq. mm)	1031.47 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	465.0 mm	930.0 mm	1395.0 mm	1860.0 mm
TOP REINF.	5-20í 2 layer(s)	3-20í 1 layer(s)	2-20í 1 layer(s)	2-20í 1 layer(s)	4-20í 1 layer(s)
BOTTOM REINF.	3-25í 1 layer(s)	2-25í 1 layer(s)	2-25í 1 layer(s)	2-25í 1 layer(s)	3-25í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 135 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 557.0 mm AWAY FROM START SUPPORT
VY = 175.55 MX = 0.07 LD= 32
Provide 2 Legged 8í @ 120 mm c/c

SHEAR DESIGN RESULTS AT 565.0 mm AWAY FROM END SUPPORT
VY = -180.13 MX = 0.15 LD= 33
Provide 2 Legged 8í @ 110 mm c/c

BEAM NO 103

CONCRETE GRADE = M25, STEEL GRADE = Fe500

IS-456 L I M I T S T A T E D E S I G N
B E A M N O. 103 D E S I G N R E S U L T S

LENGTH: 4100.0 mm SIZE: 230.0 mm X 450.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1025.0 mm	2050.0 mm	3075.0 mm	4100.0 mm
TOP REINF.	593.42 (Sq. mm)	197.86 (Sq. mm)	0.00 (Sq. mm)	197.86 (Sq. mm)	576.65 (Sq. mm)
BOTTOM REINF.	259.22 (Sq. mm)	231.26 (Sq. mm)	197.86 (Sq. mm)	198.55 (Sq. mm)	225.76 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	1025.0 mm	2050.0 mm	3075.0 mm	4100.0 mm
TOP REINF.	3-16í 1 layer(s)	2-16í 1 layer(s)	2-16í 1 layer(s)	2-16í 1 layer(s)	3-16í 1 layer(s)
BOTTOM REINF.	4-10í 1 layer(s)	3-10í 1 layer(s)	3-10í 1 layer(s)	3-10í 1 layer(s)	3-10í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c	2 legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 717.0 mm AWAY FROM START SUPPORT
VY = 55.03 MX = -0.16 LD= 30
Provide 2 Legged 8í @ 145 mm c/c

SHEAR DESIGN RESULTS AT 717.0 mm AWAY FROM END SUPPORT
VY = -55.16 MX = 0.27 LD= 31
Provide 2 Legged 8í @ 145 mm c/c

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