بسم الله الرحمن الرحيم

VARIATION OF REINFORCEMENT AT FIRST FLOOR OF SIX AND TEN STORIED BUILDINGS

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Department of Civil Engineering

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The thesis titled **"Variation of Reinforcement at First floor of Six and Ten Storied Buildings"** submitted by: -

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DECLERATION

We declare that this thesis named "VARIATION OF REINFORCEMENT AT FIRST FLOOR OF SIX AND TEN STORIED BUILDINGS" has been composed solely by ourselves and under the supervision of Mr. Rayhan Md. Faysal, Assistant Professor, Department of Civil Engineering, DIU, and from the best of our knowledge that it has not been submitted, in whole or in part in any previous application for a degree. Except where states otherwise by reference or acknowledgment, the work presented is entirely our own.

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ABSTRACT

We designed a six and a ten storied buildings in a same area (15m X 7.5m) and also in a same seismic zone. We have followed the ACI code, UBC-1994 and BNBC-2006 to build up the structures. We have endeavored our best and put an end of our project. We have used ETABS Software for design purposes. The design process of structural planning and design requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides the knowledge of practical aspects, such as recent design codes, bye laws, backed up by ample experience, intuition and judgment. The purpose of standards is to ensure and enhance the safety, keeping careful balance between economy and safety. Generally, a building structure is the combination of column, beam and slab. The detailing of these are done by Auto CAD.

We found out the steel quantity of them and clarify the difference of required steel for two buildings. We have find out the quantity of steel which is required in a floor and also costing of steel for both buildings. In terms of column at first floor 336kg more reinforcement is needed for ten storied. For beam this value is 820kg and for slab it is 1656kg. We have gotten 77.10% more reinforcement required at first floor for ten storied buildings and it should be usual practice. In amount there are 212,400 BDT more need in terms of ten storied building at first floor.

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First of all, thanks to Almighty who helped us to complete the practicum work and the practicum report, leading to the Bachelor of Science in Civil Engineering Degree. We would like to thank every families and friends that to get me in this intensity and individuals who support and share idea and also helping us to be like this. We would like to pay our gratitude to our respected Head and Assistant Professor, Department of Civil Engineering, Dr. Mohammad Hannan Mahmud Khan, who gave us the opportunity to do the report on “VARIATION OF REINFORCEMENT AT FIRST FLOOR OF SIX AND TEN STORIED BUILDINGS BY USING MANUAL CALCULATION (USD) AND SOFTWARE (ETABS) APPROACH ". Then we would like to pay my gratitude to our honorable supervisor Mr. Rayhan Md. Faysal, Assistant Professor, DIU. Also we are thankful to Mrs. Mardia Mumtaz, Lecturer, DIU, for her dedicated mind to help us to complete our work.

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LIST OF ACRONYMS & ABBREVIATION

f'_c = Specified compressive strength of concrete

σ = Specified yield stress of concrete

f_y = Allowable Stress of Steel

E_c = Modulus of Elasticity of Concrete

E_s = Modulus of Elasticity of Steel

M_u = Ultimate Moment

P = Axial Load of Column

V = Shear Stress

τ = Shear Stress Provided by Concrete

A_g= Gross Area of Concrete

A_{st}= Area of Tensile Steel

ρ= Steel Ratio

h = Slab Thickness

L= Effective Span Length

b = Width of Beam

d = Effective Depth of Beam

φ= Strength Reduction Factor

P_u= Ultimate Axial Load of Column

M_{max} = Maximum Ultimate Moment

A_s= Area of Bar

a = Equivalent Depth of Beam

⌀= Diameter of Bar

Pcf = Pound per Cubic feet

Psi = Pound per Square Inch

ASTM = American Standard for Testing Material

ACI = American Concrete Institute

BNBC = Bangladesh National Building Code

USD = Ultimate Strength Design

UBC = Uniform Building Code

CHAPTER-01

INTRODUCTION

1.1- Introduction

The construction of each structure is largely individual. However, in all construction projects the repetitive stages, the same elements of construction can be traced. One of the main tasks during construction is to ensure the safety of residents. The creation of comfortable conditions for people living in the house and providing the maximum convenience in the use of utilities in the house and also ensure the minimum costing is also important. Each stage of the building construction is largely independent. Tallness of a building is relative and cannot be defined in absolute terms either in relation to height or the number of stories. But from a structural engineer's point of view the tall building or multistoried building can be defined as one that, by virtue of its height is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. The development of the high-rise buckling has followed the growth of the city closely. Industrialization causes migration of people to urban centers where job opportunities are significant. The land available for buildings to accommodate this migration is becoming scarce, resulting in rapid increase of multistoried buildings, as they provide a large floor area in a relatively small area of land in urban centers. In some cases, small buildings and in some cases large buildings have to be built. For this, the reinforcement area in the building is also not fixed at all condition. We have tried to differentiate between reinforcements in a six and ten storied building in our project.

1.2- Background of Study

If we want to build up a R.C.C structure, then first thing we ensure that is how many floor we have to build? The second thing which all curious mind wants to know that the quantity of steel required to construct a certain height building. If we can gather a clear knowledge about the required steel, then it will be very easy to make a fixed decision to initiate for a building construction. Generally, steel is the costliest things as structural element in terms of building structure. The required steel varied with number of floor as well as height of buildings. We all may know that the required amount of steel will increase with the number of floor but we don't know the exact parameter of more necessary steel. That's why we have decided to find out the amount of steel in terms of a six and a ten storied buildings and want to clarify the difference between their amounts of steel at a certain floor of both buildings.

1.3- Objectives

The objectives of research study may be summarized as follows: -

1) To design of a six and a ten storied residential buildings.
2) To estimate the reinforcement required and the corresponding cost for the first floor.
3) To find out the variation of steel area from aforementioned floor.

1.4- Scope of Study

Structure analysis and design has been done by using computer software ETABS. And for design and analysis purpose we used ACI code, UBC 1994, BNBC-2006. Manually Calculated the Comparison of six and ten storied building. Uses of calculation related software will be better. We could use the geological data from proposed site to make it more accurate.

CHAPTER -02

Literature Review & Types of Loads

2.1- Review of Literature

There are many scholars who have researched on various topic on R.C.C structure using ETABS and also many other latest possible software. From them some of their context are given below:

Poonam et al. (2012) Results of the numerical analysis showed that any storied, especially the first storied, must not be softer/weaker than the storied above or below. Irregularity in mass distribution also contributes to the increased response of the buildings. The irregularities, if required to be provided, need to be provided by appropriate and extensive analysis and design processes. [1]

Mario De Stefano and Barbara Pintucchi (2010) presented an overview of the progress in research regarding seismic response of plan and vertically irregular building structures. Three areas of research are surveyed. Firstly, the study of the effects of plan irregularity by means of single-storied and multi storied building models. The second area encompasses passive control as a strategy to mitigate torsional effects, by means of base isolation and other types of devices. Lastly, the third area concerns vertically irregular structures and setback buildings. They clarified that discontinuities of mass, stiffness or strength along the height, considered by current seismic codes as irregularities in elevation do not necessarily result in actual increases in plastic demands and moreover results in poor seismic behavior. [2]

Sanghani and Paresh (2011) studied the behavior of beam and column at various storied levels. It was found that the maximum axial force generated in the ground floor columns, max reinforcement required in the second floor beams. [3]

Prashanth.P et al. (2012) investigated the behavior of regular and irregular multi storied building structure in STAADPro. and ETABS. Analysis and design was done according to IS-456 and IS-1893(2002) code. Also manually calculations were done to compare results. It was found that the ETABS gave the lesser steel area as that of STAADPro. Loading combinations were not considered in the analysis and influence of storied height on the structural behavior was not described. [4]

We have taken a huge idea from their work but we didn’t find any article where two different heights building’s reinforcement compared. From this point of view, we would like to start a study about the variation of reinforcement for a certain floor of a six and a ten storied residential buildings.

2.2: - RCC (IMRF Frame Structure)

An RCC framed structure is basically an assembly of slabs, beams and columns inter - connected to each other as a unit. The load transfer, in such a structure takes place from the slabs to the beams, from the beams to the columns and then to the lower columns and finally to the foundation which in turn transfers it to the soil. The floor area of a R.C.C framed structure building is 10 to 12 percent more than that of a load bearing walled building. Monolithic construction is possible with R.C.C framed structures and they can resist vibrations, earthquakes and shocks more effectively than load bearing walled buildings. Structure engineers are primarily concerned with designing and constructing buildings and structures that are safe and capable of withstanding the elements to which they will be exposed as well as improving the structural integrity of existing buildings. This is the major task of the structure engineer. [5]

2.3: - Dead Loads

Dead loads are those that are constant in magnitude and fixed in location throughout the lifetime of the structure. [6] The major part of the dead load in the structure is self-weight. This can be calculated with good accuracy from the design configuration, dimensions of the structure and density of the material. For buildings floor fill, finish floor and plastered ceilings are usually included a dead load. Not only this but also includes force setup by irreversible change in structure continuous loads due to settlement pre-stress or shrinkage and creep.

An allowable is made for suspended loads such as piping and lighting fixtures. The dead load includes loads that are relatively constant over time including the weight of the structure itself. Building materials are not dead loads until constructed in permanent position. All permanent loads are considered as a dead load.

2.4: - Live Loads

Live loads consist chiefly of occupancy loads in buildings. They may be either fully or partially in place at all and may also change in a location. The minimum live loads for which the floors and roof of a building should be designed are usually specified in the building code.

2.4.1- Floor Live Loads

Bangladesh national building codes specify a uniform Live load pounds per square foot of horizontal rejection at be used in the design of buildings. This load intended to account for the large number of loads that can occur in a residence.

2.5: – Wind loads

Wind load in primarily horizontal load caused by the movement of air relative to earth. [7] Wind load is required to be considered in structural design especially when the health of the building exceeds two times the dimension's transverse to the exposed wind surface. A high pressure system has higher pressure at this center that the areas around it. Winds blow away from high pressure. Swirling in the opposite direction from a low pressure system, the winds of a high pressure system rotate clockwise north of the equator and counter clock wise south of the equator. No reduction in wind pressure shall be taken for the shielding effect of adjacent structure. Structure is sensitive to dynamic effect, such as -building with a height to width ratio greater than five.

2.6- Earthquake Loads

Earthquakes loads are another lateral Live load. They are very much complex, uncertain, and potentially more damaging than wind loads. The earthquake creates ground movements. Due to earthquake loads major structure failures and loss of life. To design and constructed a structure to resist the effect of seismic ground motions as provided in this division. It happens at contact surfaces of a structure either with the ground. [8]

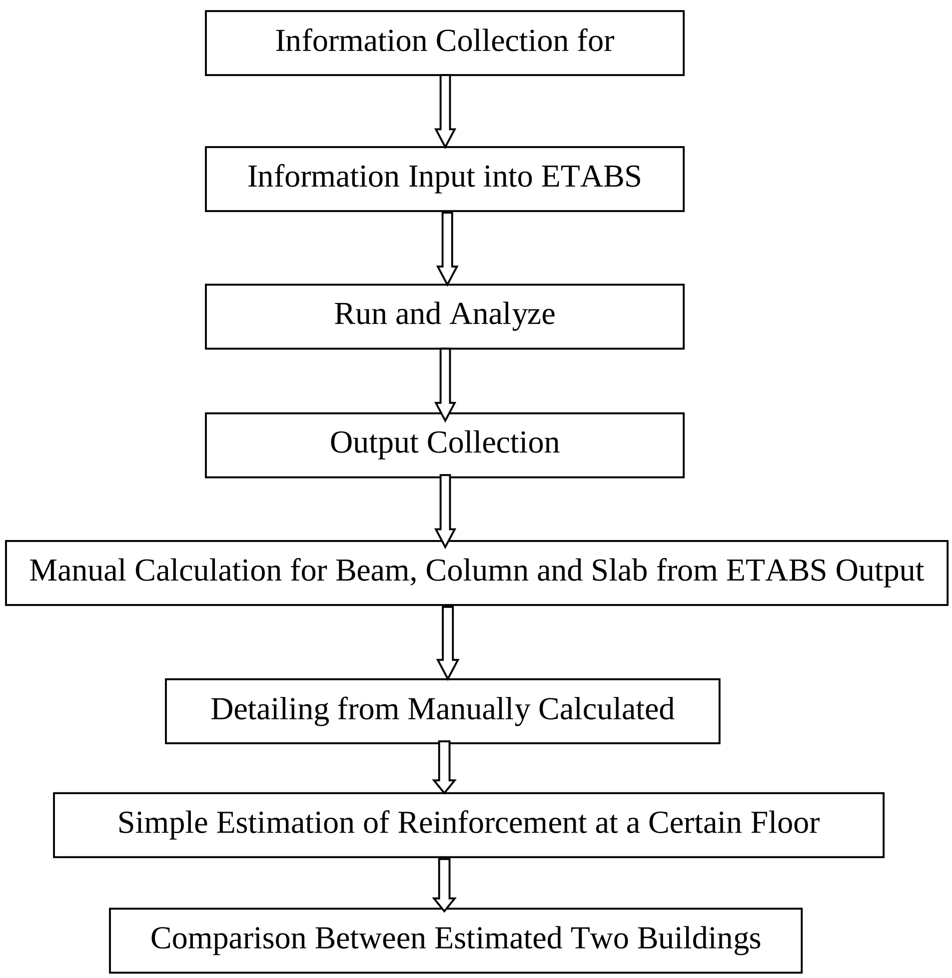
CHAPTER -03

METHODOLOGY

3.1: - General

We have used ETABS Software for the purpose of analysis and design. And for design and analysis purpose we used ACI code, UBC 1994 and BNBC-2006. Then Wind load &earthquake loads have been calculation on selected beams and columns as per BNBC, UBC 1994 CODE (coefficient, wind speed, seismic zone) for both buildings in Dhaka. Necessary comparisons have been done to check the variations. We have completed the drawing detail through Auto CAD software. The step by step process which was carried out for the modeling of structure and analyzing and designing of slab is represent in the below

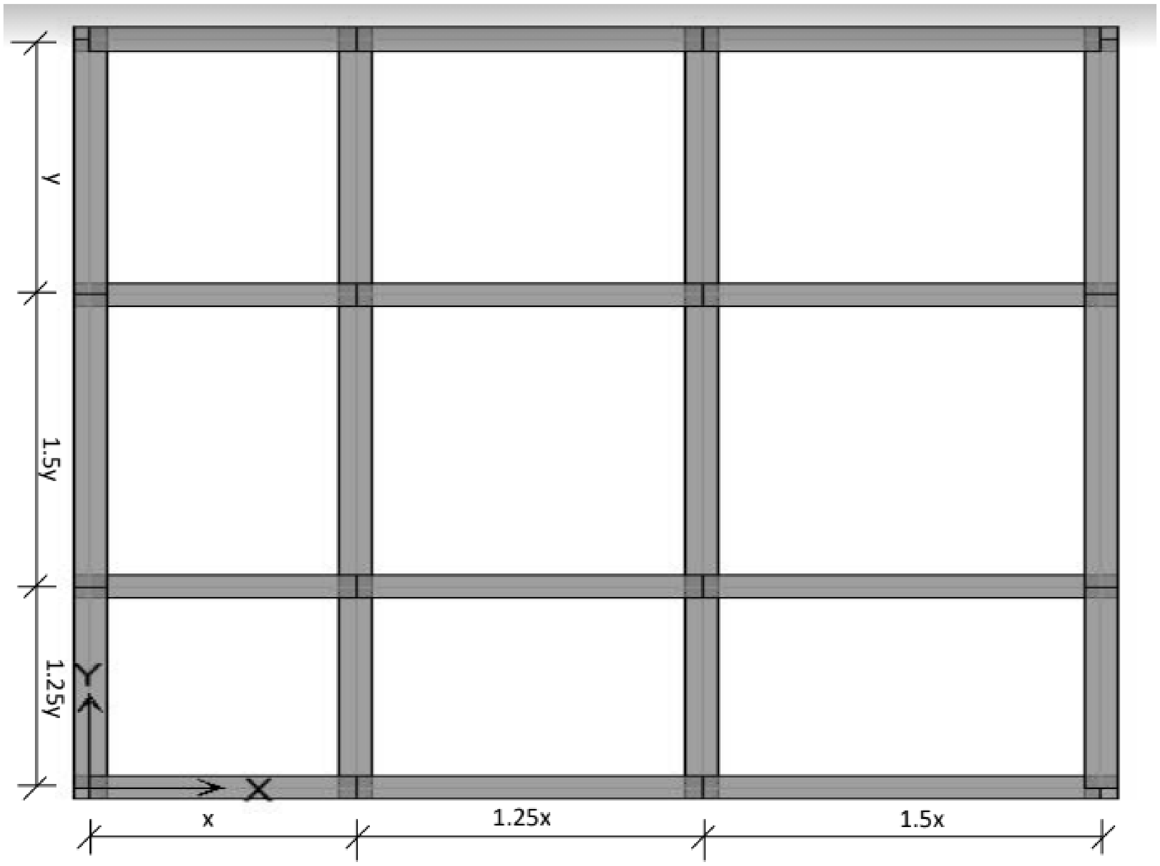
3.2:- Flow Chart



CHAPTER -4

INFORMATION, GUIDELINE & MODELING

4.1: - Basic information



y= 2 m

x = 2 + group no (in meter unit)

- Typical story height = 3.5 m (IMRF Structure, RCC Building)
- Material Properties: fc' = 3.5 ksi, fy = 60 ksi
- Slab thickness = 150 mm (for membrane), 125 mm (for bending)
- Loads: LL = 3 KN/m2, FF = 1.5 KN/m2, PW = 2.5 KN/m2

For Wind Load:

Basic wind speed = 238 Km/hr

Exposure condition =B

For Earthquake Load:

S2 type soil, Zone 2, I = 1

4.2: - Guidelines

Frame Section – use SI unit (in mm)

Maximum deflection limit due to wind load = h/500, where h = height from GF to Roof

Column rebar percentage – keep it within 4%

4.3: - Modelling

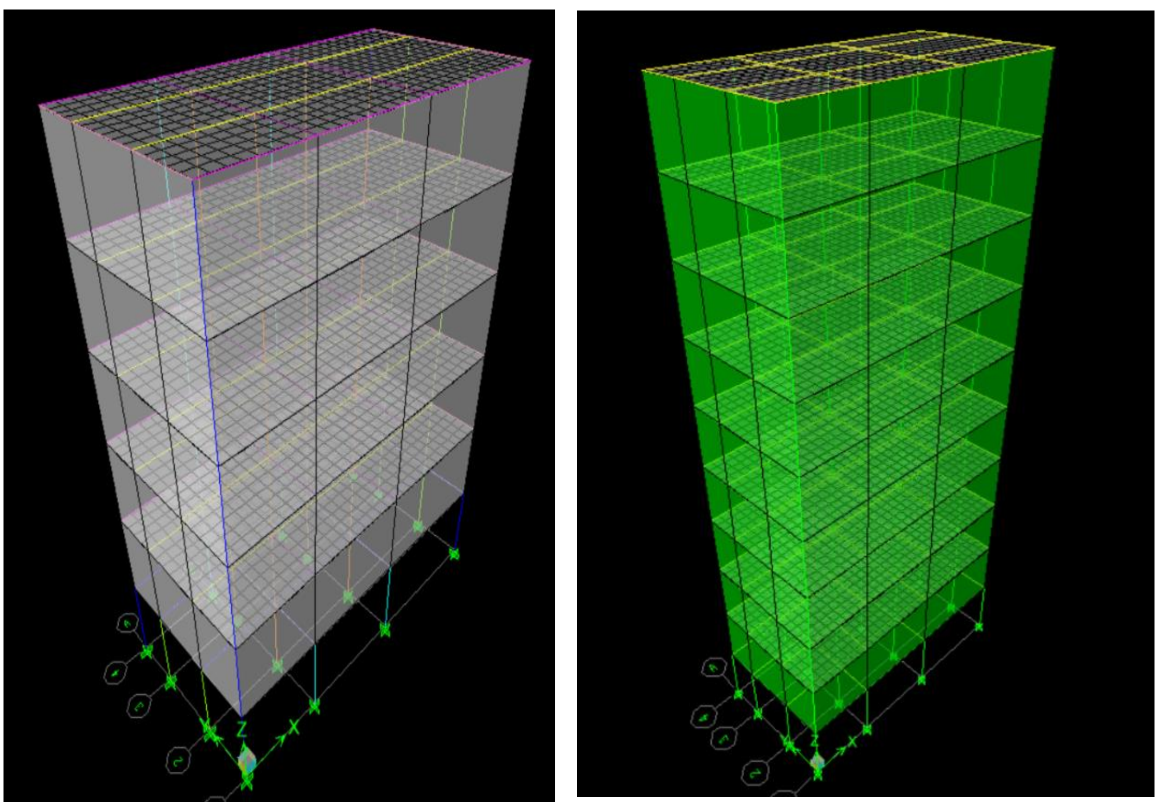


Figure 4.1 Corner View for Six(left) & Ten(right) Storied Building

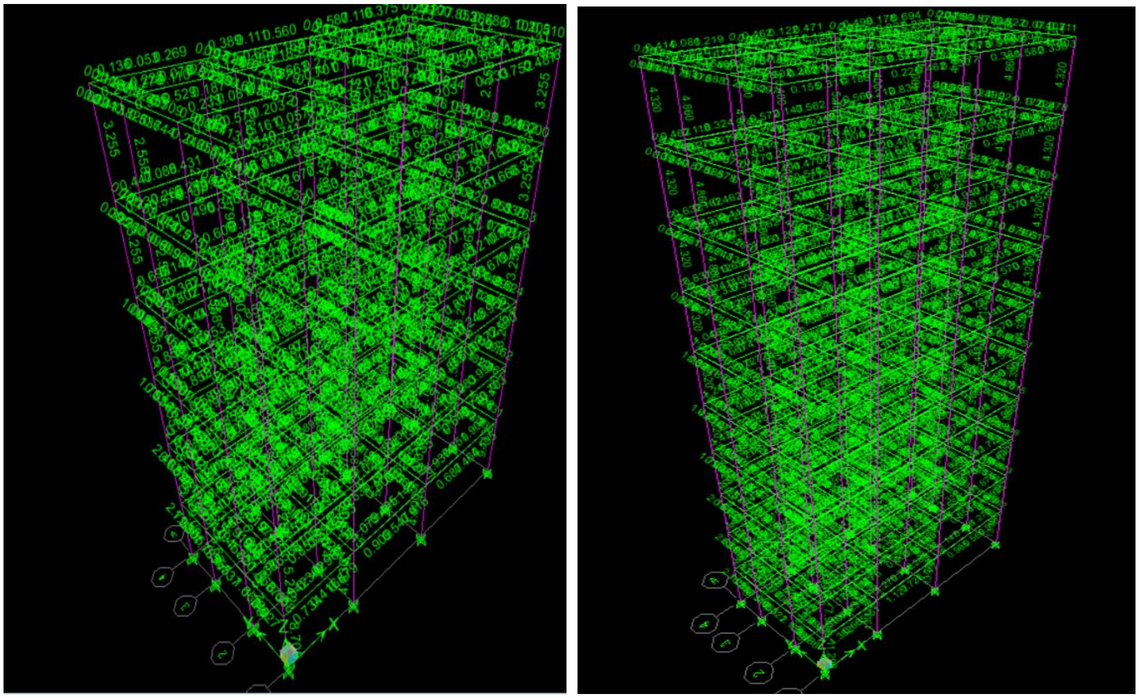


Figure 4.2 Corner View with Steel Area Six(left) & Ten(right) Storied

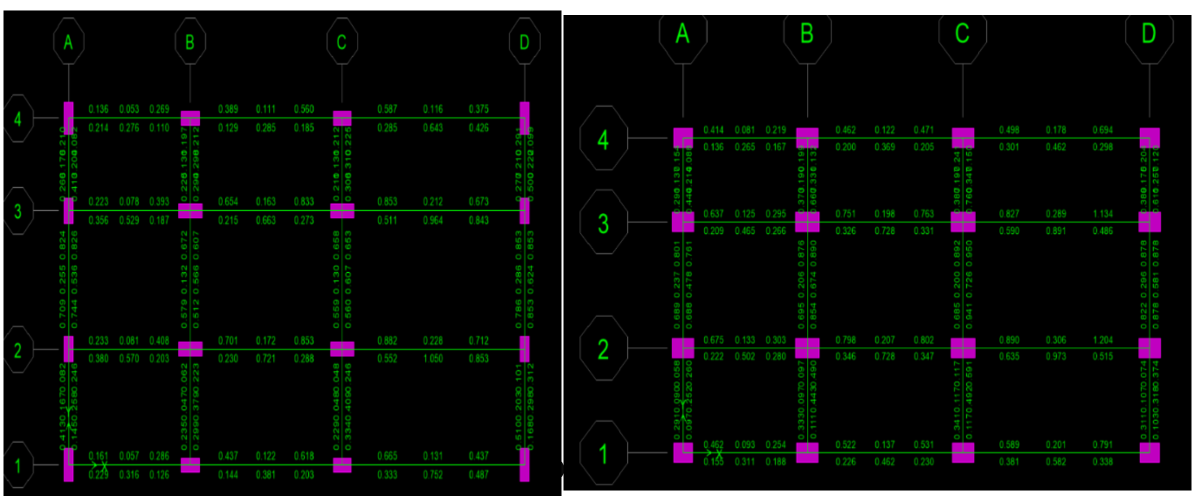


Figure 4.3: Plan View of First Floor at Six(left) & Ten(right) Storied Building

CHAPTER -05

BEAM DESIGN

A beam is a structural element that primarily resists loads applied laterally to the beam's axis. Its mode of deflection is primarily by bending. The loads applied to the beam result in reaction forces at the beam's support points. The total effect of all the forces acting on the beam is to produce shear forces and bending moments within the beams, that in turn induce internal stresses, strains and deflections of the beam.

X-axis GB

Figure 5.1 Steel Area of Grade Beam X-axis

This is the steel area from the grade beam X-axis of six storied building. Which is the output of ETABS, there are various steel area showing on figure 5.1. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.192, 0.523, 1.192. And positive side maximum steel area is left, middle, right serially 1.192, 0.630, 1.192.

Table 5.1 Reinforcement Detailing of Grade Beam X-axis:

X-axis GB											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.192	5	0.31	2	2	Left	1.192	5	0.31	3	1
Middle	0.523	5	0.31	2	-	Middle	0.630	5	0.31	3	-
Right	1.192	5	0.31	2	2	Right	1.192	5	0.31	3	1

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, two extra top in the left and right side. And positive side no. 5 bar three straight bars, one extra bottom in the left and right side.

- **GRADE BEAM (X-AXIS):**

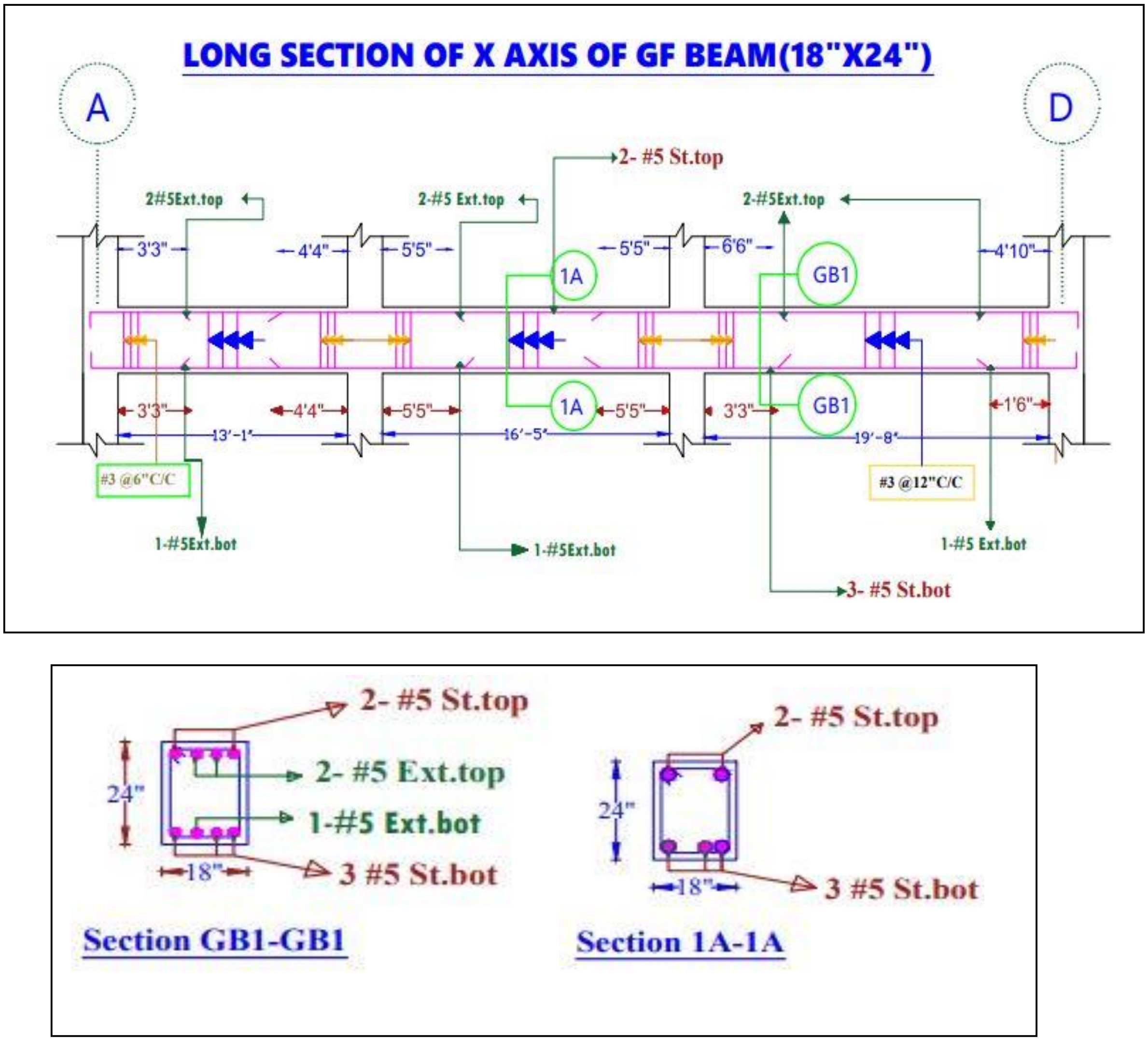


Figure 5.2 **Beam Detailing & Cross Section of X-axis**

In these sections 2 straight bars on the negative side and 3 straight bars on the positive side. 2 Extra bars on the top and 1 extra bar on the bottom. All are no.5 bar.

Y-axis GB

Figure 5.3 Steel Area of Grade Beam Y-axis

This is the steel area from the grade beam Y-axis of six storied building. There are various steel area showing on figure 5.3. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 3.530, 2.034, 3.317. And positive side maximum steel area is left, middle, right serially 3.321, 1.971, 3.151.

Table 5.2 Reinforcement Detailing of Grade Beam Y-axis

Y-axis GB											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	3.530	7	.60	4	2	Left	3.321	7	.60	4	2
Middle	2.034	7	.60	4	-	Middle	1.971	7	.60	4	-
Right	3.317	7	.60	4	2	Right	3.151	7	.60	4	2

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar four straight bars, two extra top in the left and right side. And positive side no. 7 bar four straight bars, two extra bottom in the left and right side.

- **GRADE BEAM (Y-AXIS):**

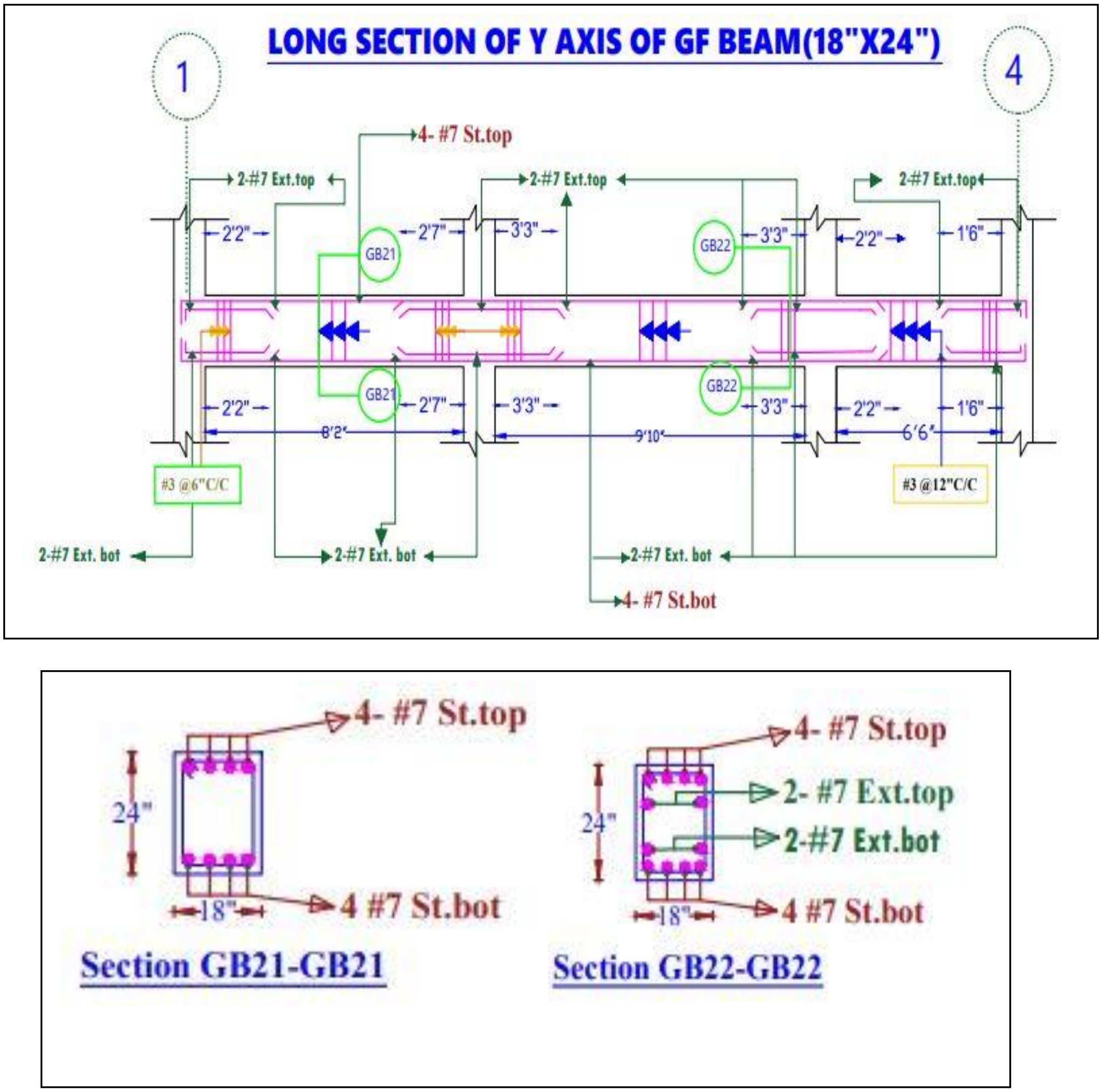


Figure 5.4 **Beam Detailing & Cross Section of Y-axis**

In these sections 4 straight bars on the negative side and 4 straight bars on the positive side. 2 Extra bars on the top and 2 extra bars on the bottom. All are no.7 bar.

X-axis 1st F

Figure 5.5 Steel Area of 1st Floor Beam X-axis

This is the steel area from the 1st floor beam X-axis of six storied building. There are various steel area showing on figure 5.5. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.553, 0.418, 1.449. And positive side maximum steel area is left, middle, right serially 0.853, 0.903, 0.853.

Table 5.3 Reinforcement Detailing of 1st Floor Beam X-axis

X-axis 1st F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.553	5	.31	2	3	Left	0.853	6	.44	2	-
Middle	0.418	5	.31	2	-	Middle	0.903	6	.44	2	1
Right	1.449	5	.31	2	3	Right	0.853	6	.44	2	-

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, three extra top in the left and right side. And positive side no. 5 bar two straight bars, one extra bottom in the middle.

- **1st FLOOR BEAM (X-AXIS):**

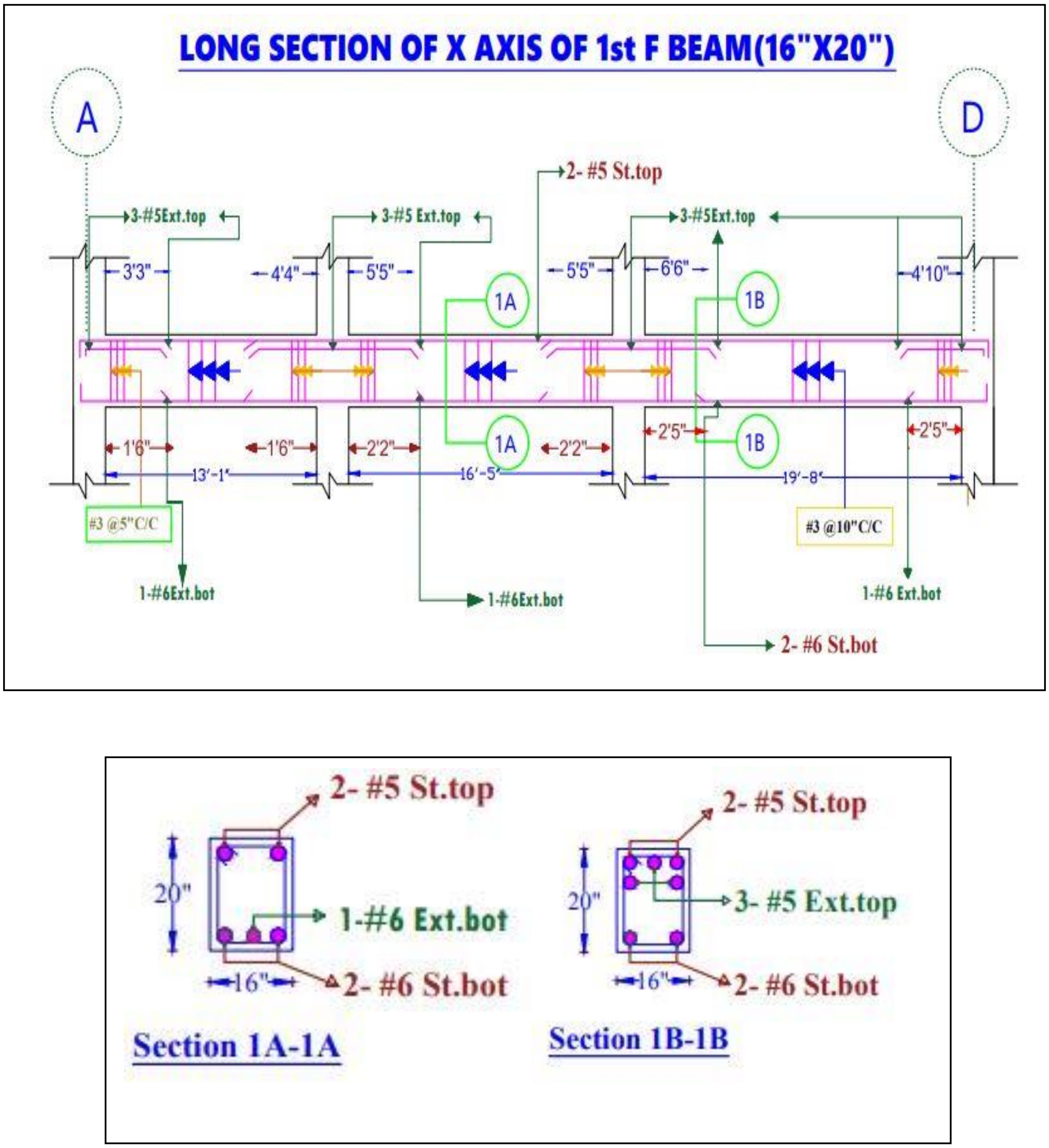


Figure 5.6 Beam Detailing & Cross Section of X-axis

In these sections no. 5 two straight bars on the negative side and no.6 two straight bars on the positive side. No. 5 three extra bars on the top and no. 6 one extra bar on the bottom.

Y-axis 1st F

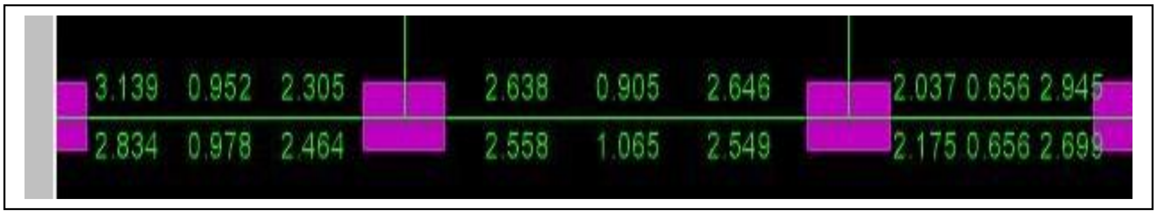


Figure 5.7 Steel Area of 1st Floor Beam Y-axis

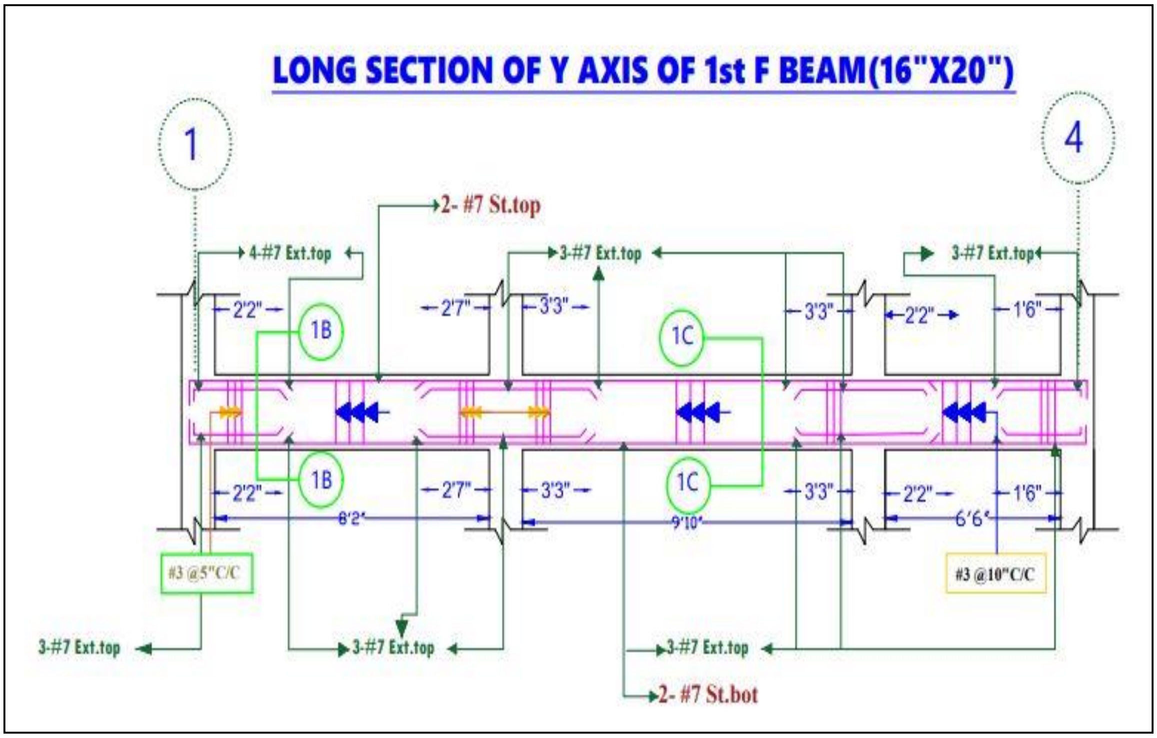
This is the steel area from the 1st floor beam Y-axis of six storied building. There are various steel area showing on figure 5.7. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 3.139, 0.952, 2.945. And positive side maximum steel area is left, middle, right serially 2.834, 1.065, 2.699.

Table 5.4 Reinforcement Detailing of 1st Floor Beam Y-axis

Y-axis 1st F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	3.139	7	.60	2	4	Left	2.834	7	.60	2	3
Middle	0.952	7	.60	2	-	Middle	1.065	7	.60	2	-
Right	2.945	7	.60	2	3	Right	2.699	7	.60	2	3

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar two straight bars, four extra top in the left and three in the right side. And positive side no. 7 bar two straight bars, three extra bottom in the left and right side.

- **1st FLOOR BEAM (Y-AXIS):**



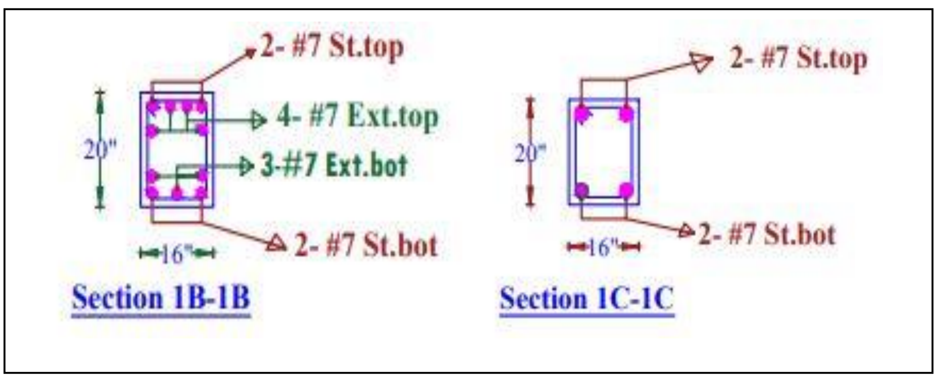


Figure 5.8 Beam Detailing & Cross Section of Y-axis

In these sections 2 straight bars on the negative side and 2 straight bars on the positive side. 4 extra bars on the top and 3 extra bars on the bottom. All are no.7 bar.

X-axis 2^{nd} F

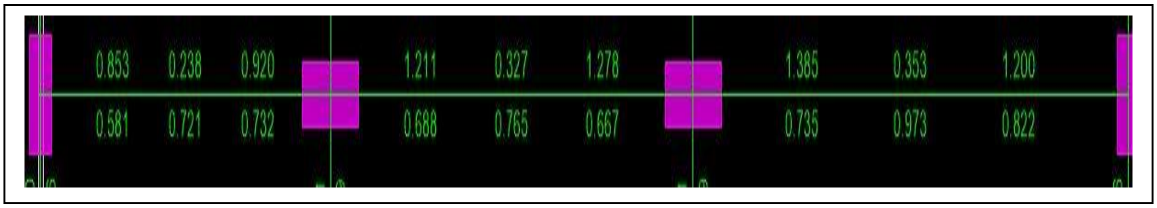


Figure 5.9 Steel Area of 2^{nd} Floor Beam X-axis

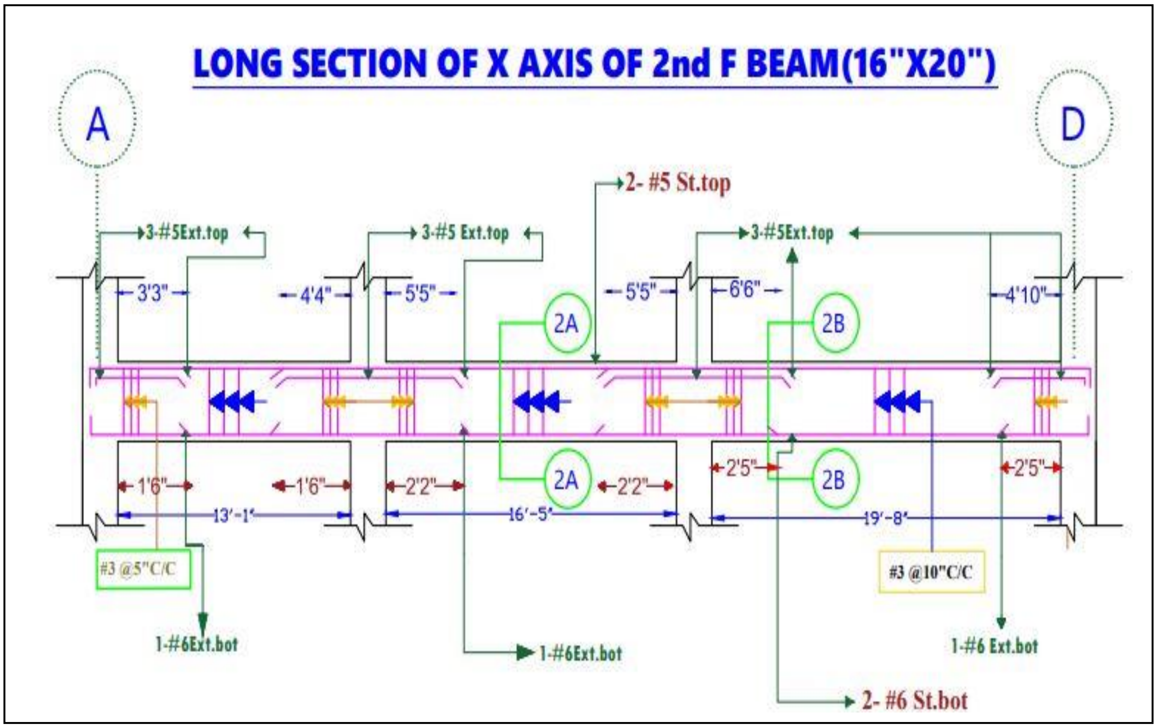
This is the steel area from the 2^{nd} floor beam X-axis of six storied building. There are various steel area showing on figure 5.9. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.385, 0.353, 1.278. And positive side maximum steel area is left, middle, right serially 0.735, 0.973, 0.822.

Table 5.5 Reinforcement Detailing of 2^{nd} Floor Beam X-axis

X-axis 2^{nd} F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.385	5	.31	2	3	Left	0.735	6	.44	2	-
Middle	0.353	5	.31	2	-	Middle	0.973	6	.44	2	1
Right	1.278	5	.31	2	3	Right	0.822	6	.44	2	-

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, three extra top in the left and right side. And positive side no. 6 bar two straight bars, one extra bottom in the middle.

- **2nd FLOOR BEAM (X-AXIS):**



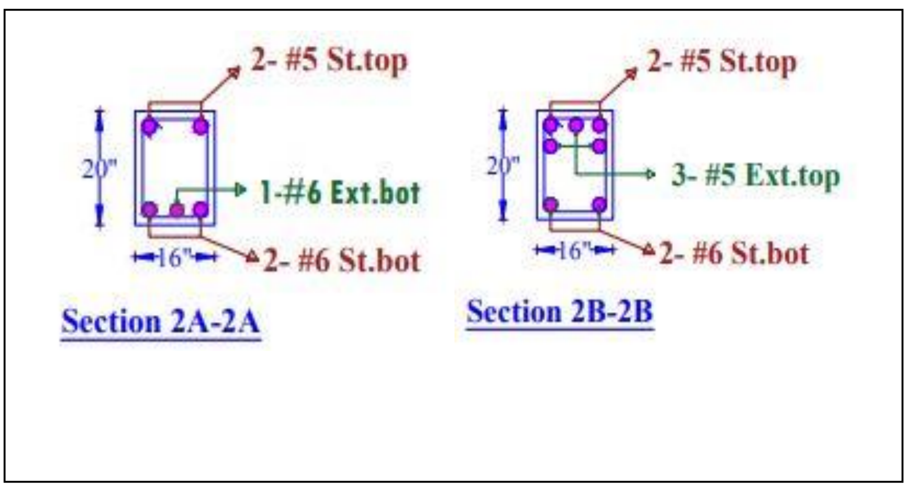


Figure 5.10 **Beam Detailing & Cross Section of X-axis**

In these sections no. 5 two straight bars on the negative side and no. 6 two straight bars on the positive side. No. 5 three extra bars on the top and no. 6 one extra bar on the bottom.

Y-axis 2nd F

Figure 5.11 Steel Area of 2nd Floor Beam Y-axis

This is the steel area from the 2nd floor beam Y-axis of six storied building. There are various steel area showing on figure 5.11. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 2.547, 0.801, 2.322. And positive side maximum steel area is left, middle, right serially 2.223, 0.963, 2.233.

Table 5.6 Reinforcement Detailing of 2nd Floor Beam Y-axis

Y-axis 2nd F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	2.547	6	.44	2	4	Left	2.223	6	.44	3	3
Middle	0.801	6	.44	2	-	Middle	0.963	6	.44	3	-
Right	2.322	6	.44	2	4	Right	2.233	6	.44	3	3

Following the maximum steel area, we found this calculation. On the negative side no. 6 bar two straight bars, and four extra top in the left and right side. And positive side no. 6 bar two straight bars, three extra bottom in the left and right side.

- **2nd FLOOR BEAM (Y-AXIS):**

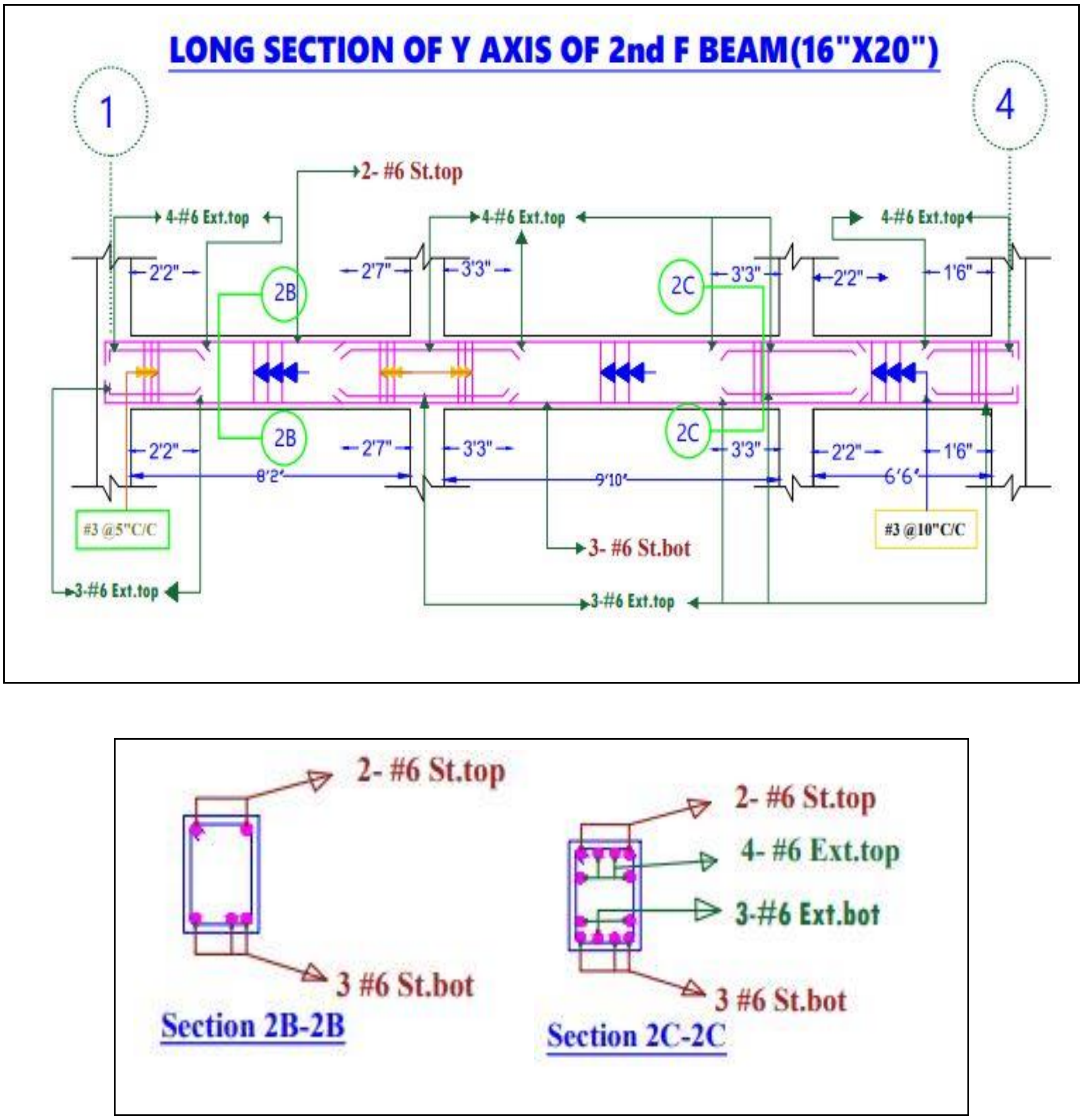


Figure 5.12 **Beam Detailing & Cross Section of Y-axis**

In these sections 2 straight bars on the negative side and 3 straight bars on the positive side. 4 extra bars on the top, 3 extra bars on the bottom. All are no.6 bar.

X-axis 3rd F

Figure 5.13 Steel Area of 3rd Floor Beam X-axis

This is the steel area from the 3rd floor beam X-axis of six storied building. There are various steel area showing on figure 5.13. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.177, 0.302, 1.055. And positive side maximum steel area is left, middle, right serially 0.619, 0.980, 0.749.

Table 5.7 Reinforcement Detailing of 3rd Floor Beam X-axis

X-axis 3rd F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.177	5	.31	2	2	Left	0.619	6	.44	2	-
Middle	0.302	5	.31	2	-	Middle	0.980	6	.44	2	1
Right	1.055	5	.31	2	2	Right	0.749	6	.44	2	-

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, two extra top in the left and right side. And positive side no. 6 bar two straight bars, one extra bottom in the middle.

- **3rd FLOOR BEAM (X-AXIS):**

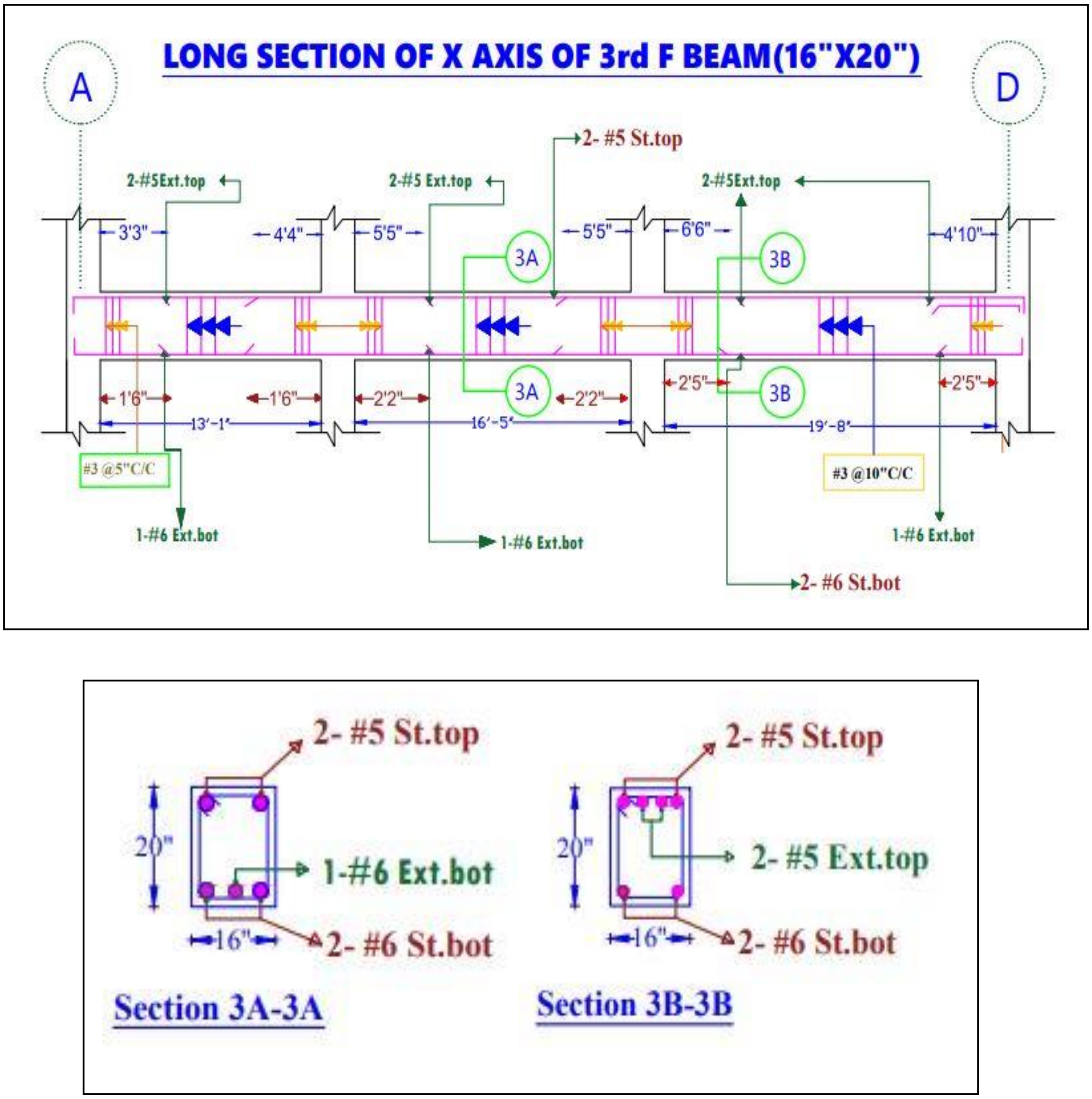


Figure 5.14 Beam Detailing & Cross Section of X-axis

In these sections no. 5 two straight bars on the negative side and no.6 two straight bars on the positive side. No. 5 two extra bars on the top and no. 6 one extra bar on the bottom.

Y-axis 3rd F

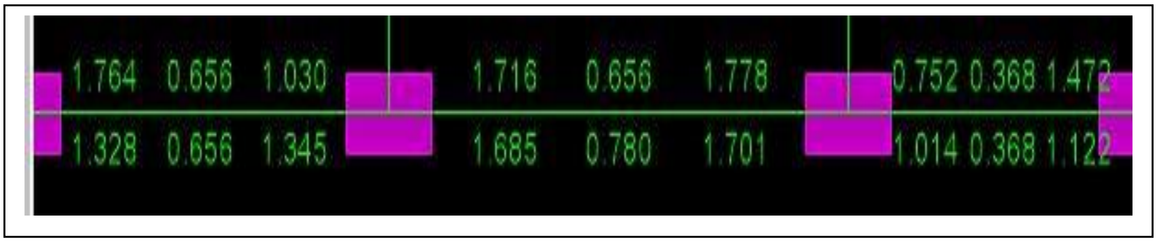


Figure 5.15 Steel Area of 3rd Floor Beam Y-axis

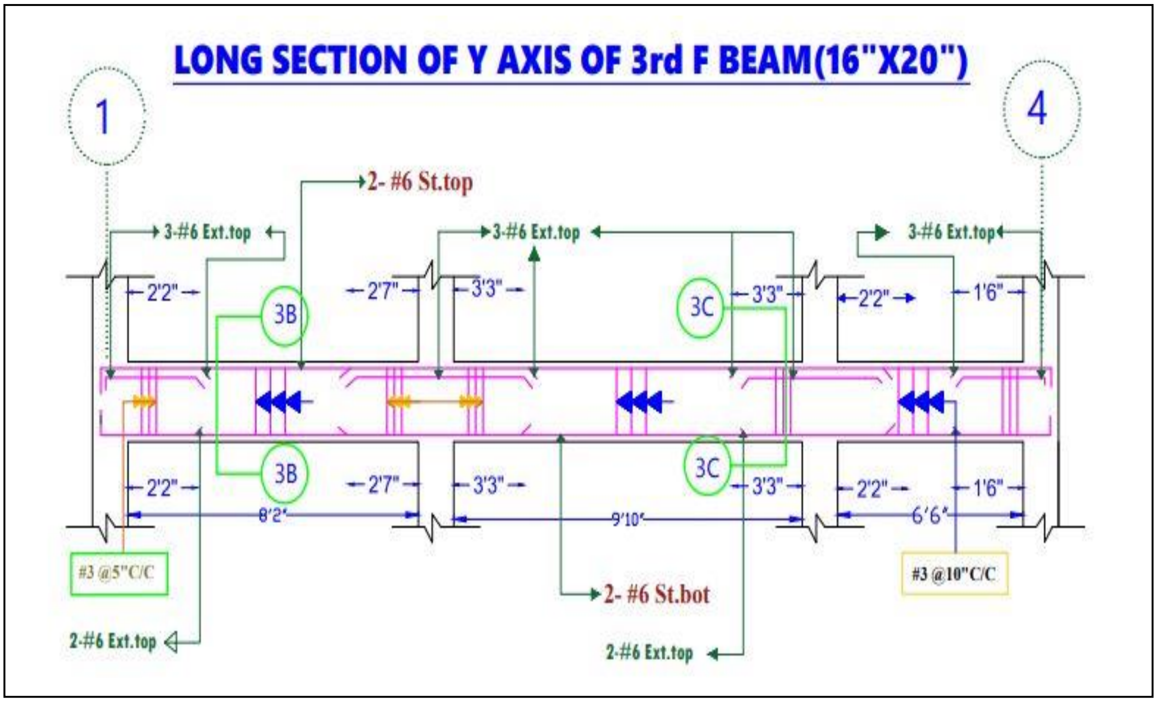
This is the steel area from the 3rd floor beam Y-axis of six storied building. There are various steel area showing on figure 5.15. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.764, 0.656, 1.778. And positive side maximum steel area is left, middle, right serially 1.658, 0.780, 1.701.

Table 5.8 Reinforcement Detailing of 3rd Floor Beam Y-axis

Y-axis 3rd F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.764	6	.44	2	3	Left	1.658	6	.44	2	2
Middle	0.656	6	.44	2	-	Middle	0.780	6	.44	2	-
Right	1.778	6	.44	2	3	Right	1.701	6	.44	2	2

Following the maximum steel area, we found this calculation. On the negative side no. 6 bar two straight bars, and three extra top in the left and right side. And positive side no. 6 bar two straight bars, two extra bottom in the left and right side.

- **3rd FLOOR BEAM (Y-AXIS):**



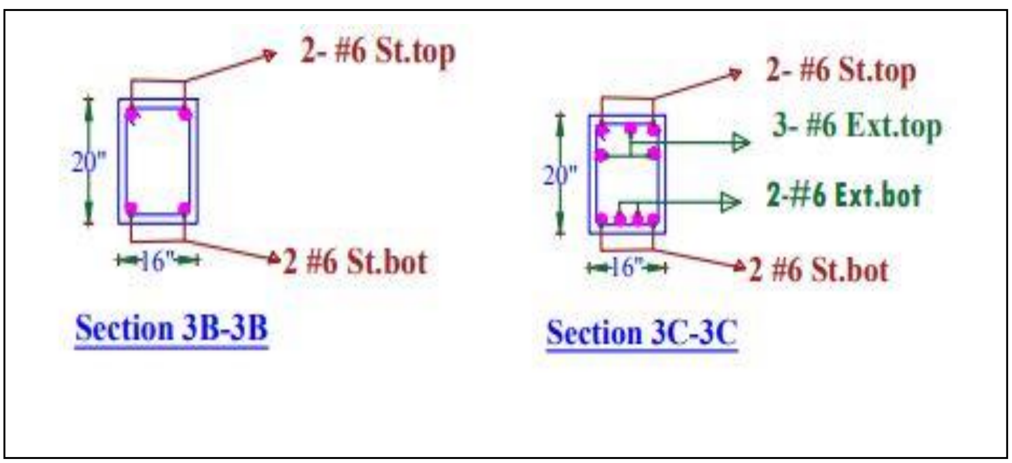


Figure 5.16 Beam Detailing & Cross Section of Y-axis

In these sections 2 straight bars on the negative side and 2 straight bars on the positive side. 3 extra bars on the top, 2 extra bars on the bottom. All are no.6 bar.

X-axis 4th F

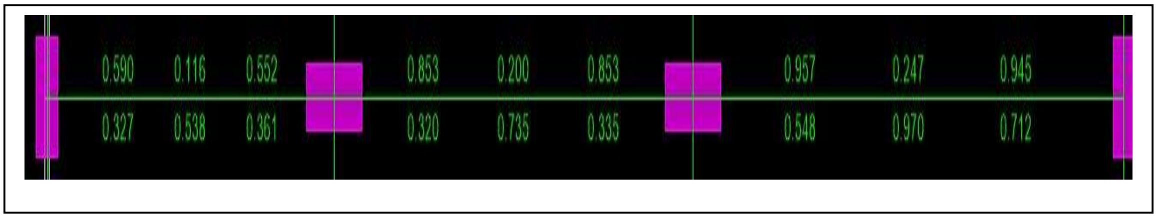


Figure 5.17 Steel Area of 4th Floor Beam X-axis

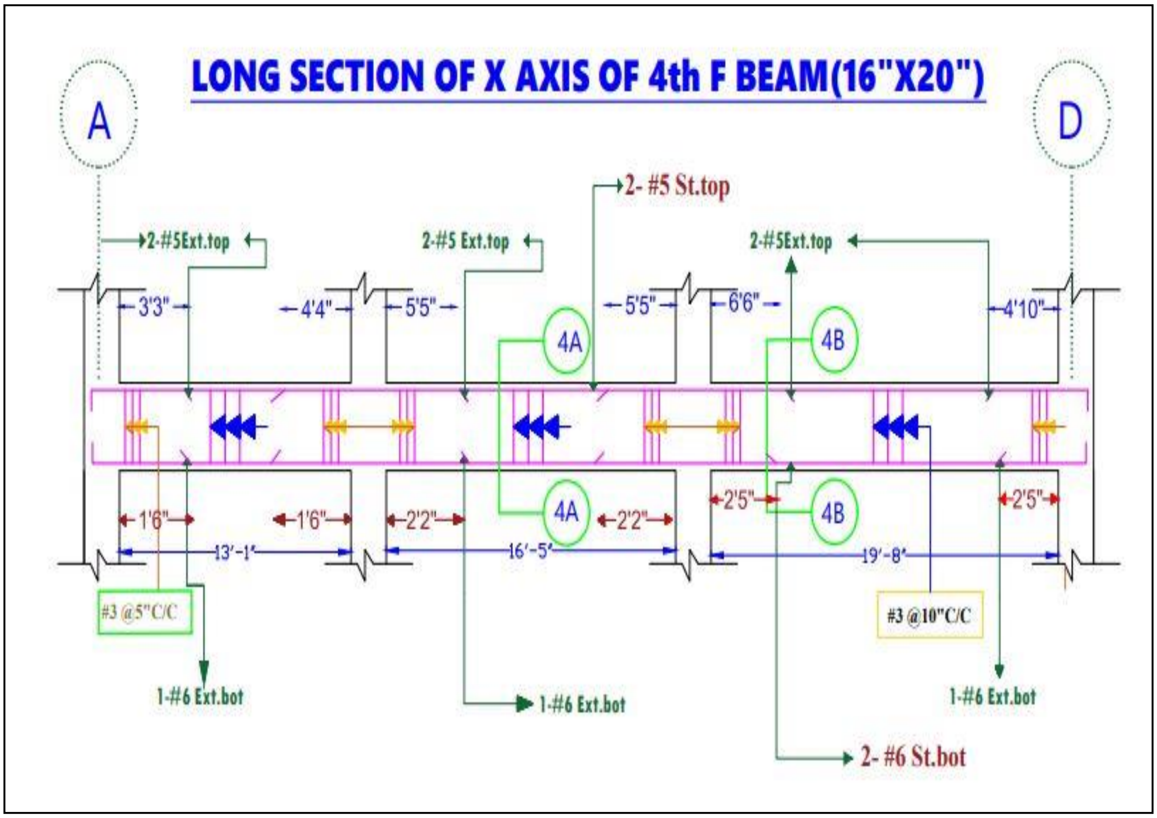
This is the steel area from the 4th floor beam X-axis of six storied building. There are various steel area showing on figure 5.17. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 0.957, 0.247, 0.945. And positive side maximum steel area is left, middle, right serially 0.548, 0.970, 0.712.

Table 5.9 Reinforcement Detailing of 4th Floor Beam X-axis

X-axis 4th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	0.957	5	.31	2	2	Left	0.548	6	.44	2	-
Middle	0.247	5	.31	2	-	Middle	0.970	6	.44	2	1
Right	0.945	5	.31	2	2	Right	0.712	6	.44	2	-

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, two extra top in the left and right side. And positive side no. 6 bar two straight bars, one extra bottom in the middle.

- **4th FLOOR BEAM (X-AXIS):**



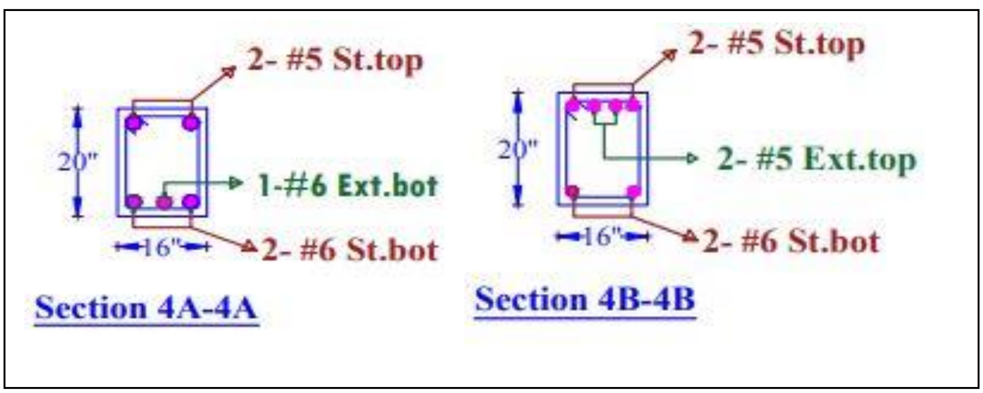


Figure 5.18 **Beam Detailing & Cross Section of X-axis**

In these sections no. 5 two straight bars on the negative side and no.6 two straight bars on the positive side. No. 5 two extra bars on the top and no. 6 one extra bar on the bottom.

Y-axis 4th F

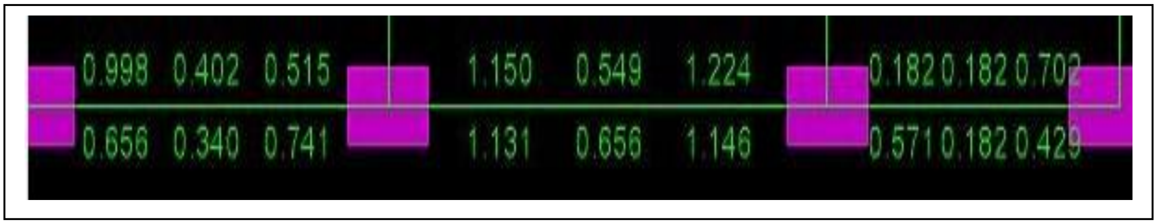


Figure 5.19 Steel Area of 4th Floor Beam Y-axis

This is the steel area from the 4th floor beam Y-axis of six storied building. There are various steel area showing on figure 5.19. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.150, 0.549, 1.224. And positive side maximum steel area is left, middle, right serially 1.131, 0.656, 1.146.

Table 5.10 Reinforcement Detailing of 4th Floor Beam Y-axis

Y-axis 4th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.150	5	.31	2	2	Left	1.131	5	.31	3	1
Middle	0.549	5	.31	2	-	Middle	0.656	5	.31	3	-
Right	1.224	5	.31	2	2	Right	1.146	5	.31	3	1

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, and two extra top in the left and right side. And positive side no. 5 bar three straight bars, one extra bottom in the left and right side.

- **4^{th} FLOOR BEAM (Y-AXIS):**

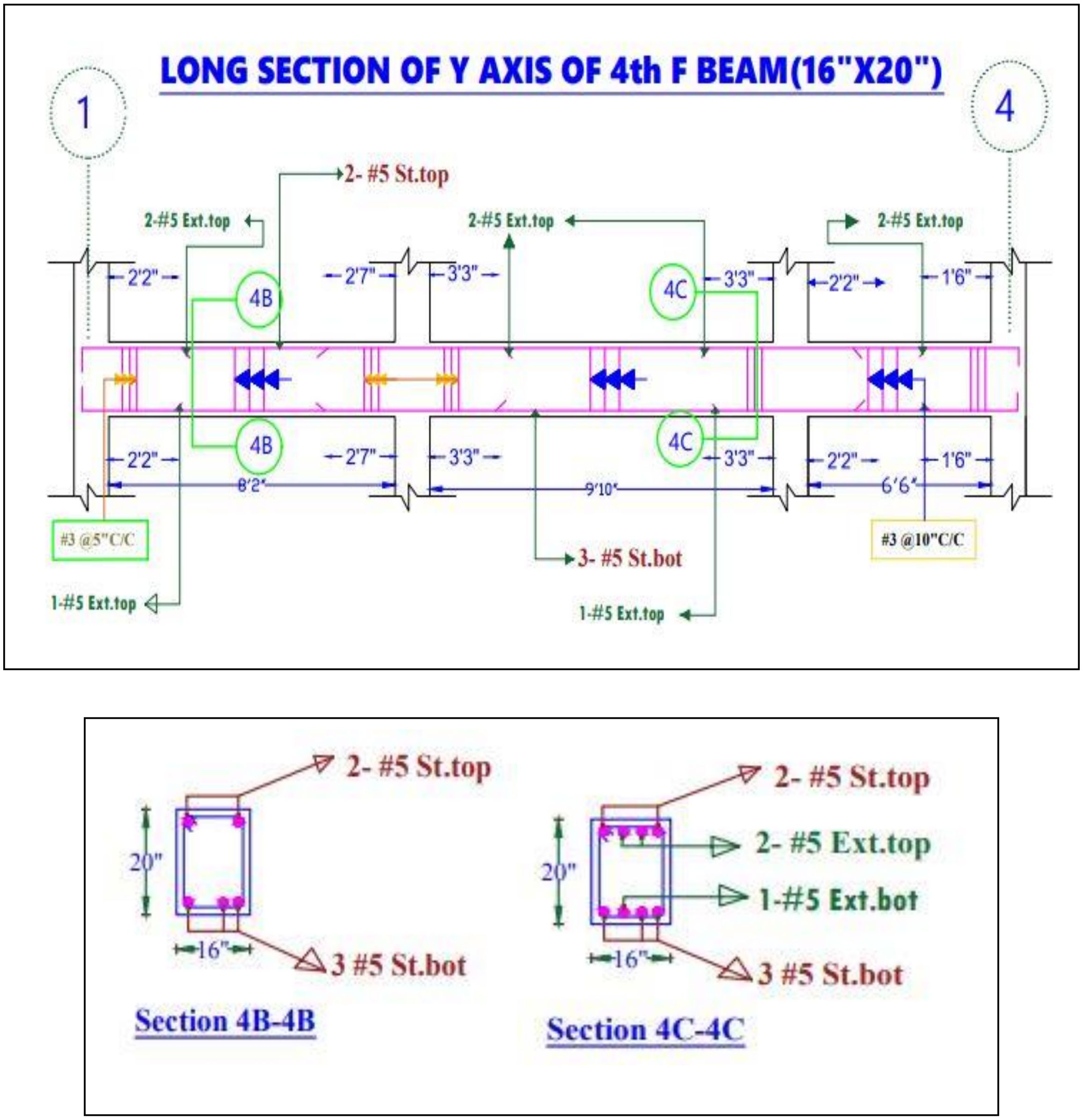


Figure 5.20 **Beam Detailing & Cross Section of Y-axis**

In these sections 2 straight bars on the negative side and 3 straight bars on the positive side. 2 extra bars on the top, 1 extra bar on the bottom. All are no. 5 bar.

X-axis RF

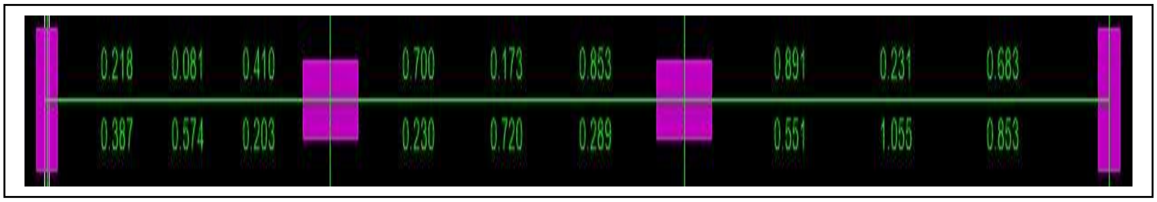


Figure 5.21 Steel Area of Roof Floor Beam X-axis

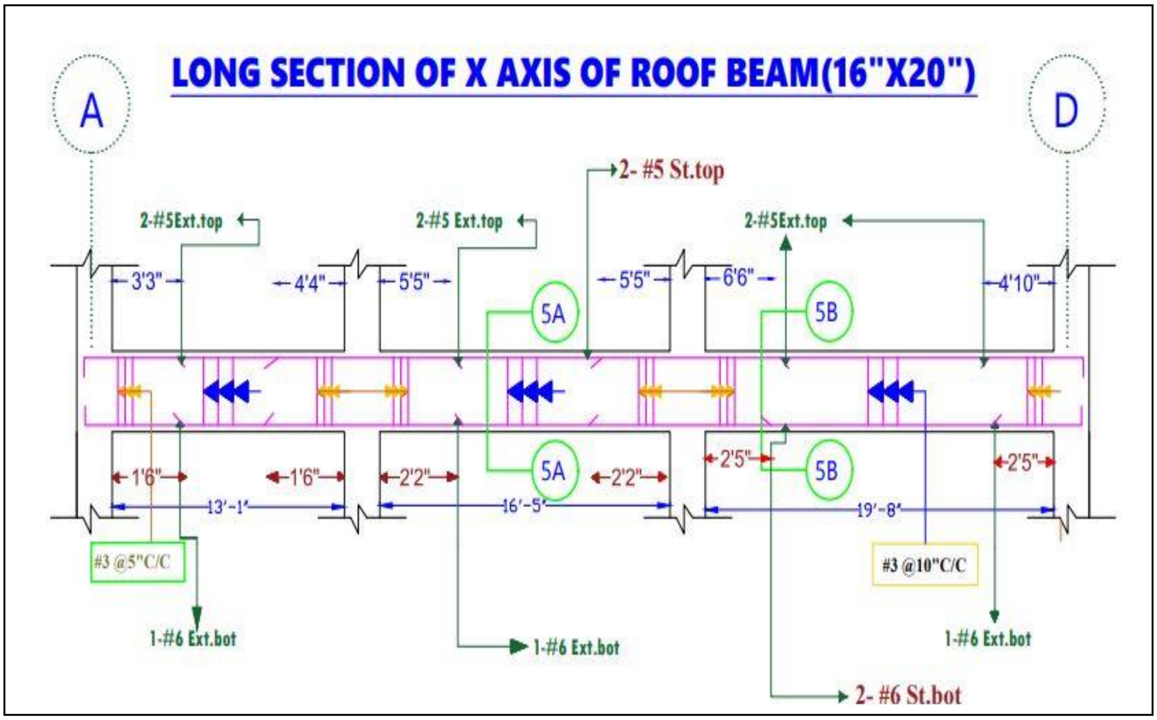
This is the steel area from the roof floor beam X-axis of six storied building. There are various steel area showing on figure 5.21. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 0.891, 0.231, 0.853. And positive side maximum steel area is left, middle, right serially 0.551, 1.055, 0.853.

Table 5.11 Reinforcement Detailing of Roof Floor Beam X-axis

X-axis RF											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	0.891	5	.31	2	1	Left	0.551	6	.44	2	-
Middle	0.231	5	.31	2	-	Middle	1.055	6	.44	2	1
Right	0.853	5	.31	2	1	Right	0.853	6	.44	2	-

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, one extra top in the left and right side. And positive side no. 6 bar two straight bars, one extra bottom in the middle.

- **ROOF FLOOR BEAM (X-AXIS):**



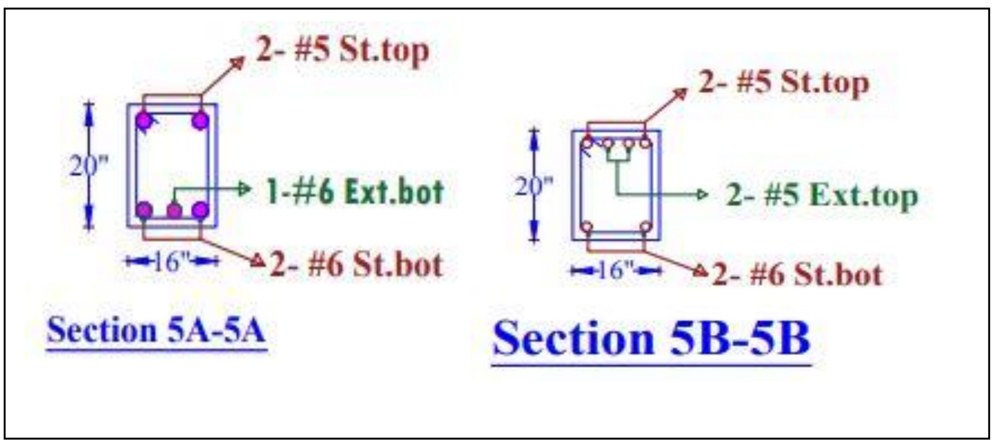


Figure 5.22 Beam Detailing & Cross Section of X-axis

In these sections no. 5 two straight bars on the negative side and no.6 two straight bars on the positive side. No. 5 two extra bars on the top and no. 6 one extra bar on the bottom.

Y-axis RF

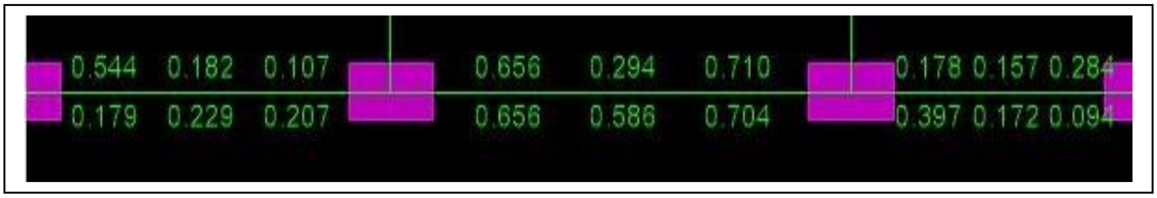


Figure 5.23 Steel Area of Roof Floor Beam Y-axis

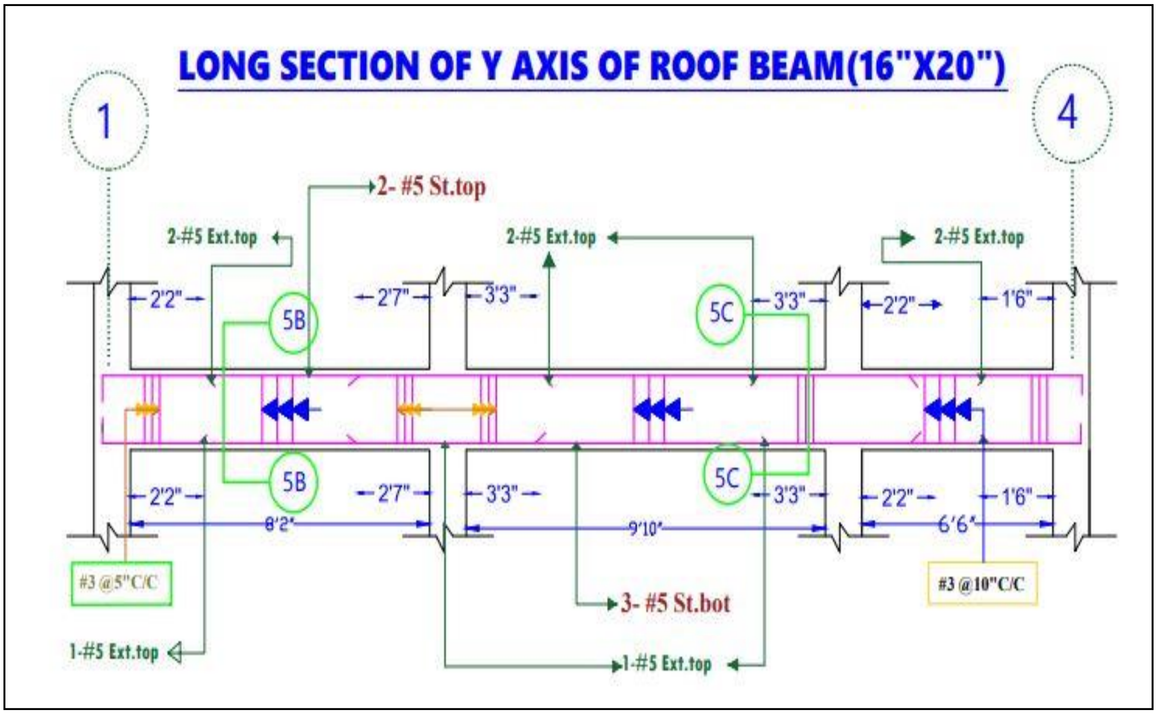
This is the steel area from the roof floor beam Y-axis of six storied building. There are various steel area showing on figure 5.23. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 0.656, 0.294, 0.710. And positive side maximum steel area is left, middle, right serially 0.565, 0.586, 0.704.

Table 5.12 Reinforcement Detailing of Roof Floor Beam Y-axis

Y-axis RF											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	0.656	5	.31	2	1	Left	0.565	5	.31	2	1
Middle	0.294	5	.31	2	-	Middle	0.586	5	.31	2	-
Right	0.710	5	.31	2	1	Right	0.704	5	.31	2	1

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, and one extra top in the left and right side. And positive side no. 5 bar two straight bars, one extra bottom in the left and right side.

- **ROOF FLOOR BEAM (Y-AXIS):**



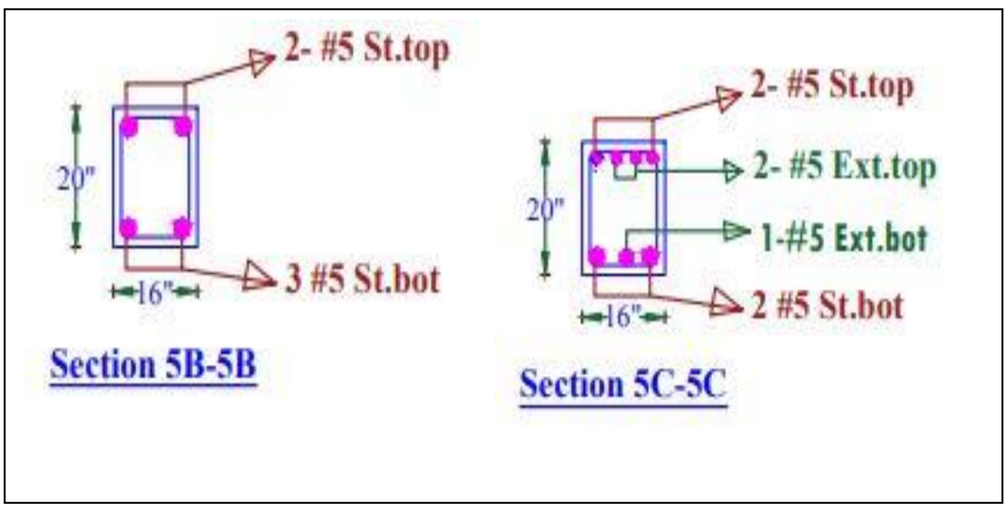


Figure 5.24 Beam Detailing & Cross Section of Y-axis

In these sections 2 straight bars on the negative side and 2 straight bars on the positive side. 2 extra bars on the top, 1 extra bar on the bottom. All are no. 5 bar.

5.0 BEAM DESIGN FOR TEN STORED

X-axis GB

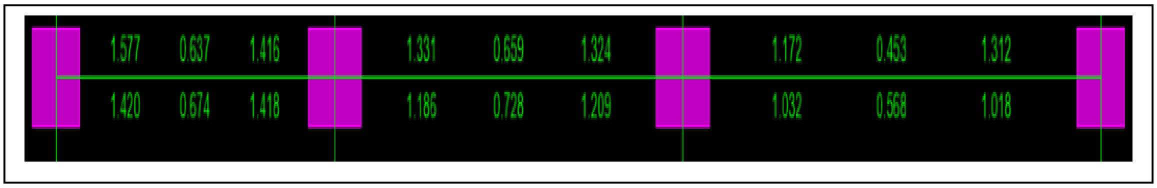


Figure 5.25 Steel Area of Grade Beam X-axis

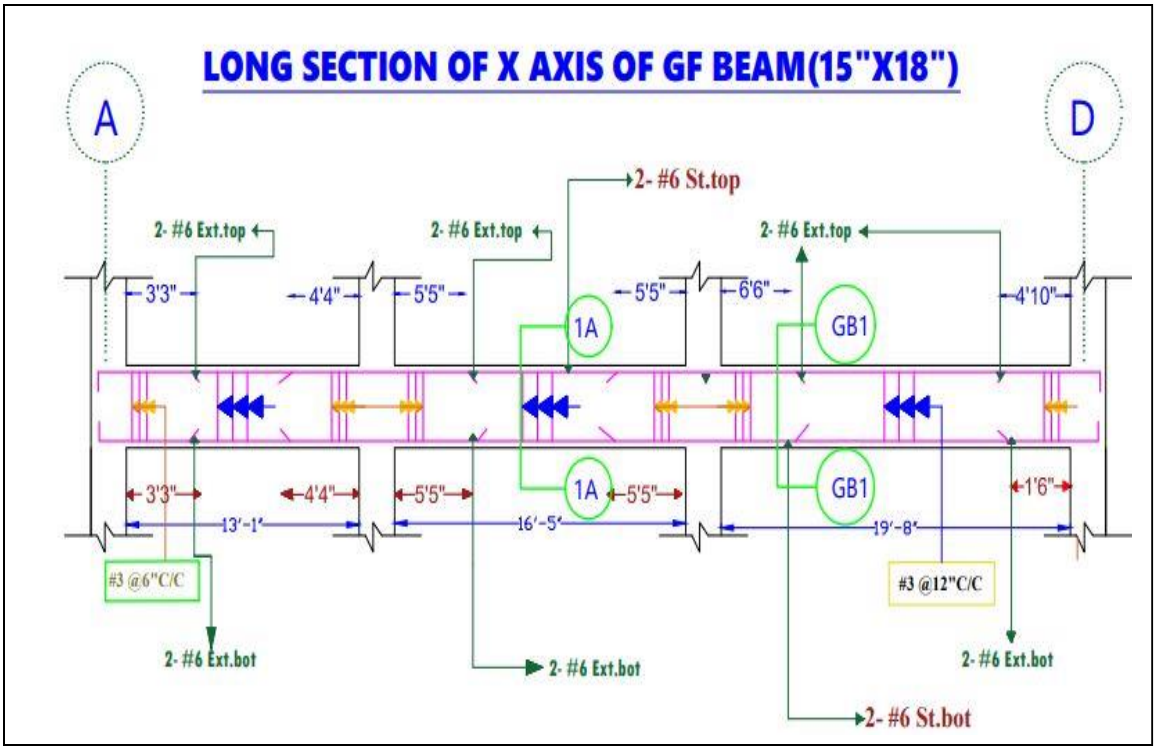
This is the steel area from the grade beam X-axis of ten storied building. Which is the output of ETABS, there are various steel area showing on figure 5.25. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.577, 0.659, 1.416. And positive side maximum steel area is left, middle, right serially 1.420, 0.728, 1.418.

Table 5.13 Reinforcement Detailing of Grade Beam X-axis

X-axis GB											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.577	6	.44	2	2	Left	1.420	6	.44	2	2
Middle	0.659	6	.44	2	-	Middle	0.728	6	.44	2	-
Right	1.416	6	.44	2	2	Right	1.418	6	.44	2	2

Following the maximum steel area, we found this calculation. On the negative side no. 6 bar two straight bars, two extra top in the left and right side. And positive side no. 6 bar two straight bars, two extra bottom in the left and right side.

- **GROUND FLOOR BEAM (X-AXIS):**



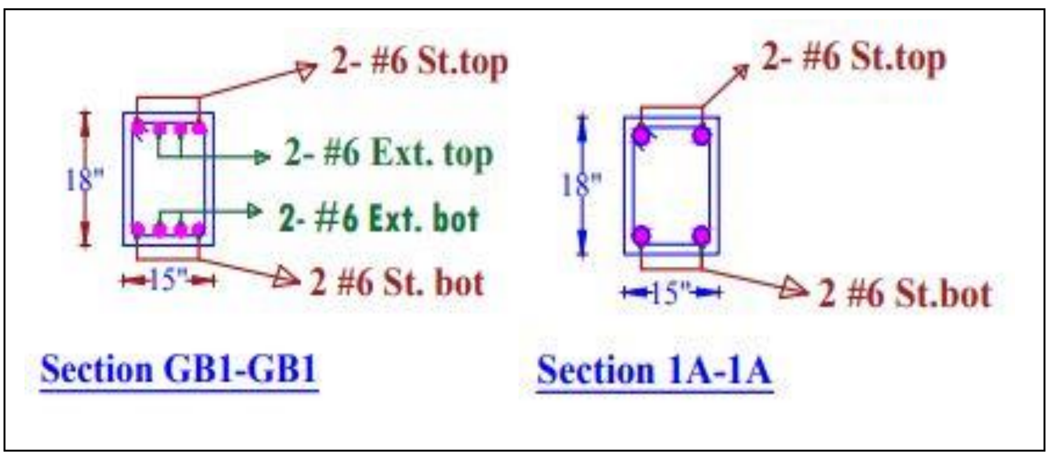


Figure 5.26 **Beam Detailing & Cross Section of X-axis**

In these sections 2 straight bars on the negative side and 2 straight bars on the positive side. 2 Extra bars on the top and 1 extra bar on the bottom. All are no. 6 bar.

Y-axis GB

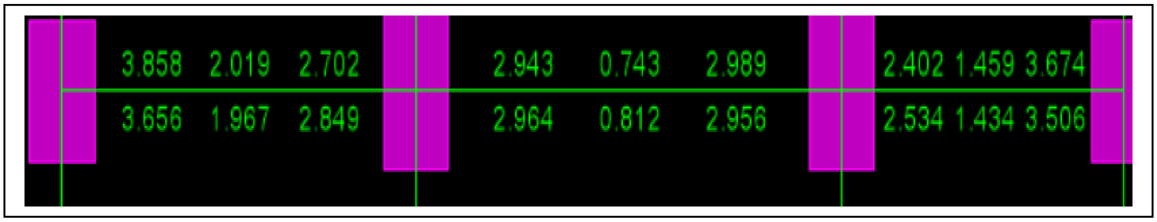


Figure 5.27 Steel Area of Grade Beam Y-axis

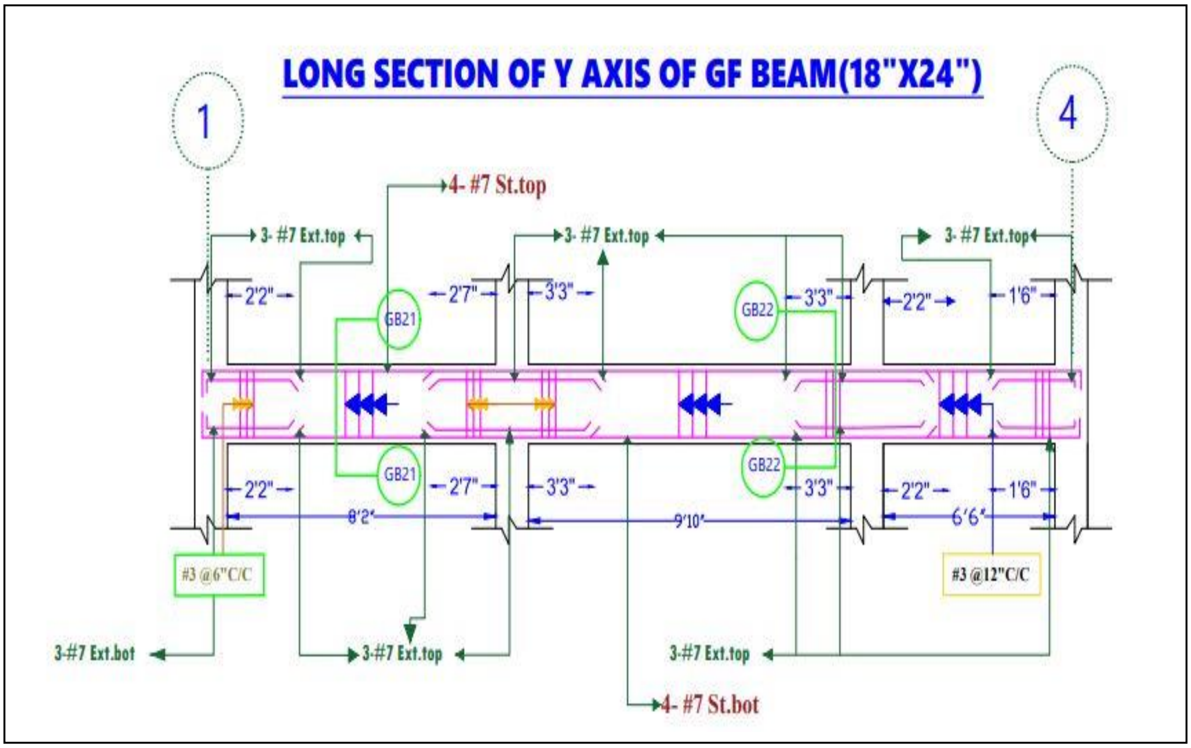
This is the steel area from the grade beam Y-axis of ten storied building. There are various steel area showing on figure 5.27. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 3.858, 2.019, 3.374. And positive side maximum steel area is left, middle, right serially 3.656, 1.967, 3.506.

Table 5.14 Reinforcement Detailing of Grade Beam Y-axis

Y-axis GB											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	3.858	7	.60	4	3	Left	3.656	7	.60	4	3
Middle	2.019	7	.60	4	-	Middle	1.967	7	.60	4	-
Right	3.374	7	.60	4	3	Right	3.506	7	.60	4	2

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar four straight bars, three extra top in the left and right side. And positive side no. 7 bar four straight bars, three extra bottom in the left and two extra in the right side.

- **GROUND FLOOR BEAM (Y-AXIS):**



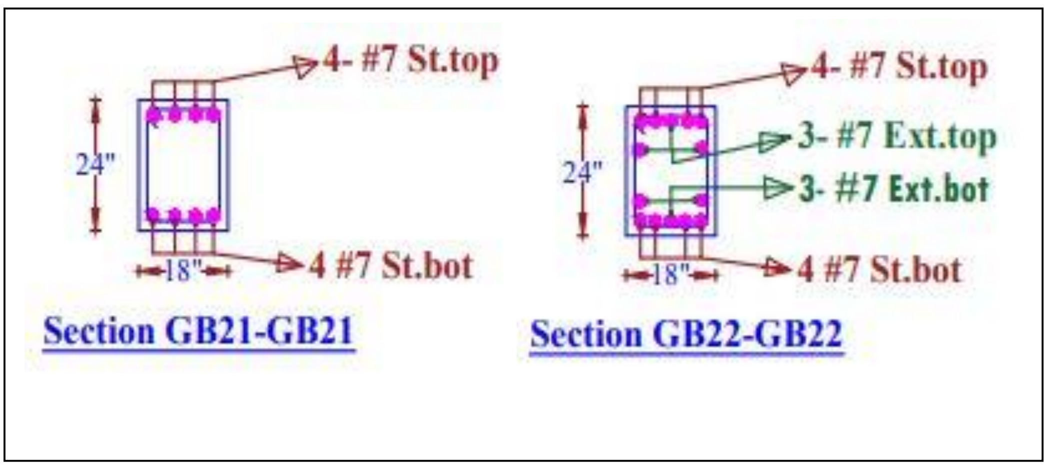


Figure 5.28 Beam Detailing & Cross Section of Y-axis

In these sections 4 straight bars on the negative side and 4 straight bar on the positive side. 3 Extra bars on the top and 3 extra bars on the bottom. All are no.7 bar.

X-axis 1st F

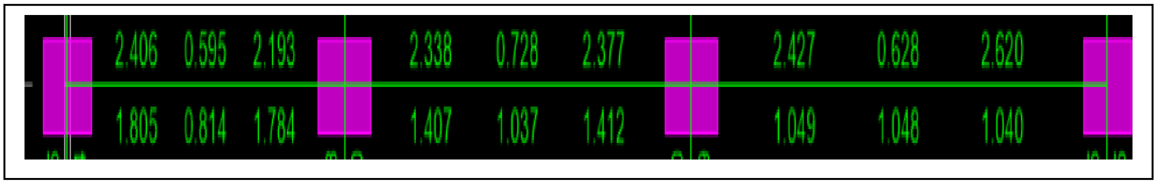


Figure 5.29 Steel Area of 1st Floor Beam X-axis

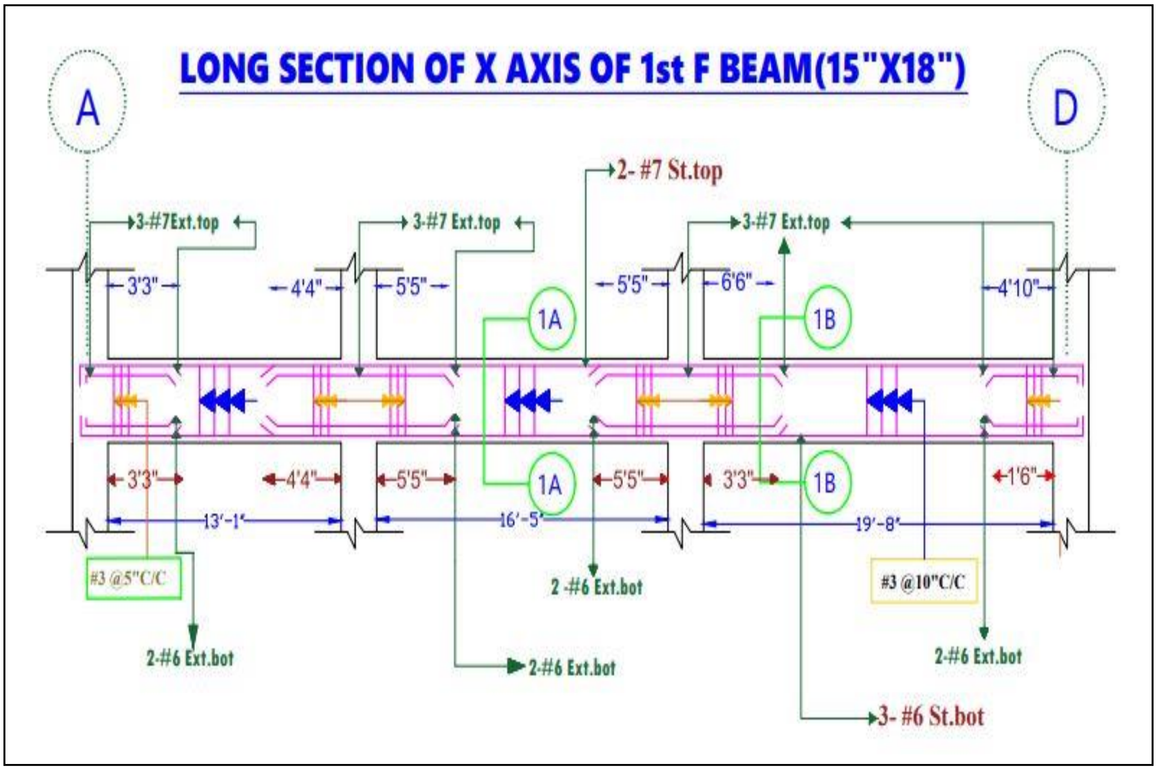
This is the steel area from the 1st beam X-axis of ten storied building. There are various steel area showing on figure 5.29. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 2.427, 0.728, 2.620. And positive side maximum steel area is left, middle, right serially 1.805, 1.048, 1.784.

Table 5.15 Reinforcement Detailing of 1st Floor X-axis

X-axis 1st F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	2.427	7	.60	2	3	Left	1.805	6	.44	3	2
Middle	0.728	7	.60	2	-	Middle	1.048	6	.44	3	-
Right	2.620	7	.60	2	3	Right	1.784	6	.44	3	2

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar two straight bars, three extra top in the left and right side. And positive side no. 6 bar three straight bars, two extra bottom in the left and right side.

- **1st FLOOR BEAM (X-AXIS):**



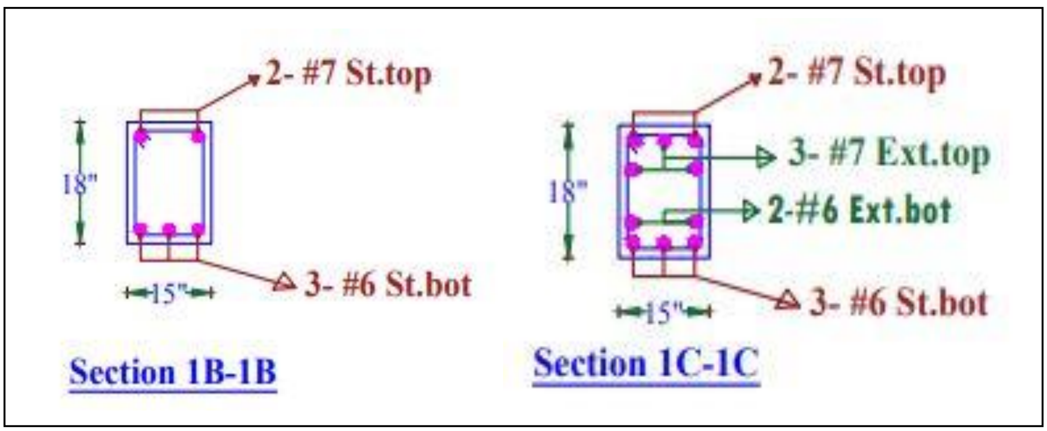


Figure 5.30 Beam Detailing & Cross Section of X-axis

In these sections no. 7 bar two straight bars on the negative side and no. 6 three straight bars on the positive side. No. 7 bar three extra bars on the top and no. 6 bar two extra bars on the bottom.

Y-axis 1st F

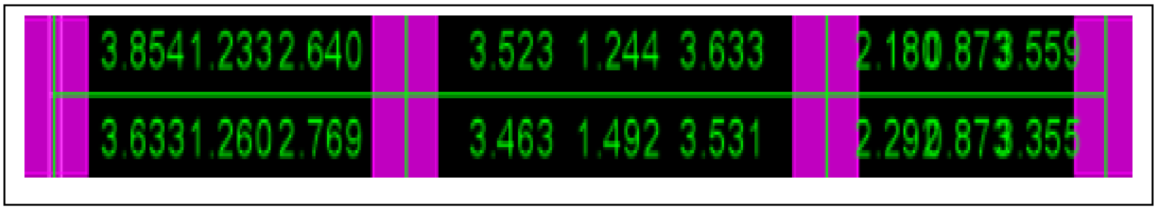


Figure 5.31 **Steel Area of 1st Floor Beam Y-axis**

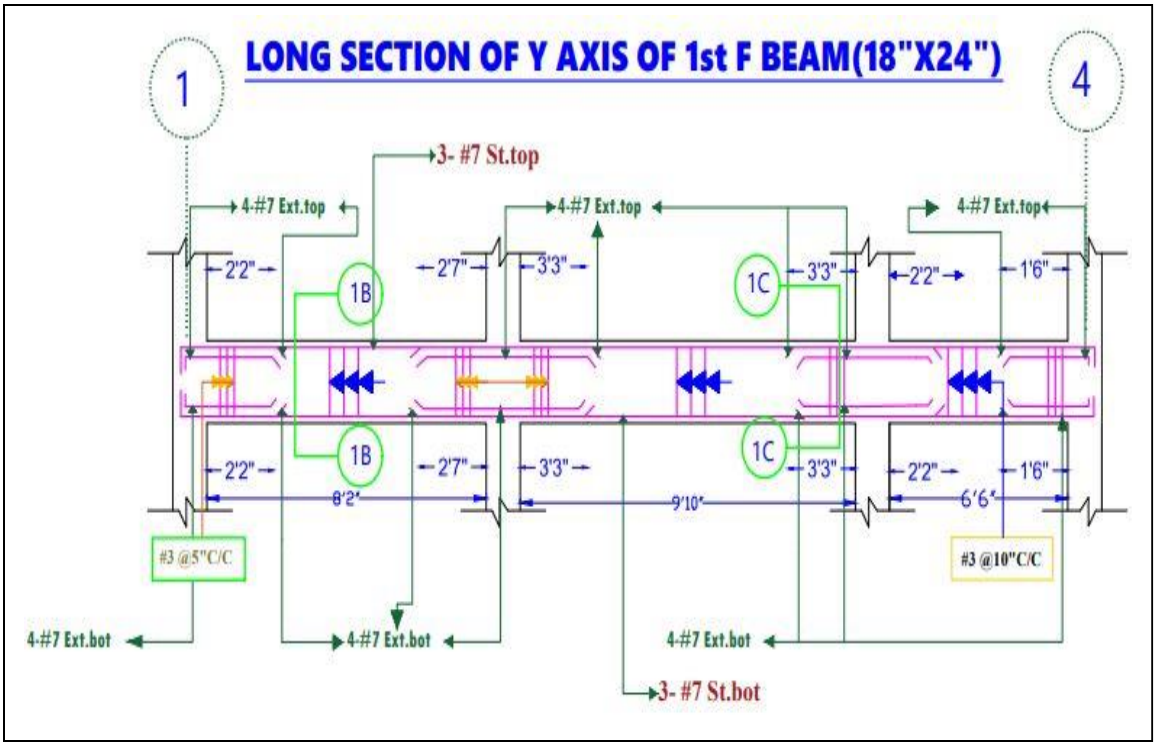
This is the steel area from the 1st beam Y-axis of ten storied building. There are various steel area showing on figure 5.31. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 3.854, 1.244, 3.633. And positive side maximum steel area is left, middle, right serially 3.633, 1.492, 3.531.

Table 5.16 **Reinforcement Detailing of 1st Floor Beam Y-axis**

Y-axis 1st F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	3.854	7	.60	3	4	Left	3.633	7	.60	3	4
Middle	1.244	7	.60	3	-	Middle	1.492	7	.60	3	-
Right	3.633	7	.60	3	3	Right	3.531	7	.60	3	3

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar three straight bars, four extra top in the left and right side. And positive side no. 7 bar three straight bars, four extra bottom in the left and three extra in the right side.

- **1st FLOOR BEAM (Y-AXIS):**



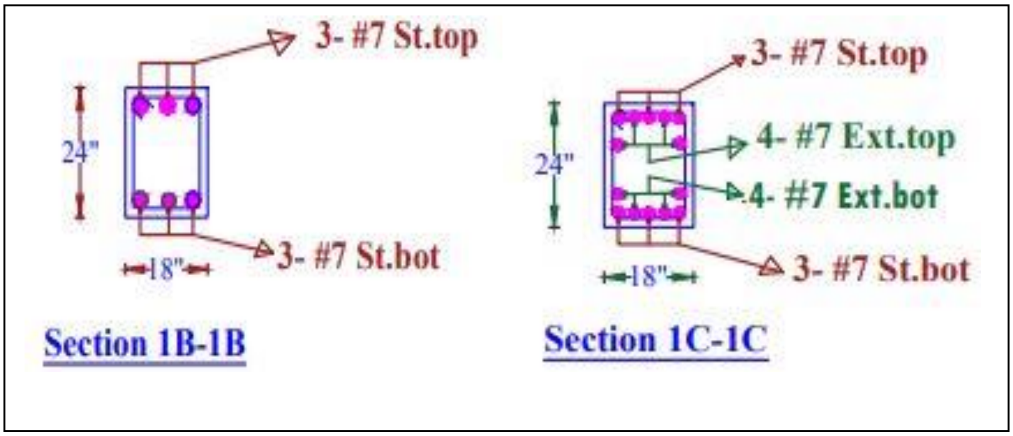


Figure 5.32 Beam Detailing & Cross Section of Y-axis

In these sections 3 straight bars on the negative side and 3 straight bars on the positive side. 4 Extra bars on the top and 4 extra bars on the bottom. All are no.7 bar.

X-axis 2nd F

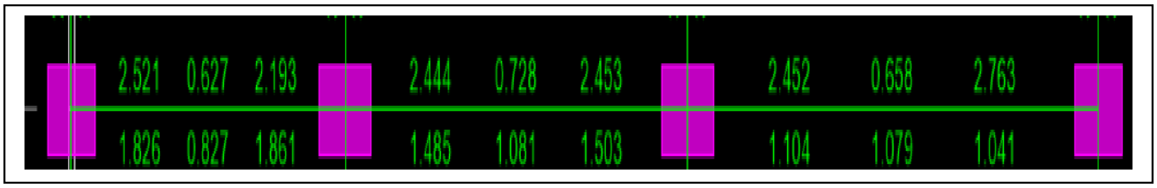


Figure 5.33 Steel Area of 2nd Floor Beam X-axis

This is the steel area from the 2nd beam X-axis of ten storied building. There are various steel area showing on figure 5.33. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 2.521, 0.728, 2.763. And positive side maximum steel area is left, middle, right serially 1.826, 1.081, 1.861.

Table 5.17 Reinforcement Detailing of 2nd Floor Beam X-axis

X-axis 2nd F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	2.521	7	.60	2	3	Left	1.826	6	.44	3	2
Middle	0.728	7	.60	2	-	Middle	1.081	6	.44	3	-
Right	2.763	7	.60	2	3	Right	1.861	6	.44	3	2

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar two straight bars, three extra top in the left and right side. And positive side no. 6 bar three straight bars, two extra bottom in the left and right side.

- **2nd FLOOR BEAM (X-AXIS):**

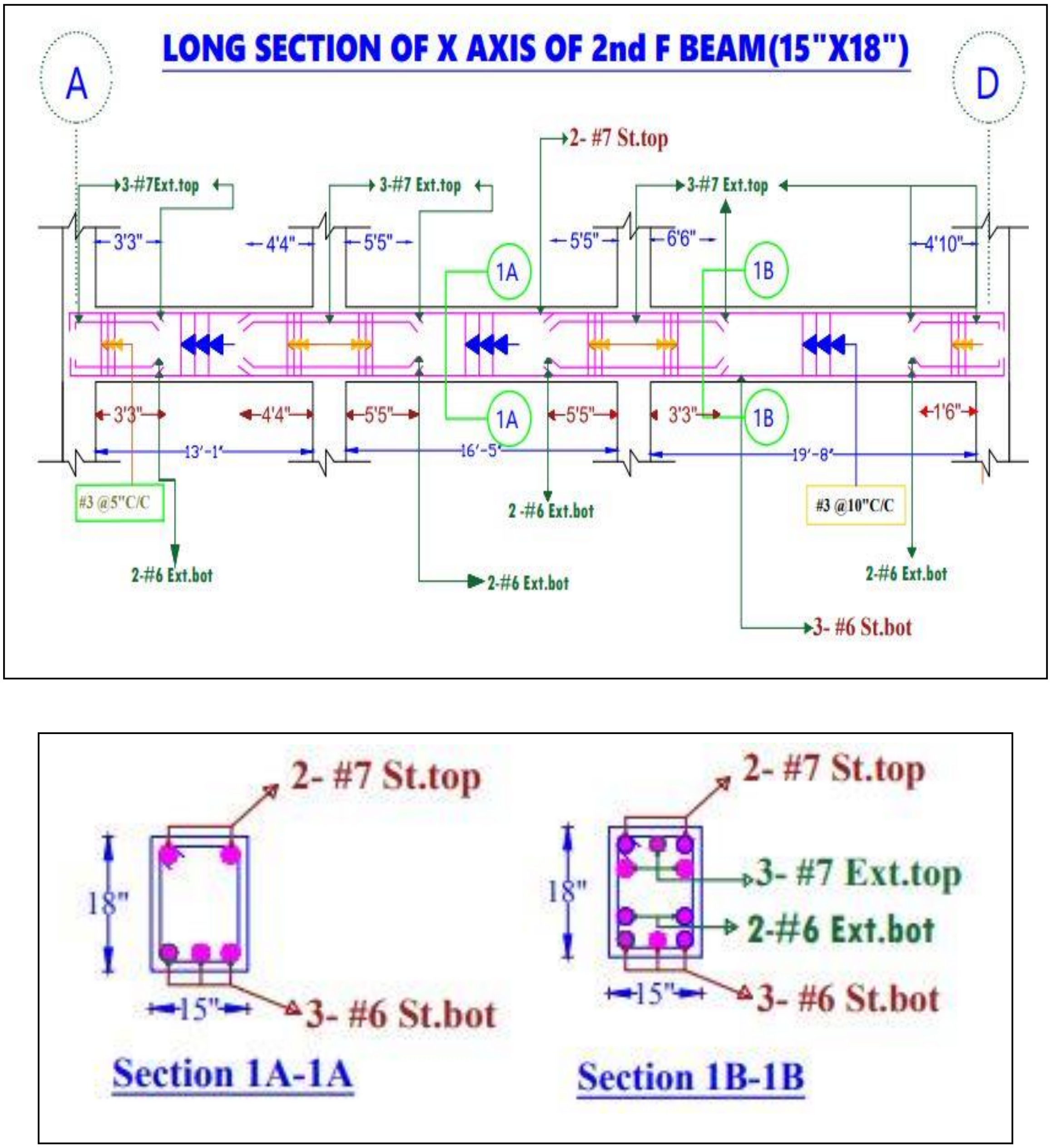


Figure 5.34 Beam Detailing & Cross Section of X-axis

In these sections no. 7 bar two straight bars on the negative side and no. 6 three straight bars on the positive side. No. 7 bar three extra bars on the top and no. 6 bar two extra bars on the bottom.

Y-axis 2nd F

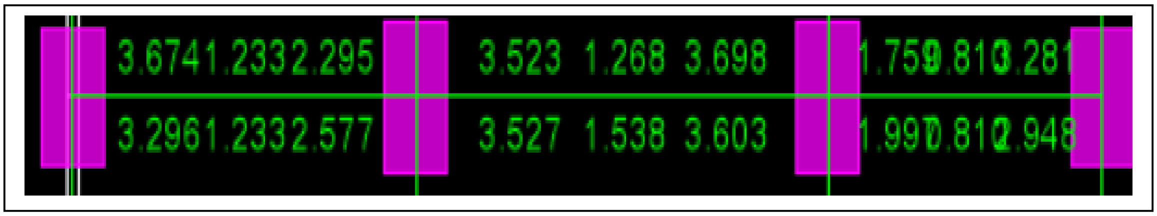


Figure 5.35 Steel Area of 2nd Floor Beam Y-axis

This is the steel area from the 2nd beam Y-axis of ten storied building. There are various steel area showing on figure 5.35. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 3.674, 1.268, 3.698. And positive side maximum steel area is left, middle, right serially 3.527, 1.538, 3.603.

Table 5.18 Reinforcement Detailing of 2nd Floor Beam Y-axis

Y-axis 2nd F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	3.674	7	.60	3	4	Left	3.527	7	.60	3	3
Middle	1.268	7	.60	3	-	Middle	1.538	7	.60	3	-
Right	3.698	7	.60	3	4	Right	3.603	7	.60	3	3

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar three straight bars, four extra top in the left and right side. And positive side no. 7 bar three straight bars, three extra bottom in the left and three extra in the right side.

- **2^{nd} FLOOR BEAM (Y-AXIS):**

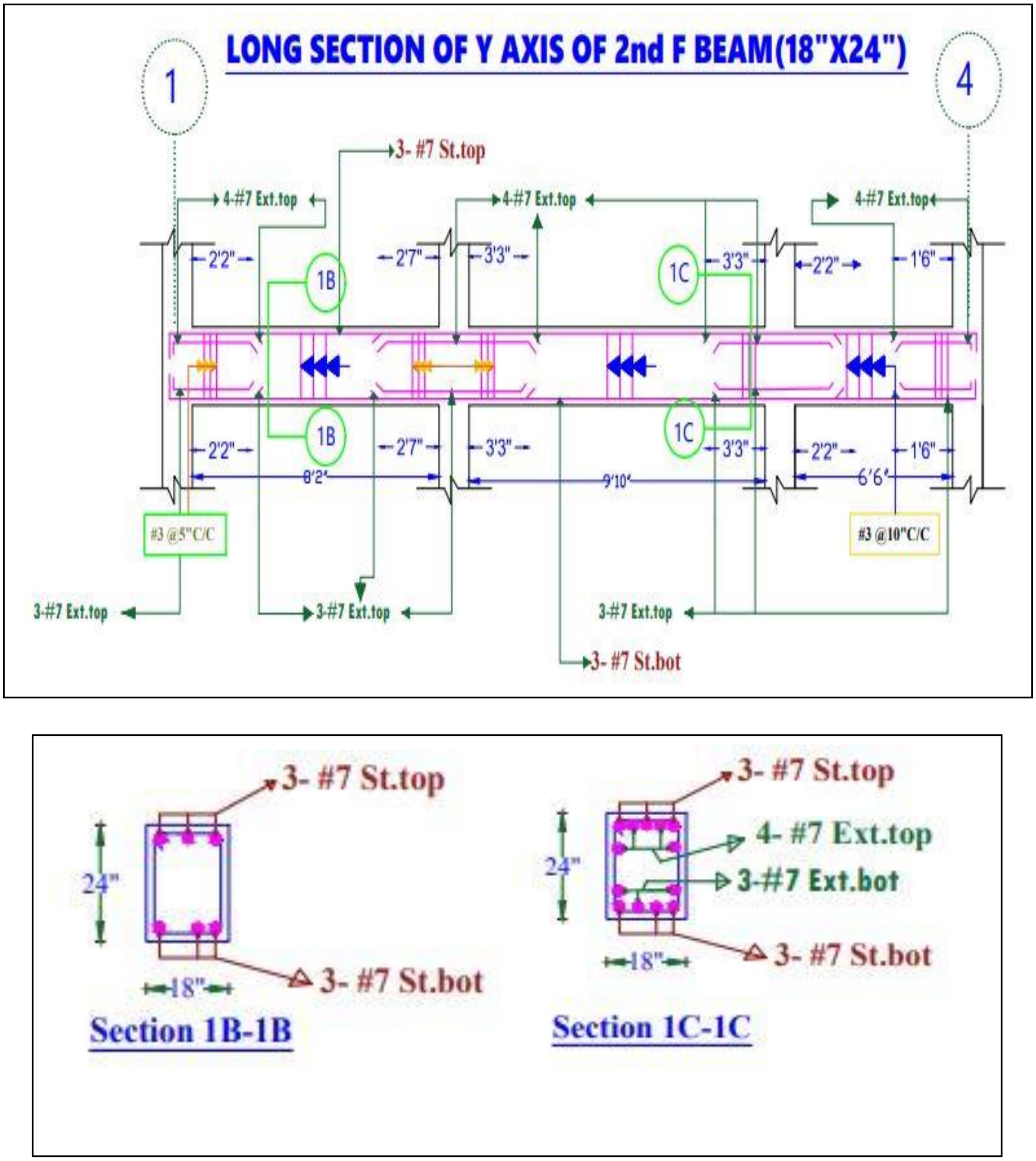


Figure 5.36 **Beam Detailing & Cross Section of Y-axis**

In these sections 3 straight bars on the negative side and 3 straight bars on the positive side. 4 Extra bars on the top and 3 extra bars on the bottom. All are no.7 bar.

X-axis 3rd F

Figure 5.37 Steel Area of 3rd Floor Beam X-axis

This is the steel area from the 3rd beam X-axis of ten storied building. There are various steel area showing on figure 5.37. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.504, 0.462, 1.662. And positive side maximum steel area is left, middle, right serially 1.031, 0.637, 1.077.

Table 5.19 Reinforcement Detailing of 3rd Floor Beam X-axis

X-axis 3rd F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.504	5	.31	2	3	Left	1.031	5	.31	3	1
Middle	0.462	5	.31	2	-	Middle	0.637	5	.31	3	-
Right	1.662	5	.31	2	4	Right	1.077	5	.31	3	1

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, three extra top in the left and four in the right side. And positive side no. 5 bar three straight bars, one extra bottom in the left and right side.

- **3rd FLOOR BEAM (X-AXIS):**

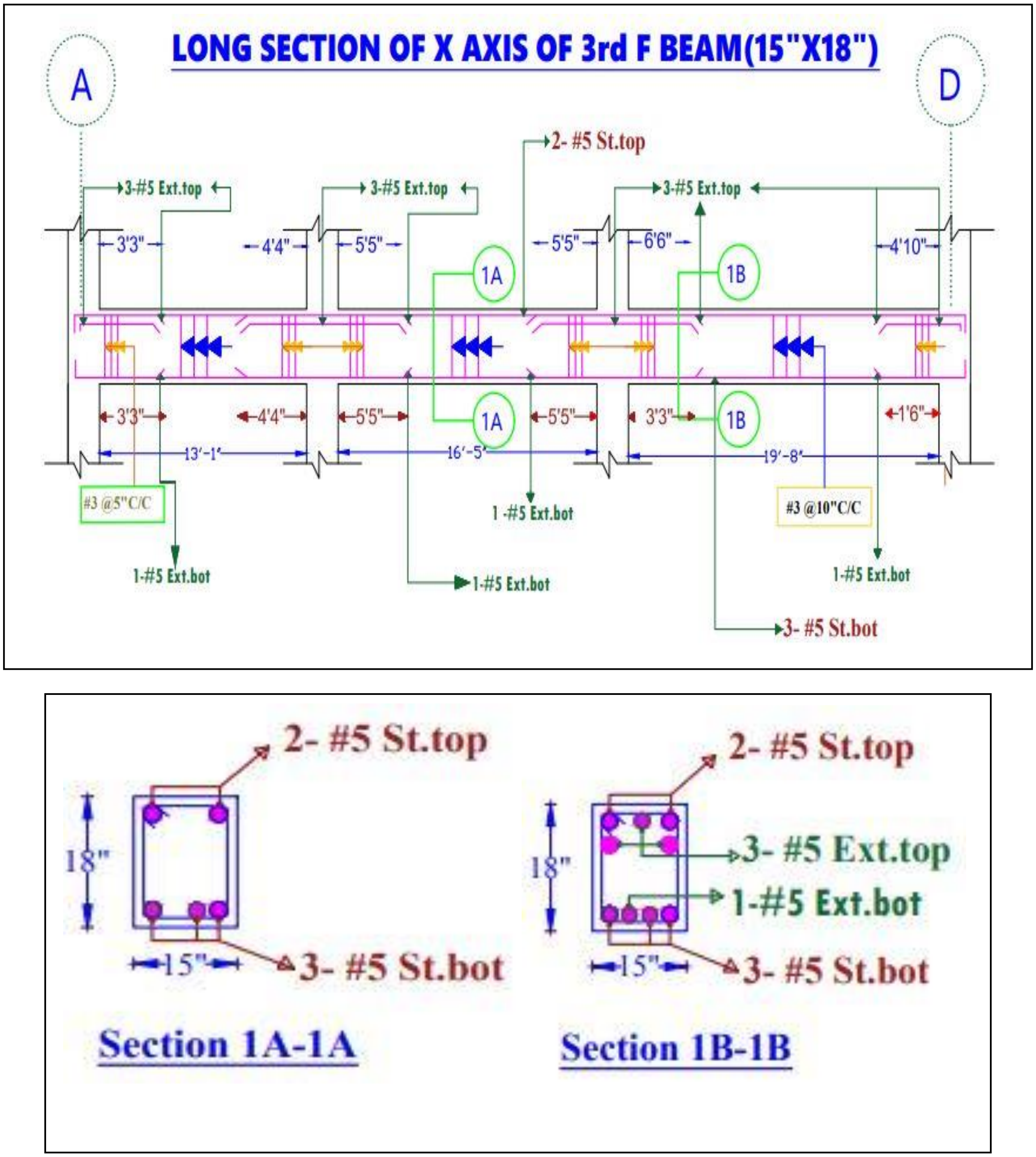


Figure 5.38 **Beam Detailing & Cross Section of X-axis**

In these sections 2 straight bars on the negative side and 3 straight bars on the positive side. 3 extra bars on the top and 2 extra bars on the bottom. All are no. 5 bar.

Y-axis 3rd F

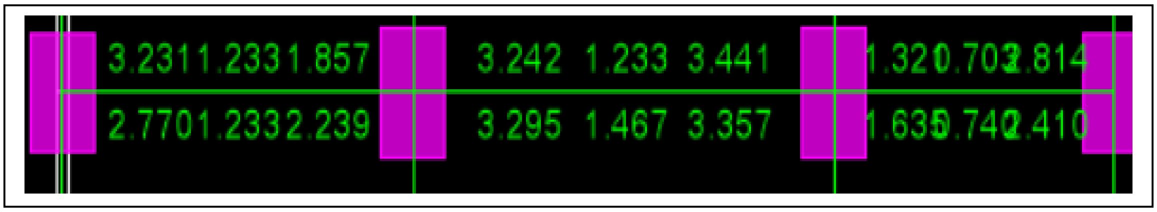


Figure 5.39 Steel Area of 3rd Floor Beam Y-axis

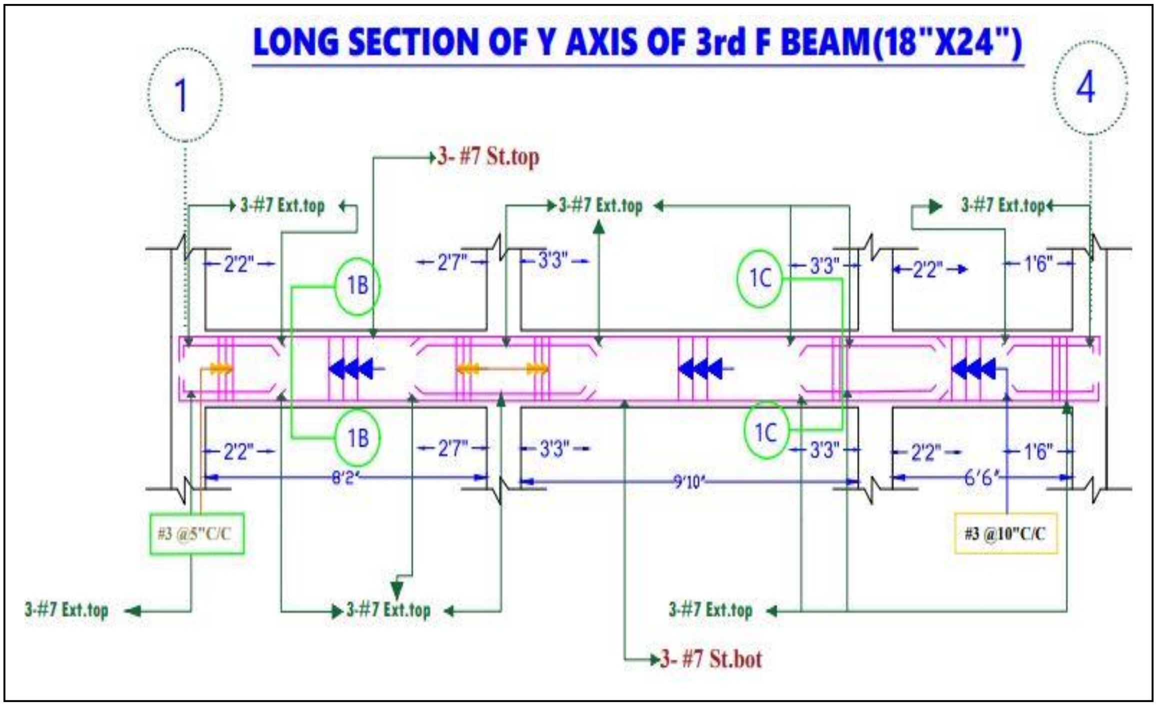
This is the steel area from the 3rd beam Y-axis of ten storied building. There are various steel area showing on figure 5.39. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 3.242, 1.233, 3.441. And positive side maximum steel area is left, middle, right serially 3.295, 1.467, 3.357.

Table 5.20 Reinforcement Detailing of 3rd Floor Beam Y-axis

Y-axis 3rd F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	3.242	7	.60	3	3	Left	3.295	7	.60	3	3
Middle	1.233	7	.60	3	-	Middle	1.467	7	.60	3	-
Right	3.441	7	.60	3	3	Right	3.357	7	.60	3	3

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar three straight bars, three extra top in the left and right side. And positive side no. 7 bar three straight bars, three extra bottom in the left and three extra in the right side.

- **3rd FLOOR BEAM (Y-AXIS):**



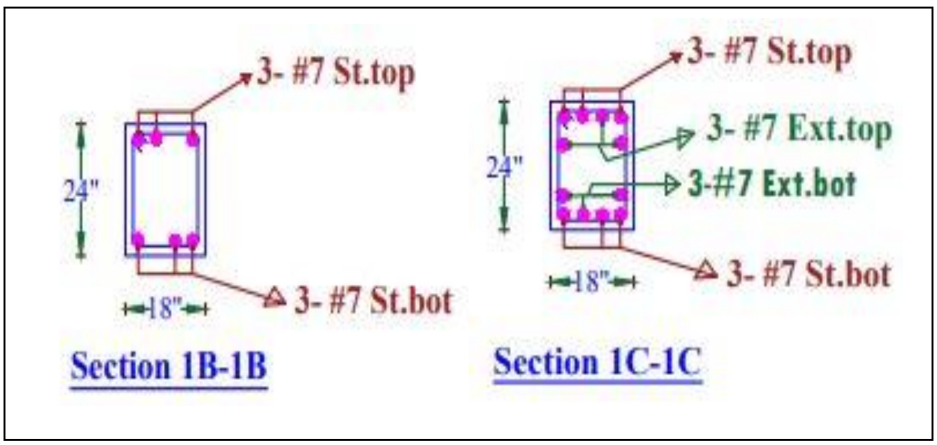


Figure 5.40 Beam Detailing & Cross Section of Y-axis

In these sections 3 straight bars on the negative side and 3 straight bars on the positive side. 3 Extra bars on the top and 3 extra bars on the bottom. All are no.7 bar.

X-axis 4th F

Figure 5.41 Steel Area of 4th Floor Beam X-axis

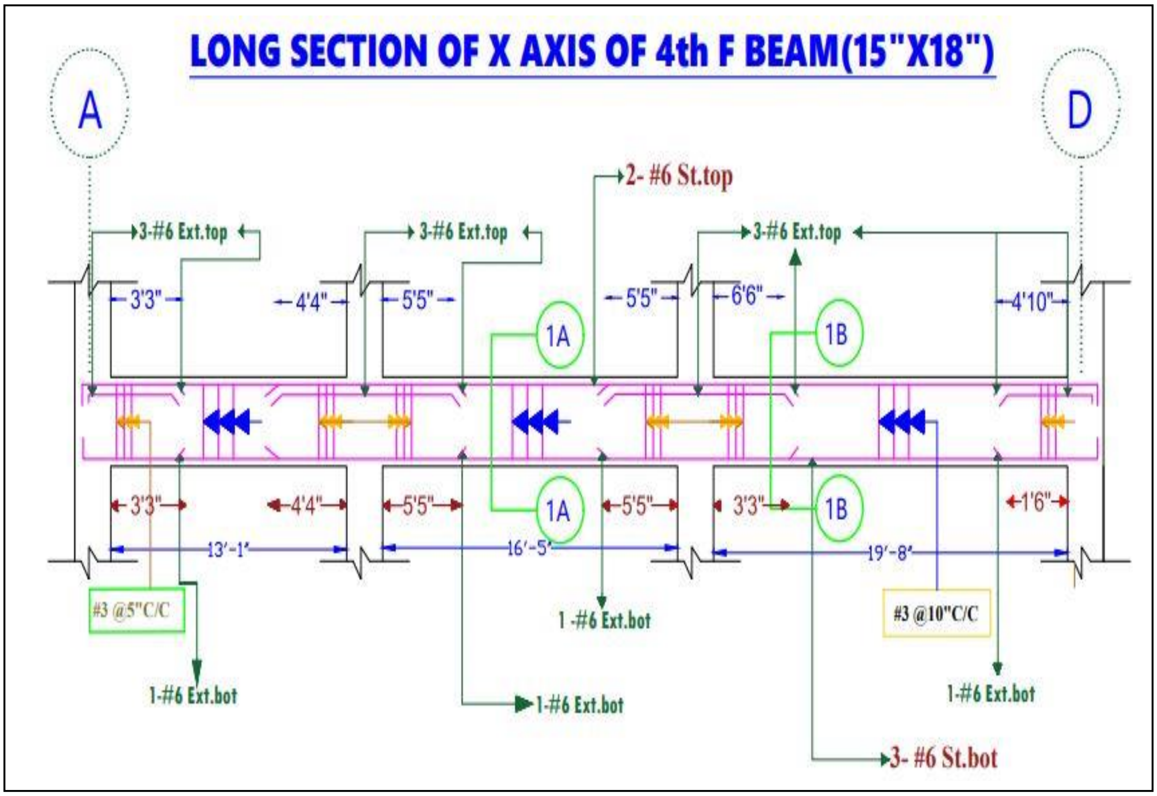
This is the steel area from the 4th beam X-axis of ten storied building. There are various steel area showing on figure 5.41. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 2.067, 0.706, 2.448. And positive side maximum steel area is left, middle, right serially 1.291, 0.986, 1.405.

Table 5.21 Reinforcement Detailing of 4th Floor Beam X-axis

X-axis 4th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	2.067	6	.44	2	3	Left	1.291	6	.44	3	1
Middle	0.706	6	.44	2	-	Middle	0.986	6	.44	3	-
Right	2.448	6	.44	2	4	Right	1.405	6	.44	3	1

Following the maximum steel area, we found this calculation. On the negative side no. 6 bar two straight bars, three extra top in the left and four in the right side. And positive side no. 6 bar three straight bars, one extra bottom in the left and right side.

- **4th FLOOR BEAM (X-AXIS):**



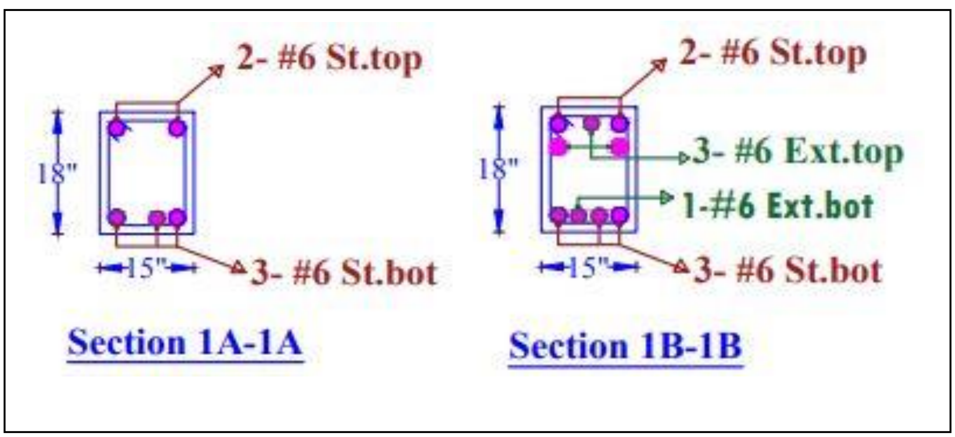


Figure 5.42 Beam Detailing & Cross Section of X-axis

In this section 2 straight bars on the negative side and 3 straight bars on the positive side. 3 extra bars on the top and 1 extra bar on the bottom. All are no. 6 bar.

Y-axis 4th F

Figure 5.43 Steel Area of 4th Floor Beam Y-axis

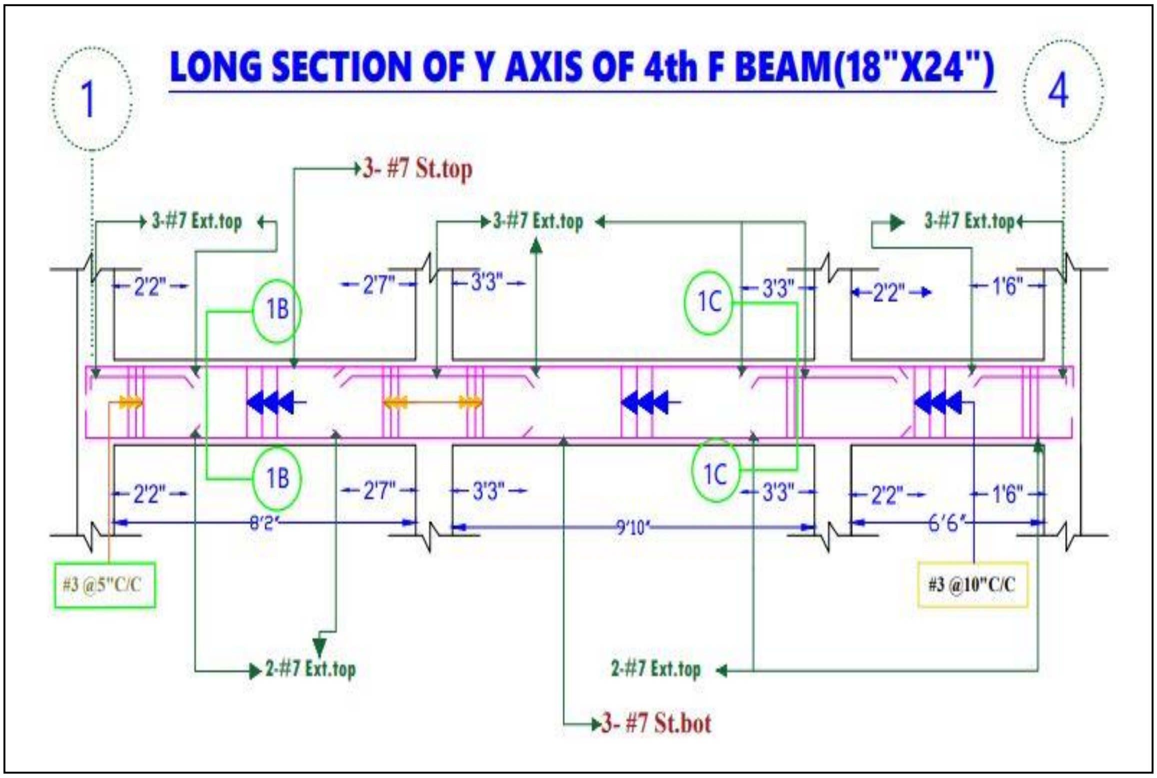
This is the steel area from the 4th beam Y-axis of ten storied building. There are various steel area showing on figure 5.43. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 2.839, 1.233, 3.044. And positive side maximum steel area is left, middle, right serially 2.927, 1.338, 2.966.

Table 5.22 Reinforcement Detailing of 4th Floor Beam Y-axis

Y-axis 4th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	2.839	7	.60	3	2	Left	2.927	7	.60	3	2
Middle	1.233	7	.60	3	-	Middle	1.338	7	.60	3	-
Right	3.044	7	.60	3	3	Right	2.966	7	.60	3	2

Following the maximum steel area, we found this calculation. On the negative side no. 7 bar three straight bars, two extra top in the left and three in the right side. And positive side no. 7 bar three straight bars, two extra bottom in the left and right side.

- **4th FLOOR BEAM (Y-AXIS):**



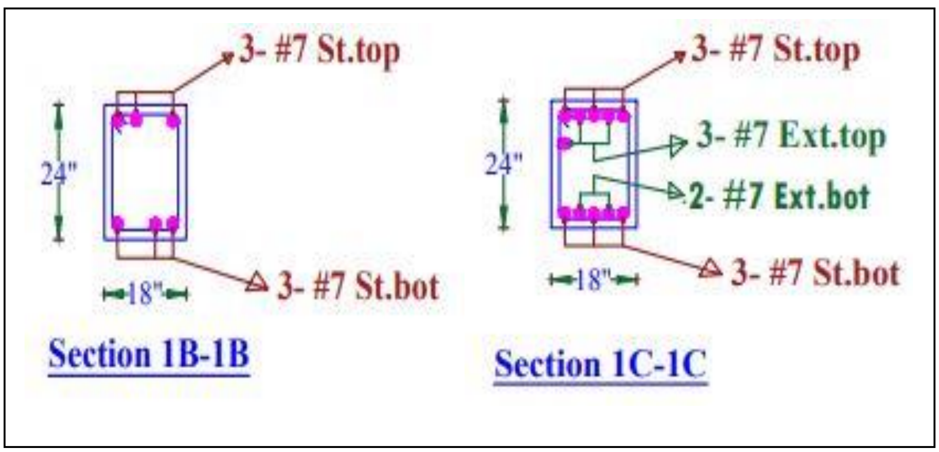


Figure 5.44 Beam Detailing & Cross Section of Y-axis

In this section 3 straight bars on the negative side and 3 straight bars on the positive side. 3 Extra bars on the top and 2 extra bars on the bottom. All are no.7 bar.

X-axis 5th F

Figure 5.45 Steel Area of 5th Floor Beam X-axis

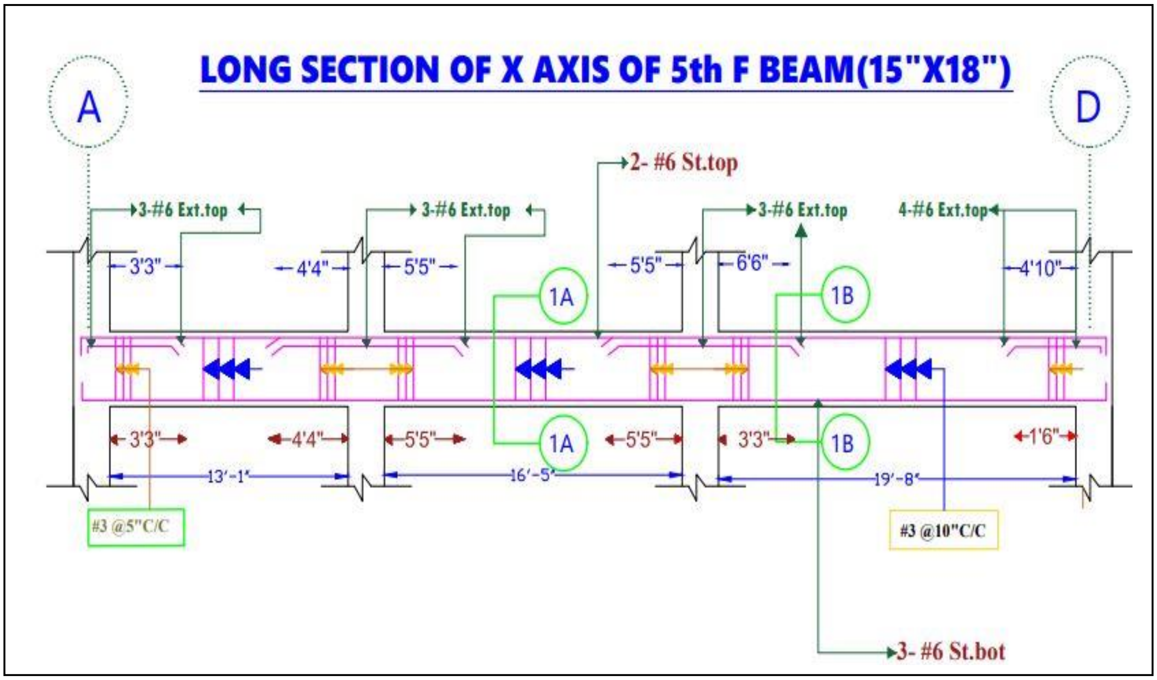
This is the steel area from the 5th beam X-axis of ten storied building. There are various steel area showing on figure 5.45. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.799, 0.556, 2.211. And positive side maximum steel area is left, middle, right serially 0.960, 0.946, 1.106.

Table 5.23 Reinforcement Detailing of 5th Floor Beam X-axis

X-axis 5th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.799	6	.44	2	3	Left	0.960	6	.44	3	-
Middle	0.556	6	.44	2	-	Middle	0.946	6	.44	3	-
Right	2.211	6	.44	2	4	Right	1.106	6	.44	3	-

Following the maximum steel area, we found this calculation. On the negative side no. 6 bar two straight bars, three extra top in the left and four in the right side. And positive side no. 6 bar three straight bars.

- **5th FLOOR BEAM (X-AXIS):**



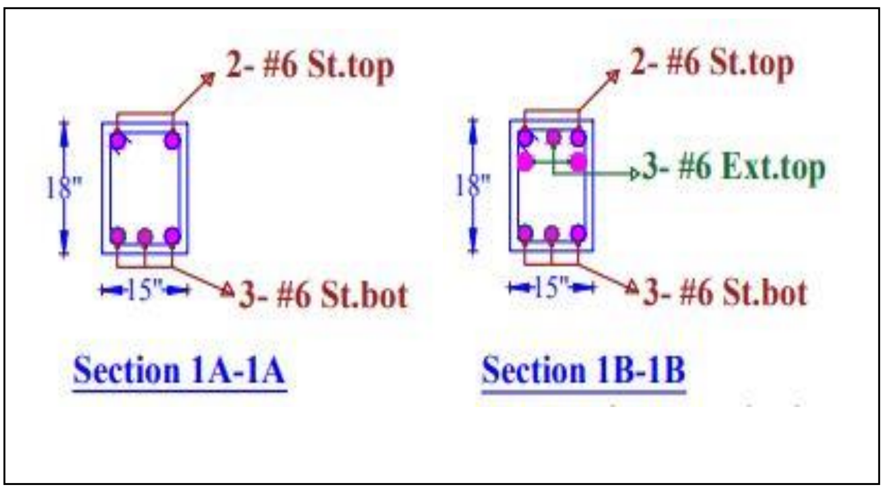


Figure 5.46 **Beam Detailing & Cross Section of X-axis**

In this section 2 straight bars on the negative side and 3 straight bars on the positive side. 3 extra bars on the top. All are no. 6 bar.

Y-axis 5th F

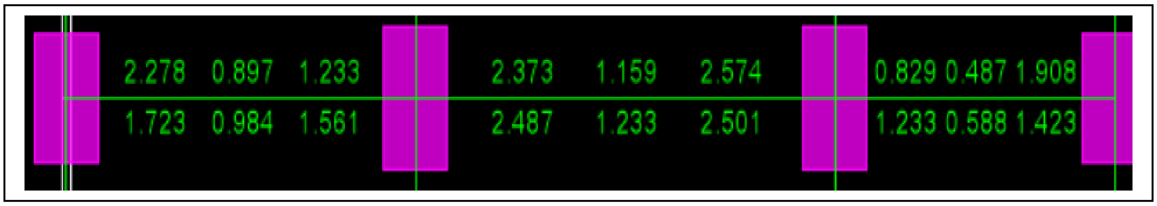


Figure 5.47 Steel Area of 5th Floor Beam Y-axis

This is the steel area from the 5th beam Y-axis of ten storied building. There are various steel area showing on figure 5.47. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 2.373, 1.159, 2.574. And positive side maximum steel area is left, middle, right serially 2.487, 1.233, 2.501.

Table 5.24 Reinforcement Detailing of 5th Floor Beam Y-axis

Y-axis 5th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	2.373	7	.60	2	2	Left	2.487	7	.60	3	2
Middle	1.159	7	.60	2	-	Middle	1.233	7	.60	3	-
Right	2.574	7	.60	2	3	Right	2.501	7	.60	3	2

Following the maximum steel area, we found this calculation. On the negative side no. 7 bars two straight bar, two extra top in the left and three in the right side. And positive side no. 7 bar three straight bars, two extra bottom in the left and right side.

- **5th FLOOR BEAM (Y-AXIS):**

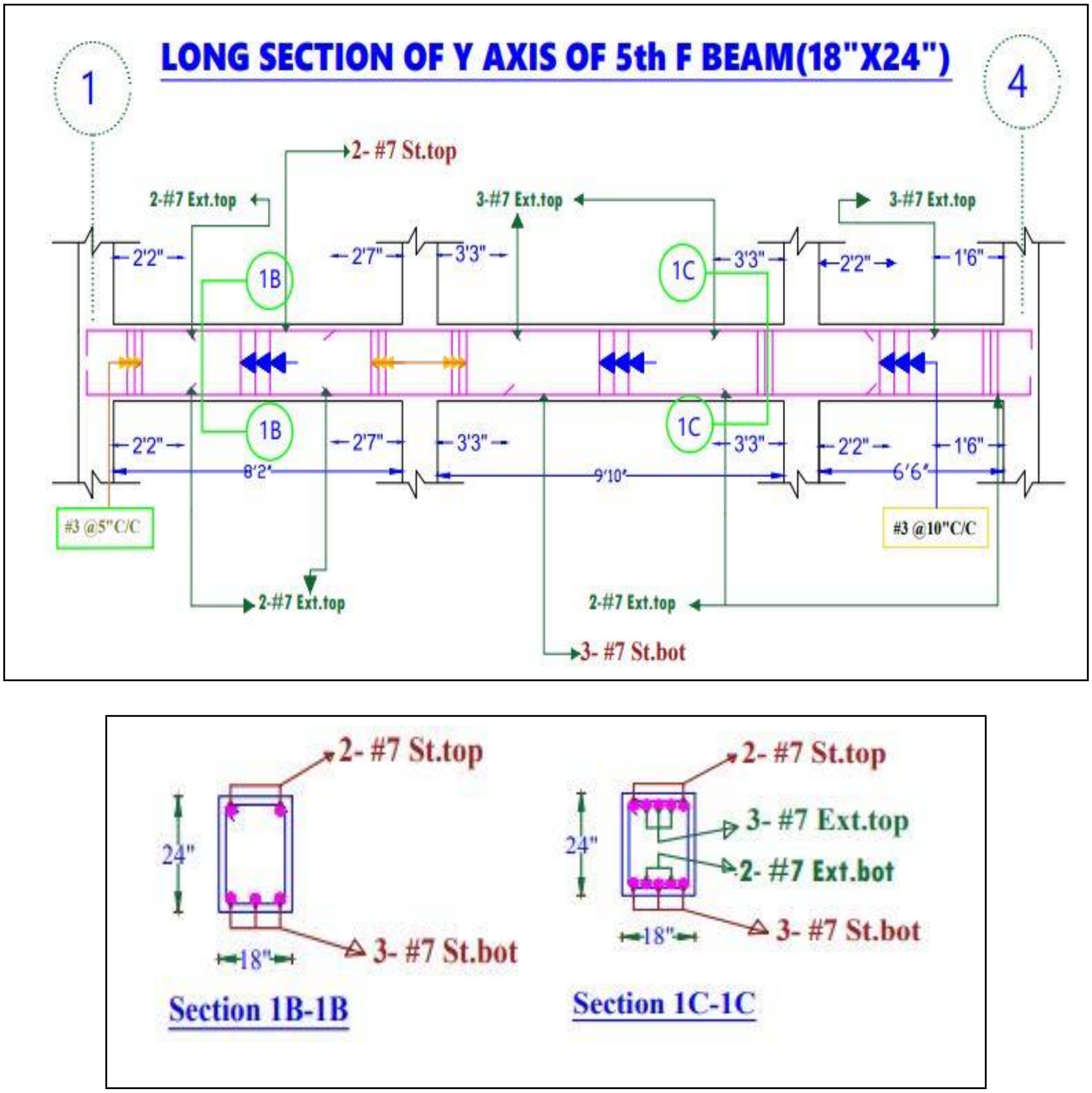


Figure 5.48 **Beam Detailing & Cross Section of Y-axis**

In this section 2 straight bars on the negative side and 3 straight bars on the positive side. 3 Extra bars on the top and 2 extra bars on the bottom. All are no.7 bar.

X-axis 6th F

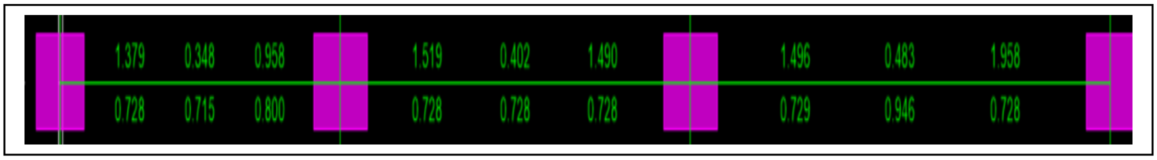


Figure 5.49 Steel Area of 6th Floor Beam X-axis

This is the steel area from the 6th beam X-axis of ten storied building. There are various steel area showing on figure 5.49. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.519, 0.483, 1.958. And positive side maximum steel area is left, middle, right serially 0.729, 0.946, 0.800.

Table 5.25 Reinforcement Detailing of 6th Floor Beam X-axis

X-axis 6th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.519	6	.44	2	2	Left	0.729	6	.44	2	-
Middle	0.483	6	.44	2	-	Middle	0.946	6	.44	2	1
Right	1.958	6	.44	2	3	Right	0.800	6	.44	2	-

Following the maximum steel area, we found this calculation. On the negative side no. 6 bar two straight bars, two extra top in the left and three in the right side. And positive side no. 6 bar three straight bars, one extra bottom in the middle.

- **6th FLOOR BEAM (X-AXIS):**

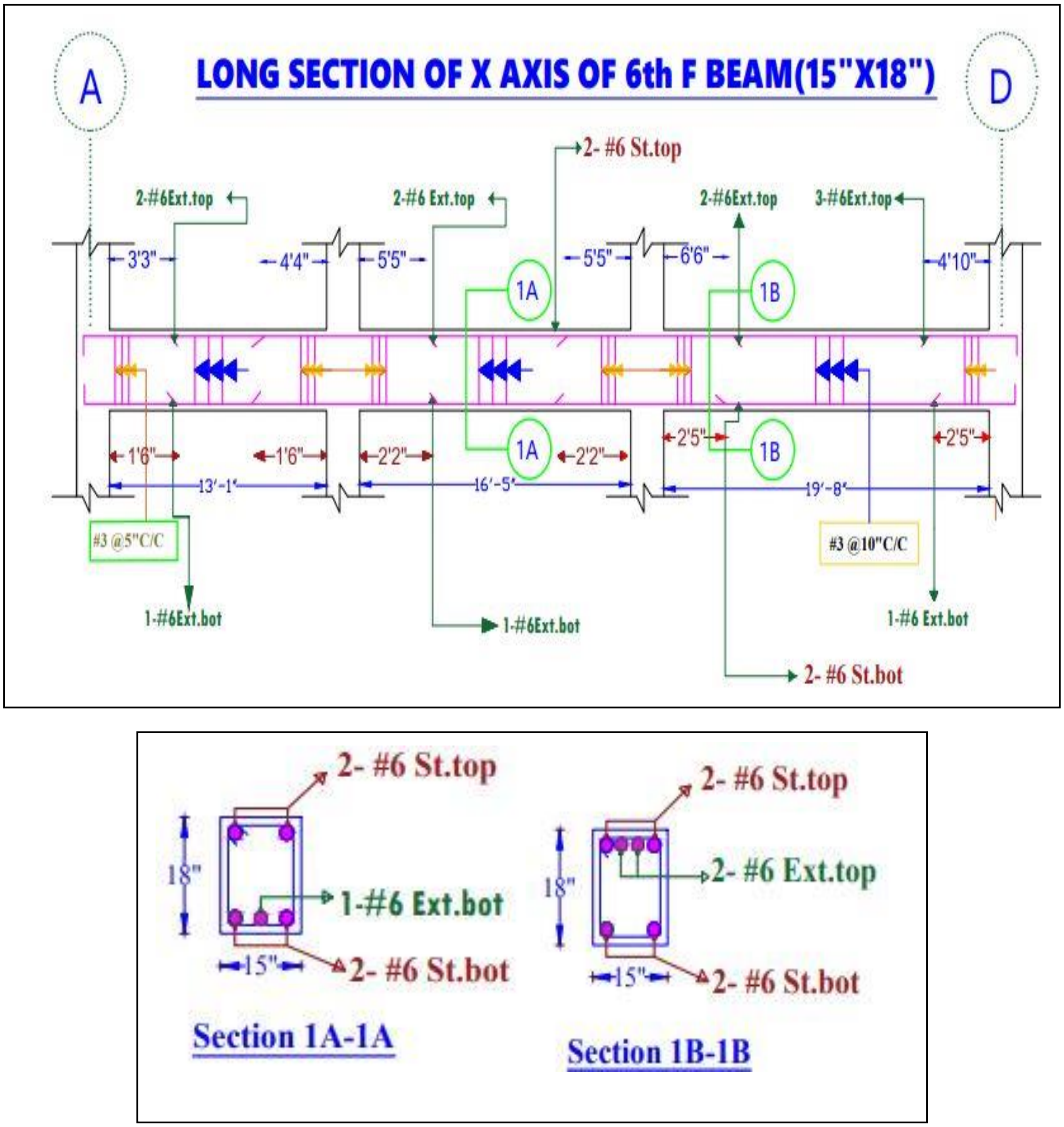


Figure 5.50 Beam Detailing & Cross Section of X-axis

In this section 2 straight bars on the negative side and 2 straight bars on the positive side. 2 extra bars on the top, 1 extra bar on the bottom. All are no. 6 bar.

Y-axis 6th F

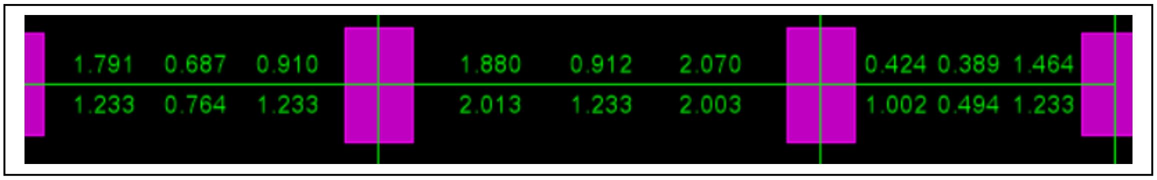


Figure 5.51 Steel Area of 6th Floor Beam Y-axis

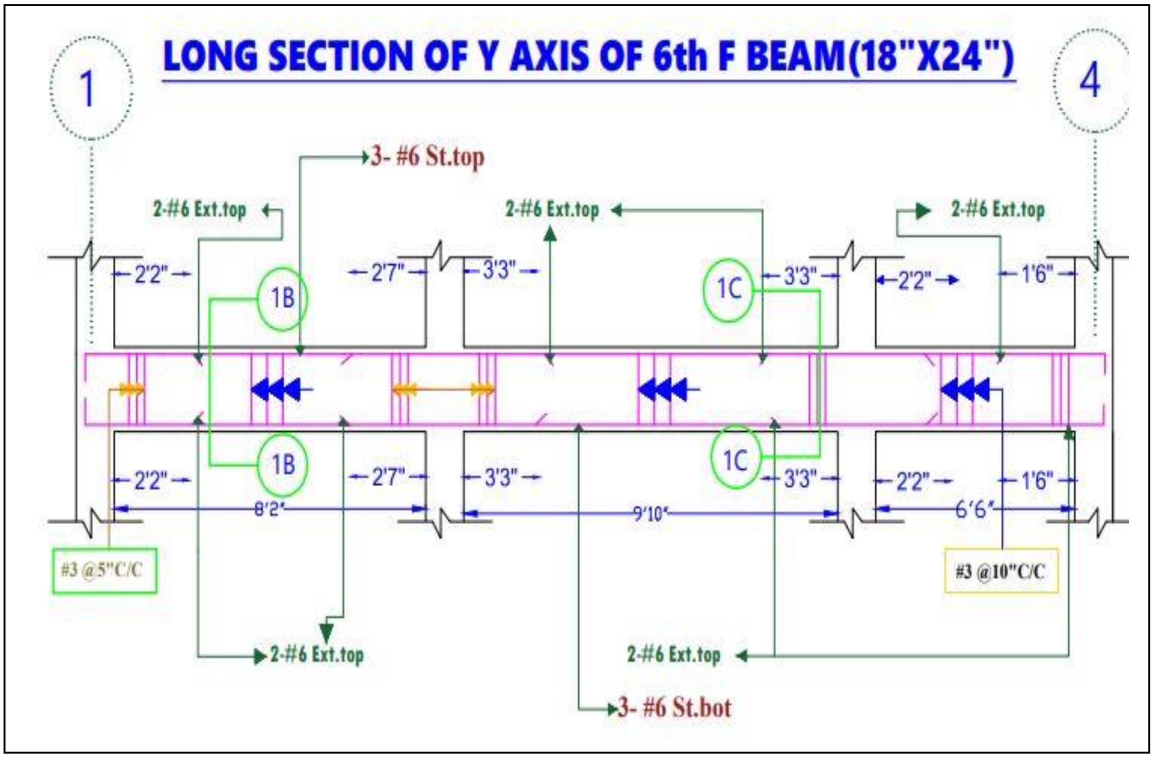
This is the steel area from the 6th beam Y-axis of ten storied building. There are various steel area showing on figure 5.51. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.880, 0.912, 2.070. And positive side maximum steel area is left, middle, right serially 2.013, 1.233, 2.003.

Table 5.26 Reinforcement Detailing of 6th Floor Beam Y-axis

Y-axis 6th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.880	6	.44	3	2	Left	2.013	6	.44	3	2
Middle	0.912	6	.44	3	-	Middle	1.233	6	.44	3	-
Right	2.070	6	.44	3	2	Right	2.003	6	.44	3	2

Following the maximum steel area, we found this calculation. On the negative side no. 6 bar three straight bars, two extra top in the left and right side. And positive side no. 6 bar three straight bars, two extra bottom in the left and right side.

- **6th FLOOR BEAM (Y-AXIS):**



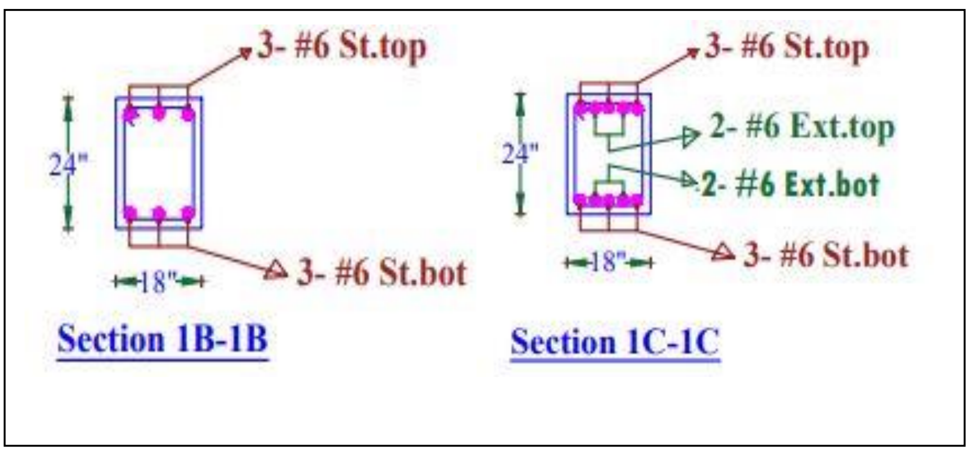


Figure 5.52 Beam Detailing & Cross Section of Y-axis

In this section 3 straight bars on the negative side and 3 straight bars on the positive side. 2 extra bars on the top and 2 extra bars on the bottom. All are no. 6 bar.

X-axis 7th F

Figure 5.53 Steel Area of 7th Floor Beam X-axis

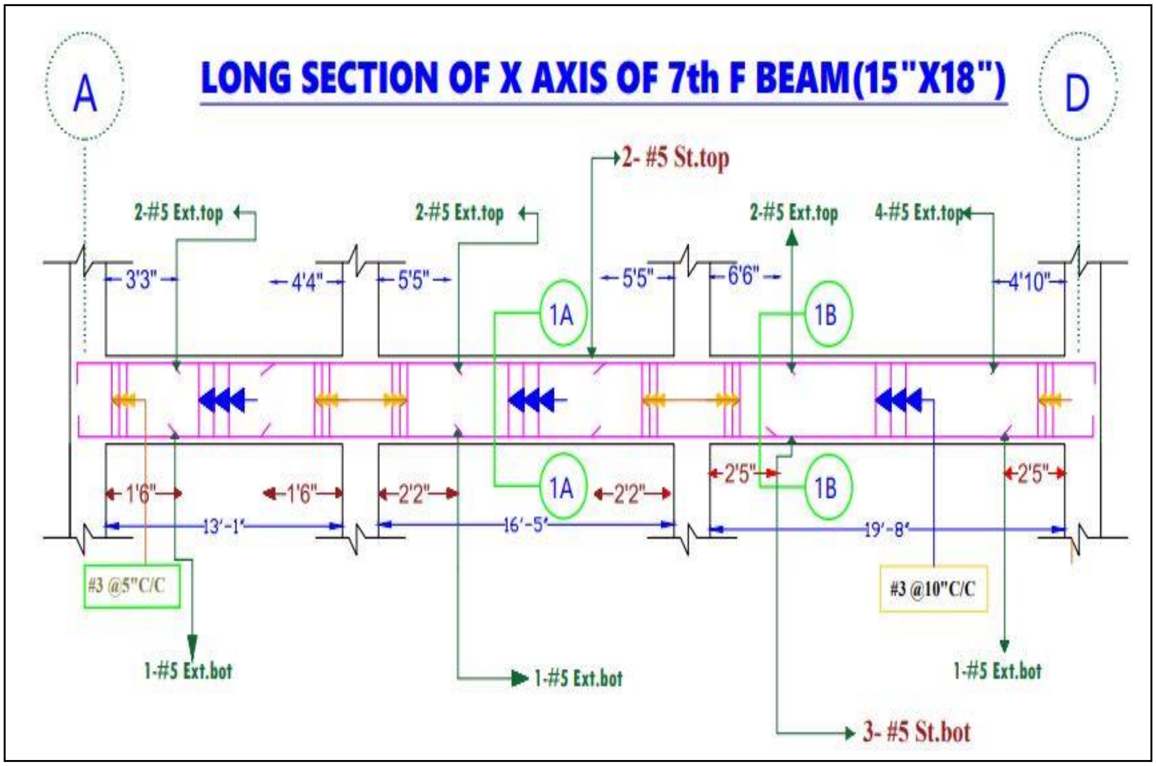
This is the steel area from the 7th beam X-axis of ten storied building. There are various steel area showing on figure 5.53. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.241, 0.424, 1.699. And positive side maximum steel area is left, middle, right serially 0.728, 0.947, 0.713.

Table 5.27 Reinforcement Detailing of 7th Floor Beam X-axis

X-axis 7th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.241	5	.31	2	2	Left	0.728	5	.31	3	-
Middle	0.424	5	.31	2	-	Middle	0.947	5	.31	3	1
Right	1.699	5	.31	2	4	Right	0.713	5	.31	3	-

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, two extra top in the left and four in the right side. And positive side no. 5 bar three straight bars, one extra bottom in the middle.

- **7th FLOOR BEAM (X-AXIS):**



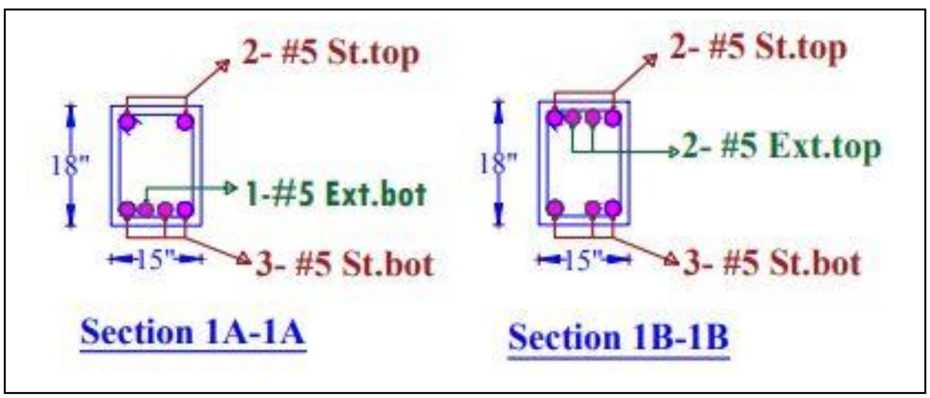


Figure 5.54 **Beam Detailing & Cross Section of X-axis**

In this section 2 straight bars on the negative side and 3 straight bars on the positive side. 2 extra bars on the top, 1 extra bar on the bottom. All are no. 5 bar.

Y-axis 7th F

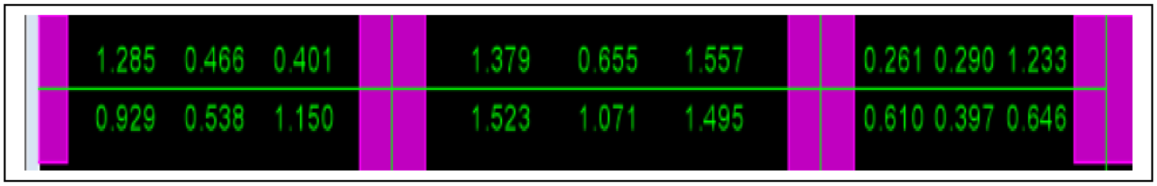


Figure 5.55 Steel Area of 7th Floor Beam Y-axis

This is the steel area from the 7th beam Y-axis of ten storied building. There are various steel area showing on figure 5.55. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.379, 0.655, 1.557. And positive side maximum steel area is left, middle, right serially 1.523, 1.071, 1.495.

Table 5.28 Reinforcement Detailing of 7th Floor Beam Y-axis

Y-axis 7th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.379	5	.31	3	2	Left	1.523	6	.44	3	1
Middle	0.655	5	.31	3	-	Middle	1.071	6	.44	3	-
Right	1.557	5	.31	3	2	Right	1.495	6	.44	3	1

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar three straight bars, two extra top in the left and right side. And positive side no. 6 bar three straight bars, one extra bottom in the left and right side.

- **7th FLOOR BEAM (Y-AXIS):**

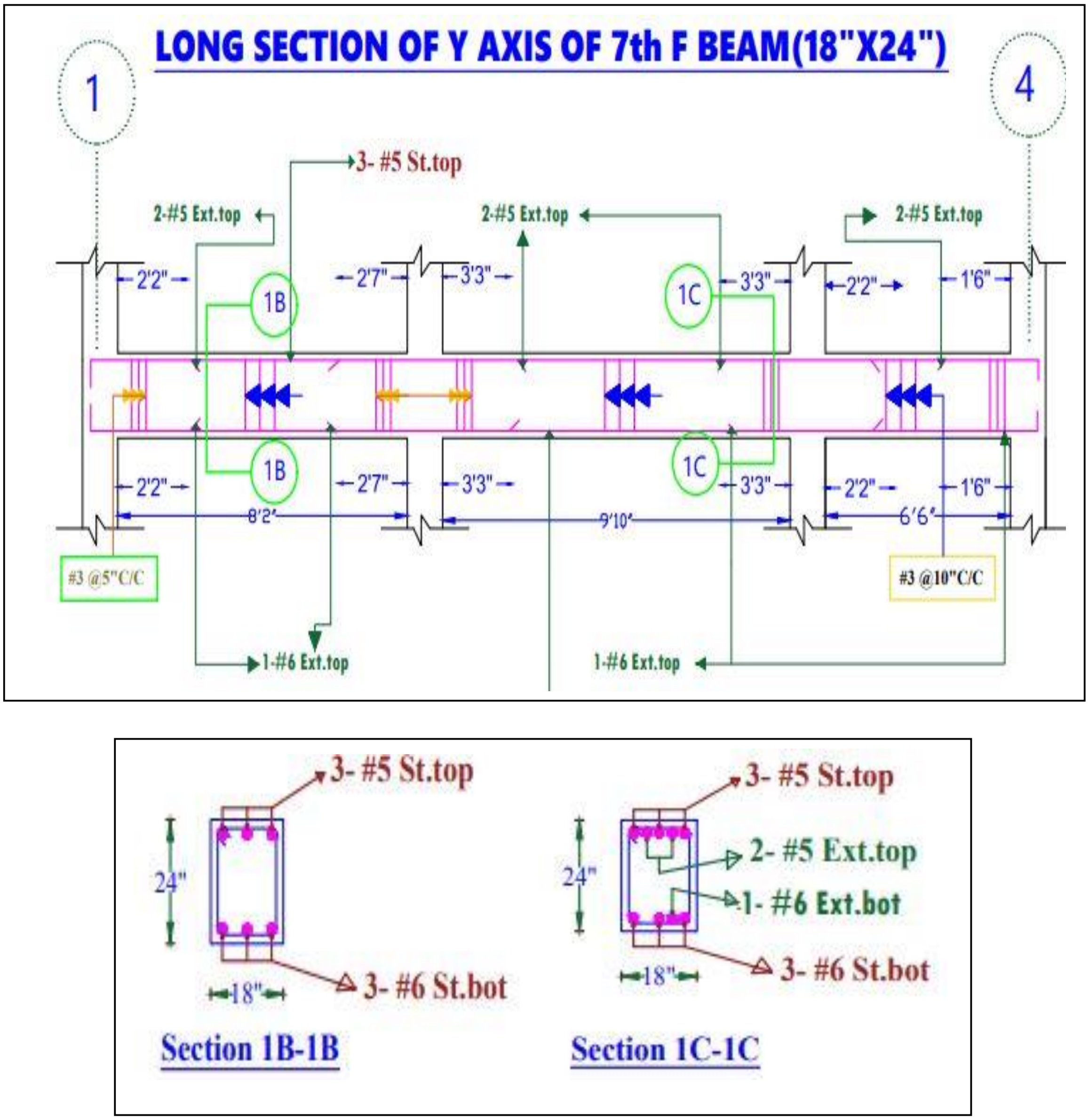


Figure 5.56 Beam Detailing & Cross Section of Y-axis

In this section 3 straight bars on the negative side and 3 straight bars on the positive side. 2 extra bars on the top and 1 extra bar on the bottom. All are no. 5 bar.

X-axis 8th F

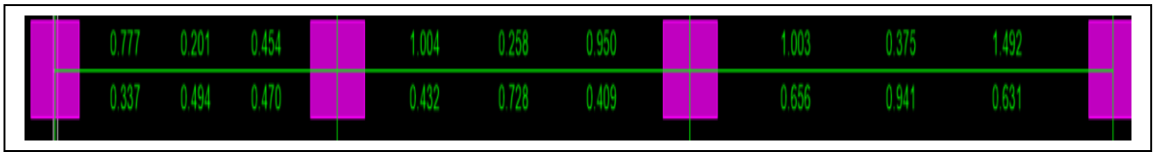


Figure 5.57 Steel Area of 8th Floor Beam X-axis

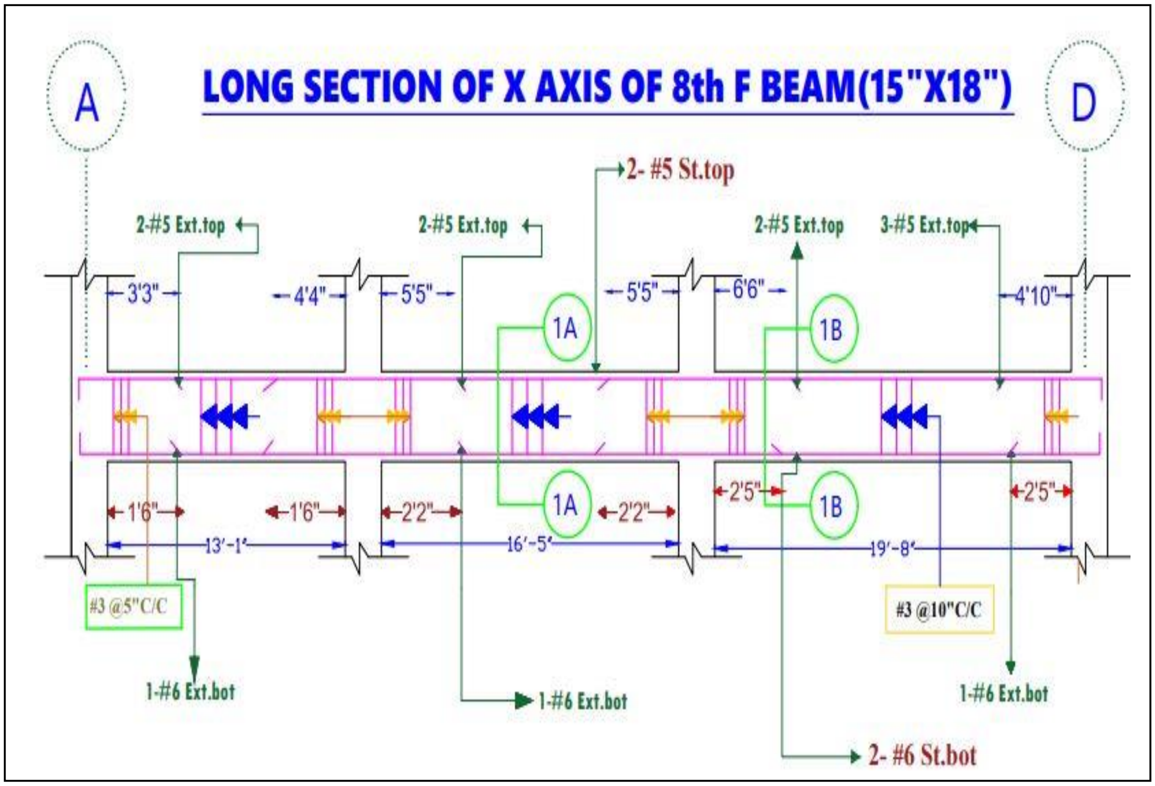
This is the steel area from the 8th beam X-axis of ten storied building. There are various steel area showing on figure 5.57. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.004, 0.375, 1.492. And positive side maximum steel area is left, middle, right serially 0.656, 0.941, 0.631.

Table 5.29 Reinforcement Detailing of 8th Floor Beam X-axis

X-axis 8th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.004	5	.31	2	2	Left	0.656	6	.44	2	-
Middle	0.375	5	.31	2	-	Middle	0.941	6	.44	2	1
Right	1.492	5	.31	2	3	Right	0.631	6	.44	2	-

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, two extra top in the left and three in the right side. And positive side no. 6 bar two straight bars, one extra bottom in the middle.

- **8th FLOOR BEAM (X-AXIS):**



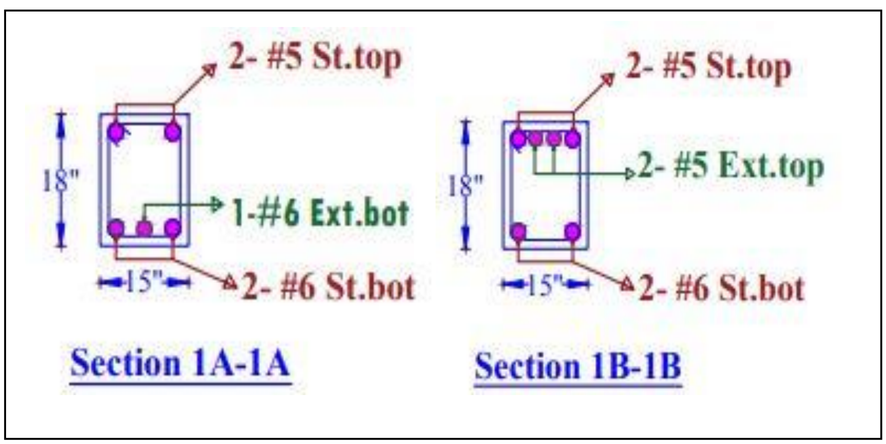


Figure 5.58 Beam Detailing & Cross Section of X-axis

In this section no. 5 bar two straight bars on the negative side and no. 6 bar two straight bars on the positive side. No. 5 bar two extra bars on the top, no. 6 bar one extra bar on the bottom.

Y-axis 8th F

Figure 5.59 Steel Area of 8th Floor Beam Y-axis

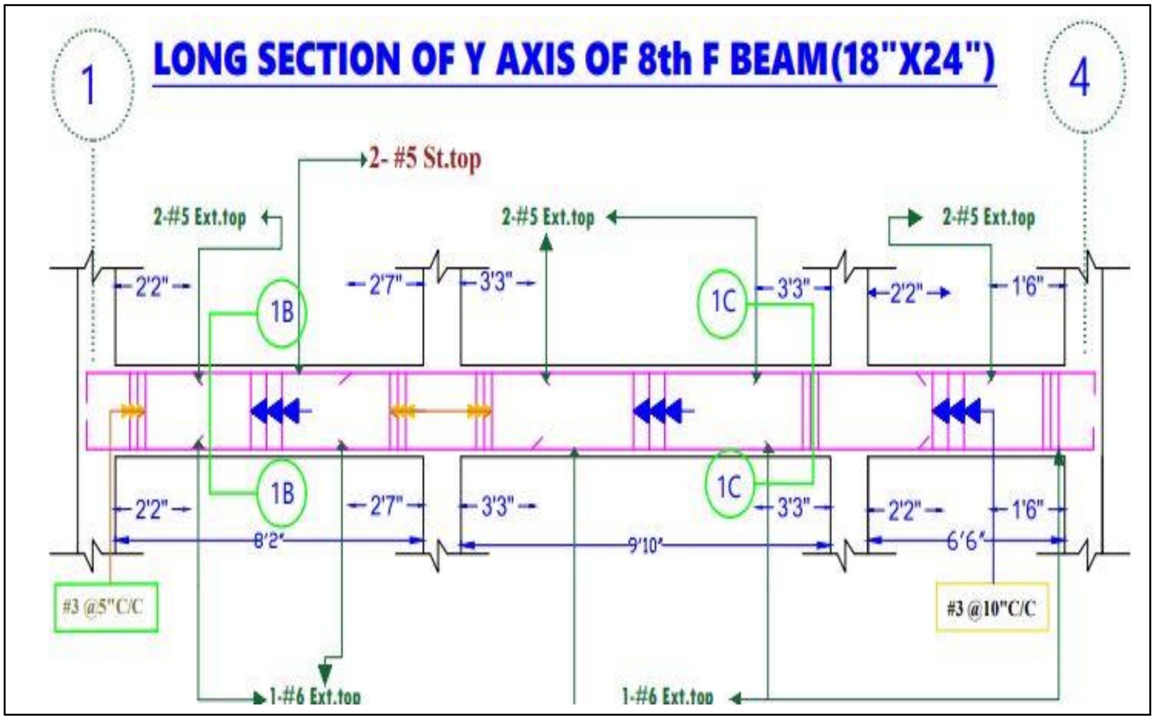
This is the steel area from the 8th beam Y-axis of ten storied building. There are various steel area showing on figure 5.59. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 1.233, 0.420, 1.233. And positive side maximum steel area is left, middle, right serially 1.233, 0.834, 1.233.

Table 5.30 Reinforcement Detailing of 8th Floor Beam Y-axis

Y-axis 8th F											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	1.233	5	.31	2	2	Left	1.233	6	.44	2	1
Middle	0.420	5	.31	2	-	Middle	0.834	6	.44	2	-
Right	1.233	5	.31	2	2	Right	1.233	6	.44	2	1

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, two extra top in the left and right side. And positive side no. 6 bar two straight bars, one extra bottom in the middle.

- **8th FLOOR BEAM (Y-AXIS):**



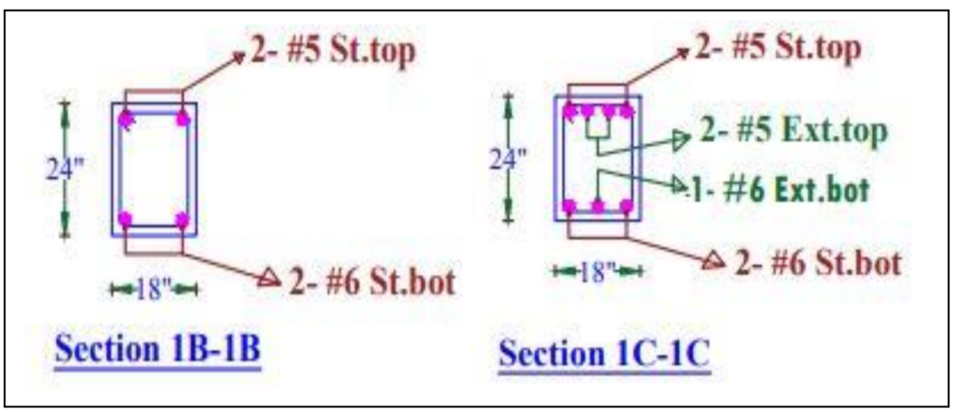


Figure 5.60 **Beam Detailing & Cross Section of Y-axis**

In this section no. 5 bar three straight bars on the negative side and no. 6 bar two straight bars on the positive side. No. 5 bar two extra bars on the top and no. 6 one extra bar on the bottom.

X-axis RF

Figure 5.61 Steel Area of Roof Floor Beam X-axis

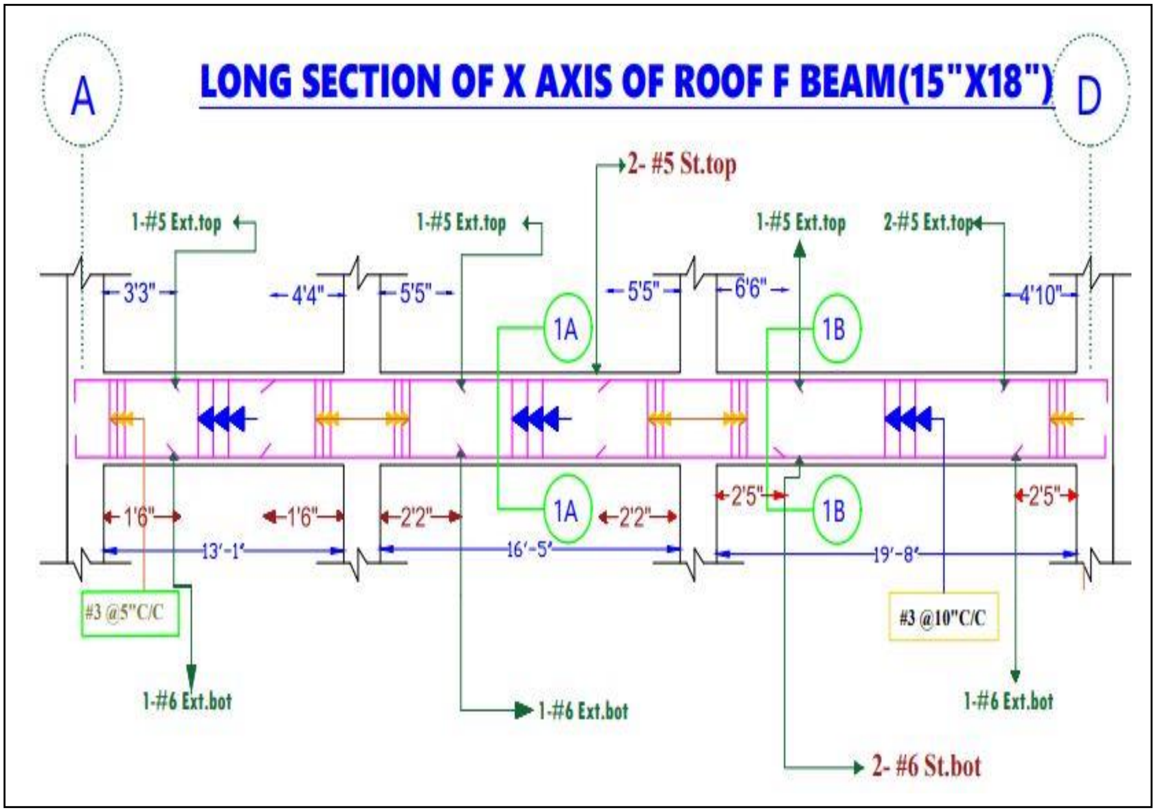
This is the steel area from the roof beam X-axis of ten storied building. There are various steel area showing on figure 5.61. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 0.890, 0.306, 1.204. And positive side maximum steel area is left, middle, right serially 0.635, 0.973, 0.515.

Table 5.31 Reinforcement Detailing of Roof Floor Beam X-axis

X-axis RF											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	0.890	5	.31	2	1	Left	0.635	6	.44	2	-
Middle	0.306	5	.31	2	-	Middle	0.973	6	.44	2	1
Right	1.204	5	.31	2	2	Right	0.515	6	.44	2	-

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, one extra top in the left and two in the right side. And positive side no. 6 bar two straight bars, one extra bottom in the middle.

- **ROOF FLOOR BEAM (X-AXIS):**



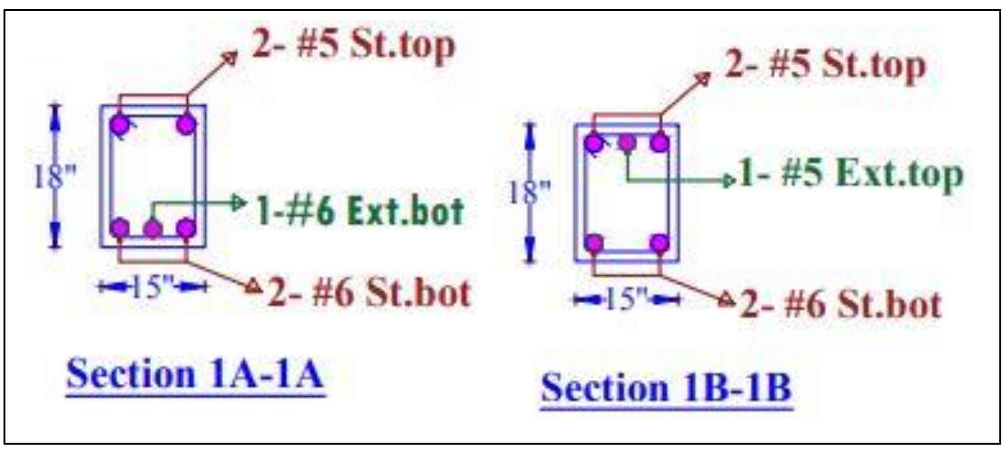


Figure 5.62 **Beam Detailing & Cross Section of X-axis**

In this section no. 5 bar two straight bars on the negative side and no. 6 bar two straight bars on the positive side. No. 5 bar one extra bar on the top, no. 6 bar one extra bar on the bottom.

Y-axis RF

Figure 5.63 Steel Area of Roof Floor Beam Y-axis

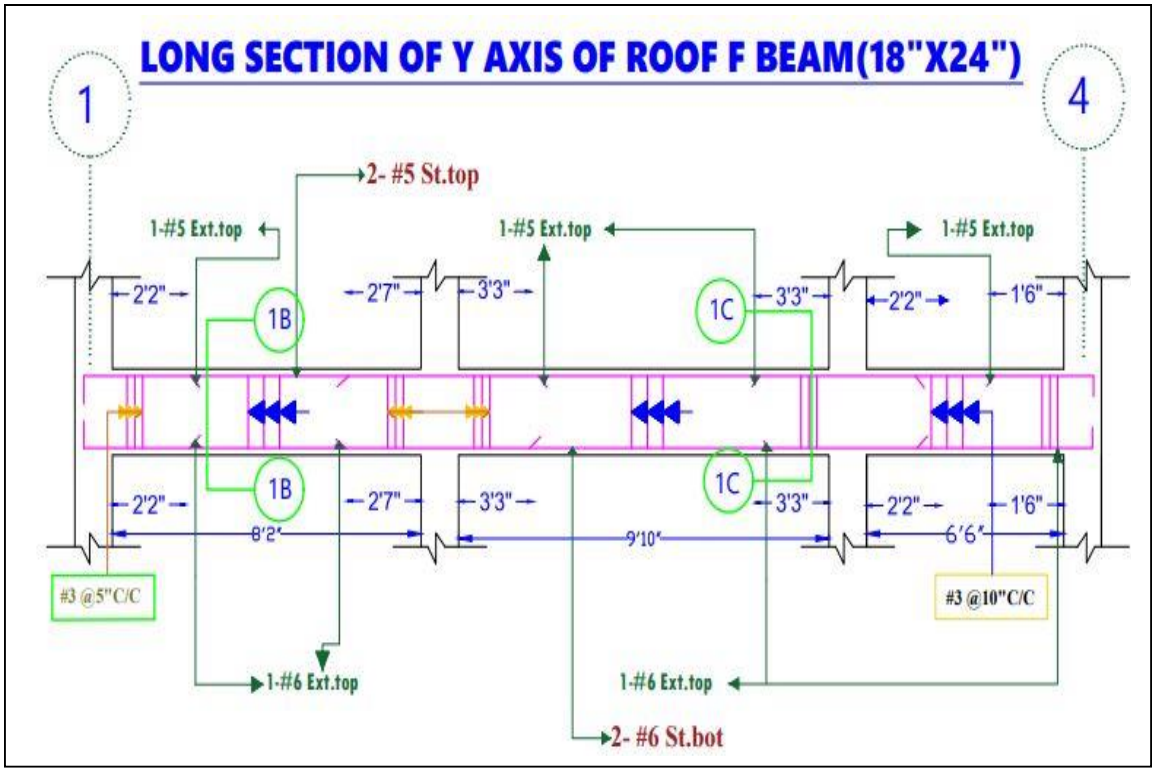
This is the steel area from the roof beam Y-axis of ten storied building. There are various steel area showing on figure 5.63. But we selected the maximum steel area for design purposes. On the negative side, the maximum steel area is left, middle, right serially 0.685, 0.200, 0.892. And positive side maximum steel area is left, middle, right serially 0.941, 0.726, 0.950

Table 5.32 Reinforcement Detailing of Roof Floor Beam Y-axis

Y-axis RF											
Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided		Maximum Reinforcement Needed		Bar Selected to be used		Number of Bar Provided	
Negative side (in^2)		No	Area (in^2)	Str.	Ext	Positive side (in^2)		No	Area (in^2)	Str.	Ext
Left	0.685	5	.31	2	1	Left	0.941	6	.44	2	1
Middle	0.200	5	.31	2	-	Middle	0.726	6	.44	2	-
Right	0.892	5	.31	2	1	Right	0.950	6	.44	2	1

Following the maximum steel area, we found this calculation. On the negative side no. 5 bar two straight bars, one extra top in the left and right side. And positive side no. 6 bar two straight bars, one extra bottom in the left and right side.

- **ROOF FLOOR BEAM (Y-AXIS):**



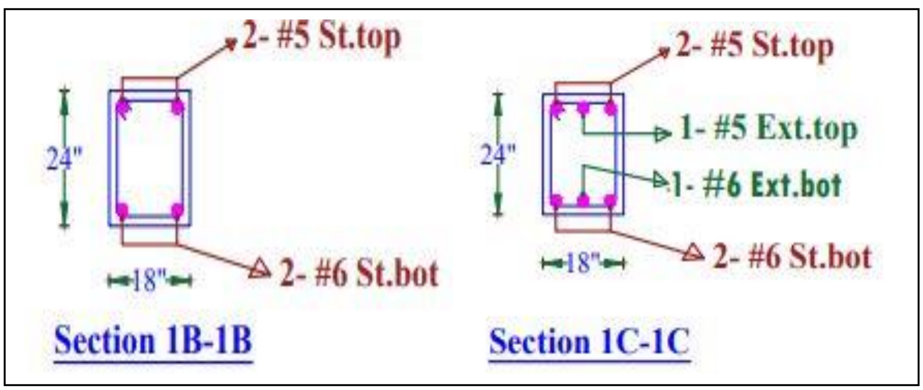


Figure 5.62 Beam Detailing & Cross Section of Y-axis

In this section no. 5 bar two straight bars on the negative side and no. 6 bar two straight bars on the positive side. No. 5 bar one extra bars on the top and no. 6 one extra bar on the bottom.

CHAPTER -06

COLUMN DESIGN FOR SIX STORIED

6.1: Column: Column is an important part of a structure. Which is vertical structure transmit the compressive loads. Data is taken from “ETABS” which we have modeled, by trial and trial we have got acceptable values.

6.2: Layout of Column For Six Storied

According to ETABS out put we have selected four types columns.

These are: **C1= 12″X28″**

C2= 12″X24″

C3= 12″X22″

C4= 12″X31″

The layout of columns are given below.

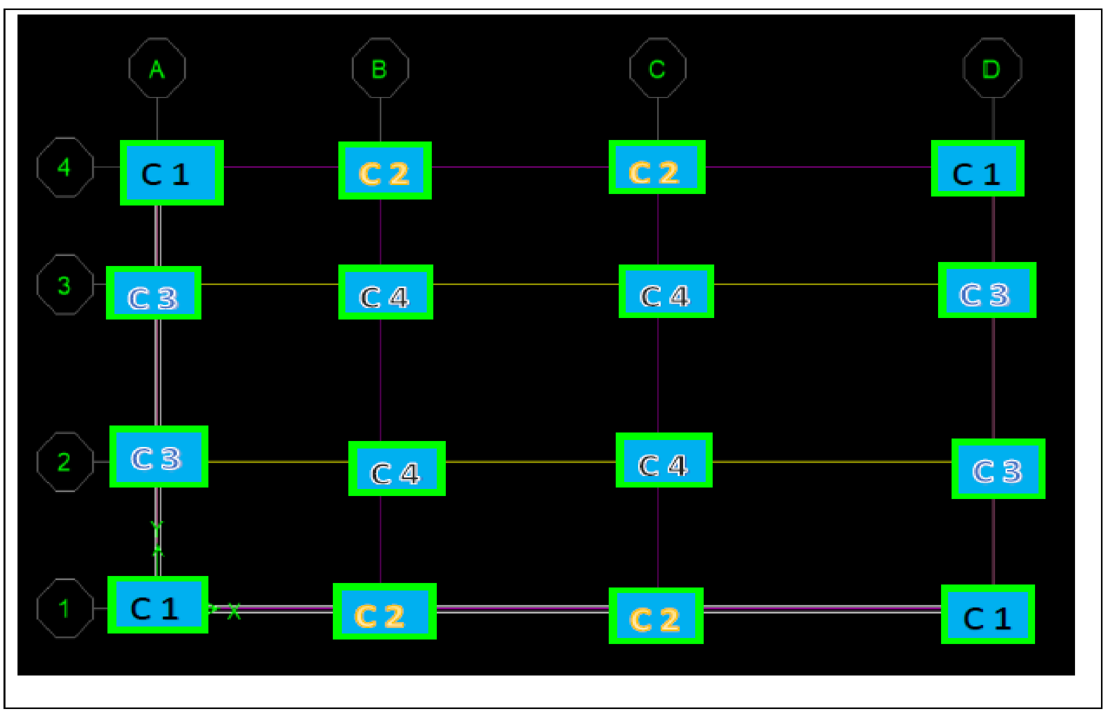


Figure 6.0 Column layout

6.3:- Detailing(Tie&Main Bar) of Column

Column (1): C1 There are different steel area for same column beacause of most of load carry below portion of column. Steel area of Ground floor is 9.408 in^2,First Floor is 5.870 in^2 and Second Floor to Fifth floor is 3.255 in^2.

ACCORDING TO ACI MANUAL FOR ALL SIX STORIED COLUMN’S TIE

TOP&BOTTOM = #3 BAR 2’-6”@3” c/c

AND MIDDLE = #3 BAR 6’-6”@6”c/c

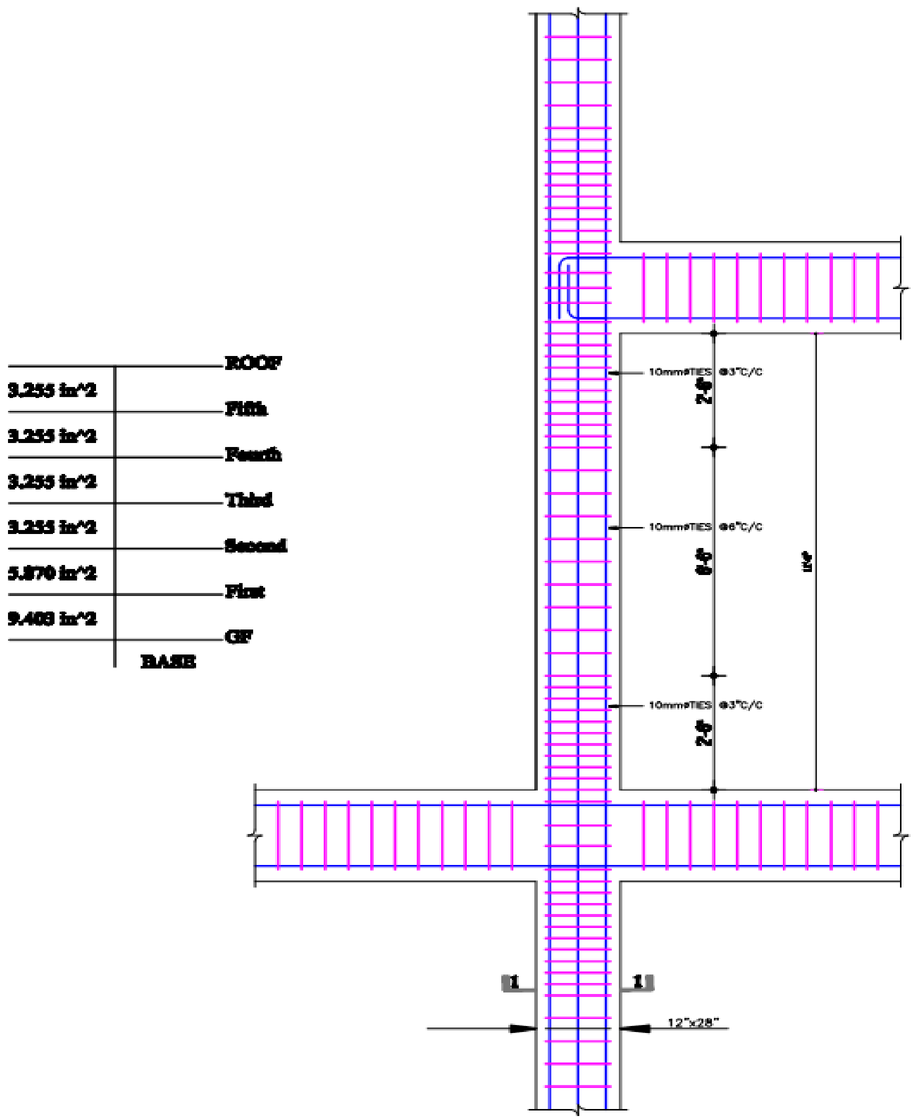


Figure 6.1 Column Detailing (C1)

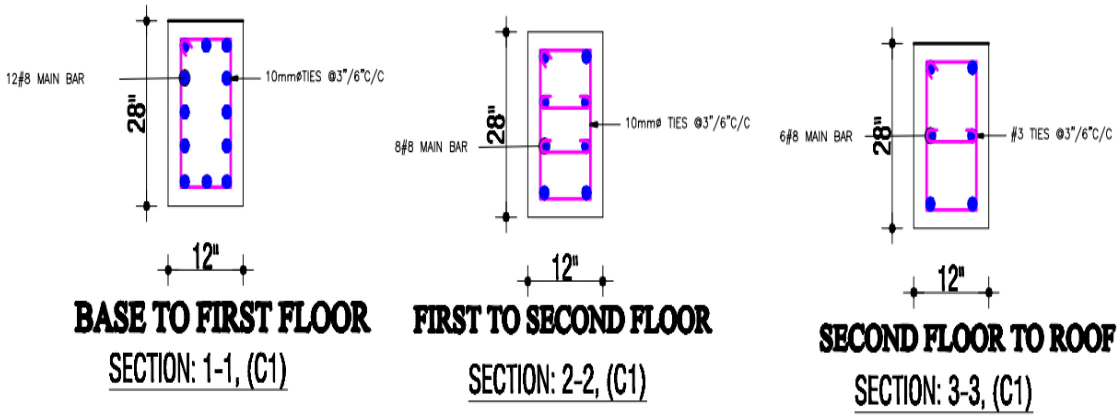


Figure 6.2 Cross Section (C1)

In this column base to first floor use number 12 main bar, first floor to second floor use number 8 main bar and second to roof use number 6 bar. All main bar is no, 8 bar.

Column (2): Steel area of Ground floor is 5.283 in^2,First Floor is 4.188 in^2, Second Floor is 3.570 in^2 and Third floor to Fifth floor is 2.790 in^2.

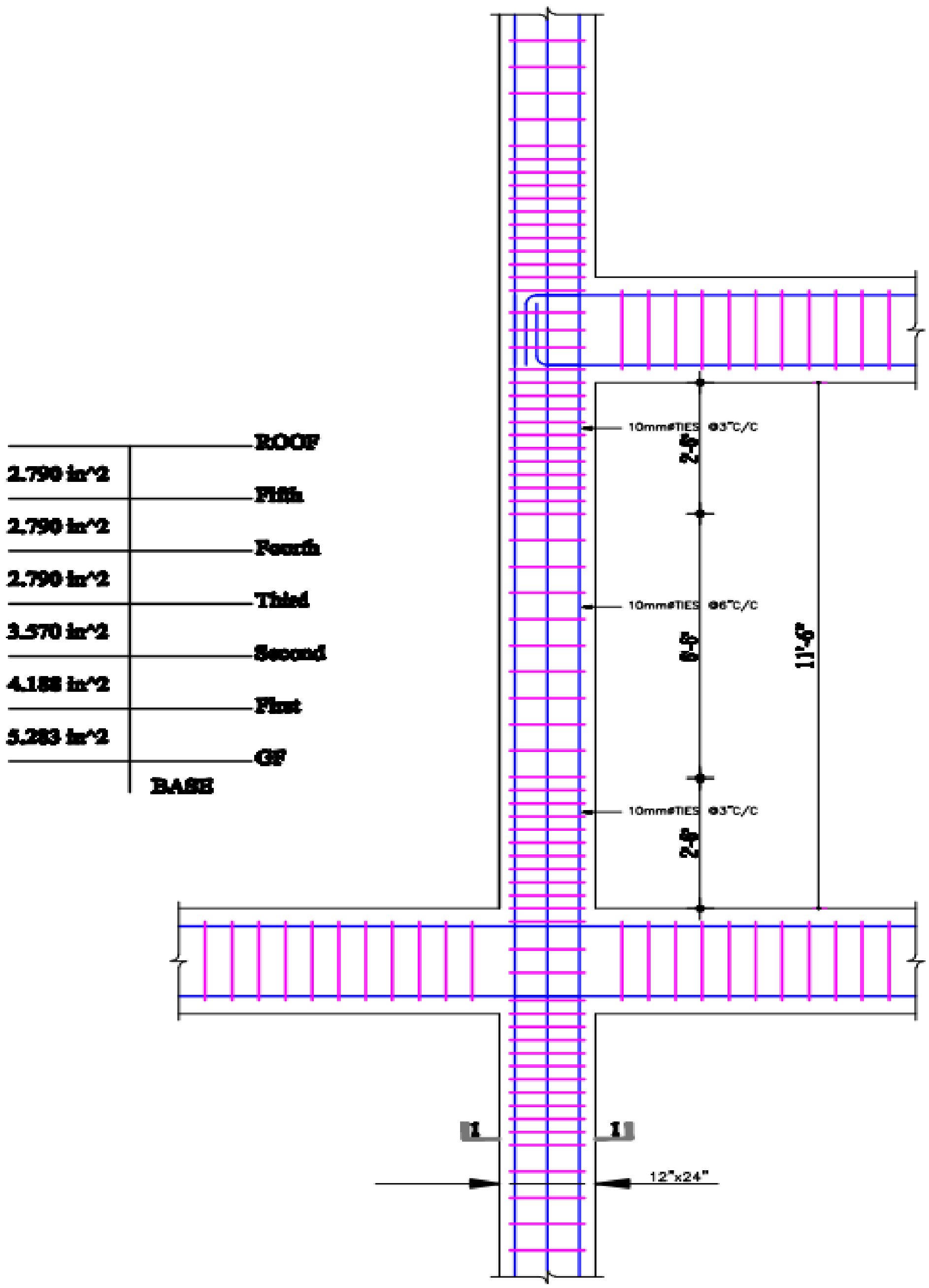


Figure 6.3 **Column Detailing (C2)**

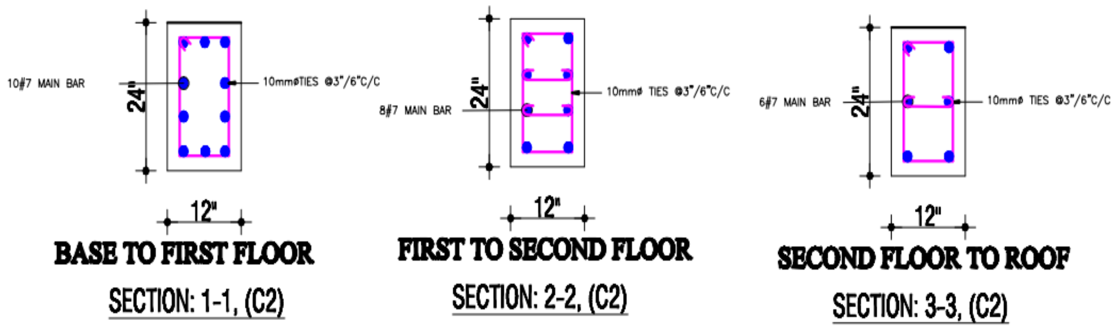


Figure 6.4 Cross Section (C2)

Base to first floor decrease 10 main bar. First floor to second floor use number 8 main bar and second to roof use number 6 bar. Main bar is no,8 bar.

Column(C3): Steel area of Ground floor is 6.346 in^2,First Floor is 7.613 ^2, Second Floor is 5.561 in^2 Third floor is 3.872 and Fourth floor to Fifth floor is 2.558 in^2.

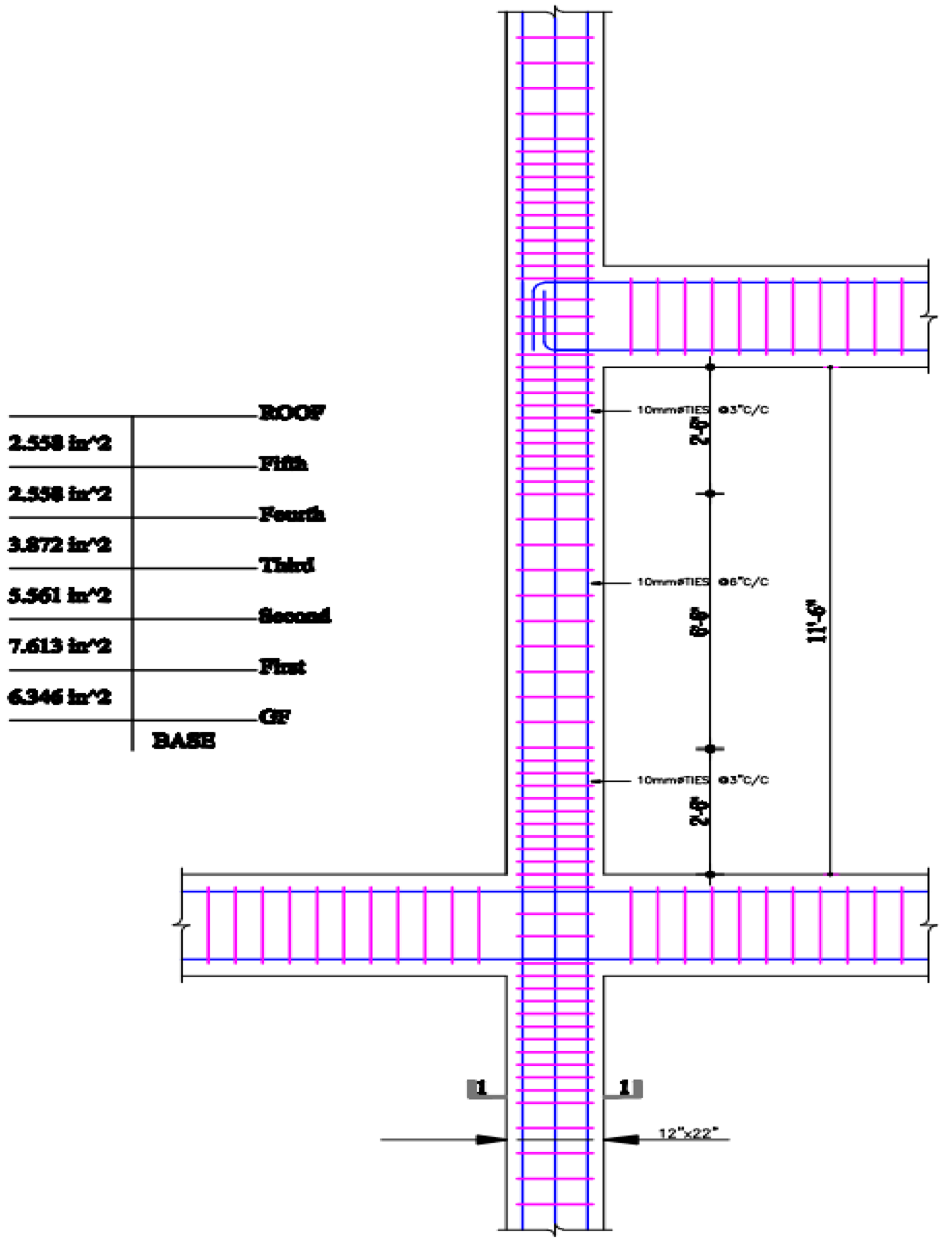


Figure 6.5 Column Detailing (C3)

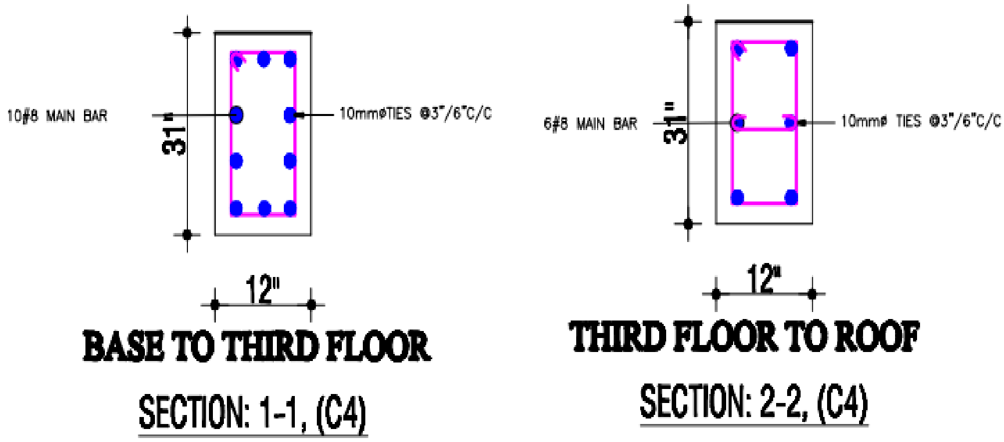


Figure 6.6 Cross Section (C3)

In this column base to third floor use number 10 main bar and third to roof use number 6 main bar. All main bar is no.8 bar.

Column(C4): Steel area of Ground floor is 5.961 in^2,First Floor is 5.955 in^2, Second Floor is 6.579in^2 Third floor is 3.872in^2 and Fourth floor to Fifth floor is 3.604 in^2.

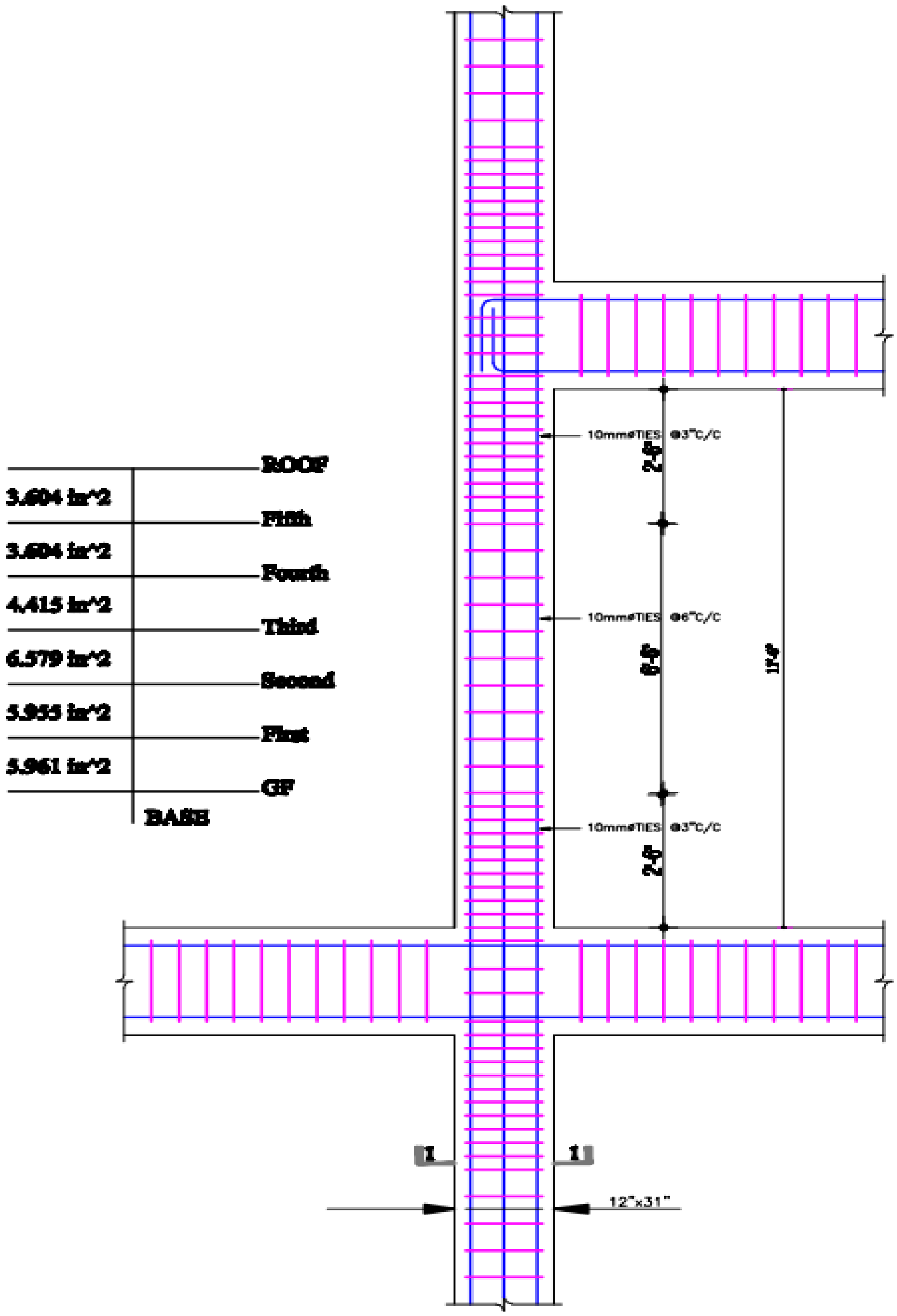


Figure 6.7 Column Detailing (C4)

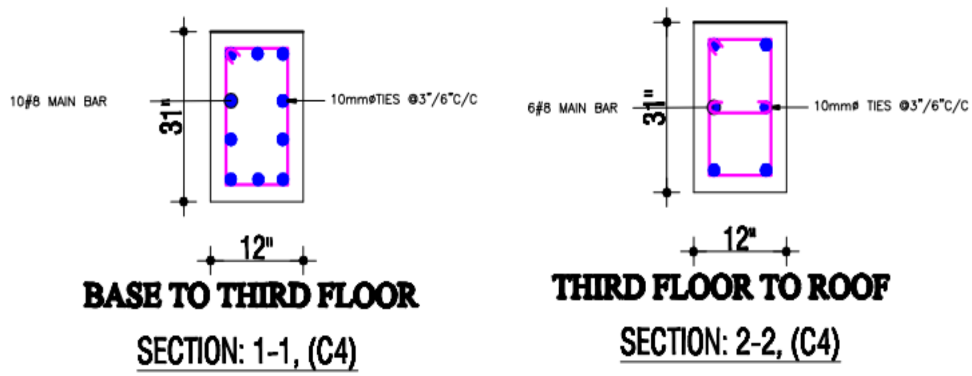


Figure 6.8 Cross Section (C4)

In this column base to third floor use number 10 main bar and third to roof use number 6 main bar. All main bar is no.8 bar.

COLUMN DESIGN FOR TEN STORIED

6.3:- Layout of Column

Layout of column a storied and a ten storied are same because of both are "Plan View"

According to ETABS out put we have selected four types columns.

These are: **C1= 18"X24"**

C2= 18"X27"

C3= 18"X27"

C4= 18"X30"

The layout of columns are given below.

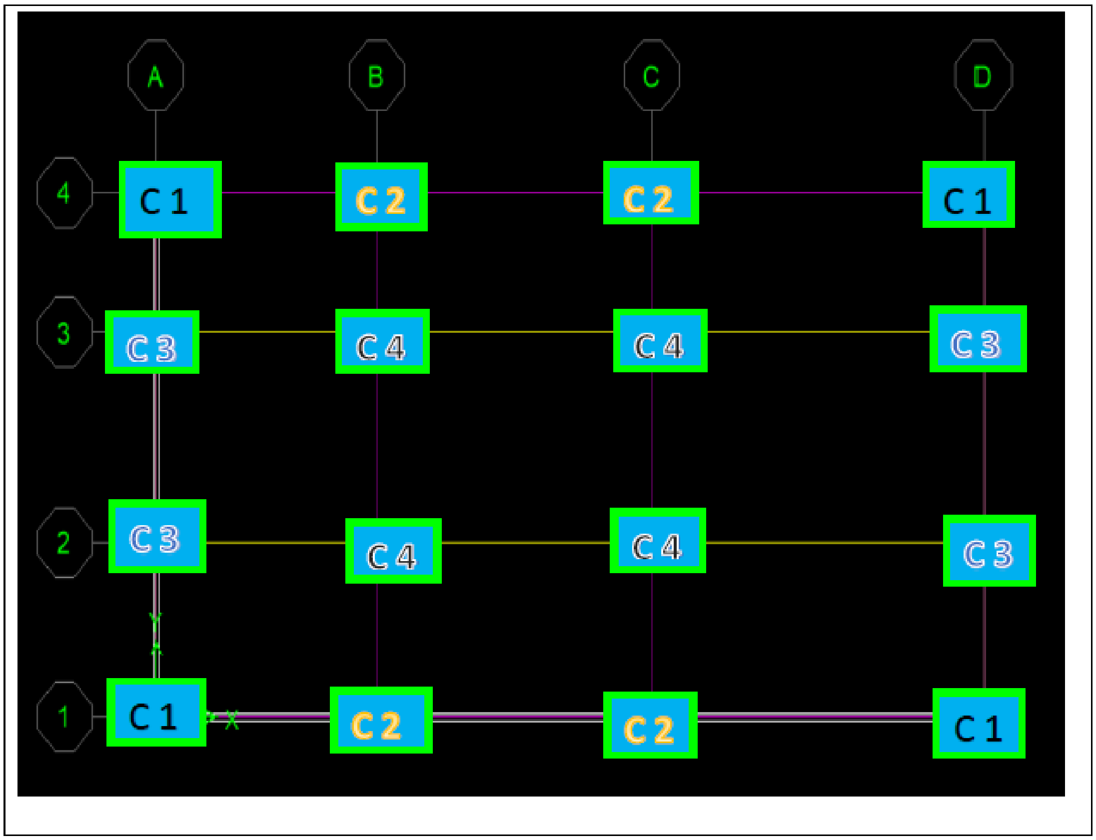


Figure 6.00 Column layout

6.4:- Detailing(Tie&Main Bar) of Column

ACCORDING TO ACI MANUAL FOR ALL SIX STORIED COLUMN'S TIE

AT TOP&BOTTOM = #3 BAR 2'-6"@4" c/c

AT MIDDLE = #3 BAR 6'-6"@8"c/c

Column(C1): Steel area of Ground floor is 15.448 in^2,First Floor is 10.952 in^2, Second Floor is 7.528 in^2 Third floor is 5.933 in^2 and Fourth floor to Roof floor is 4.320 in^2.

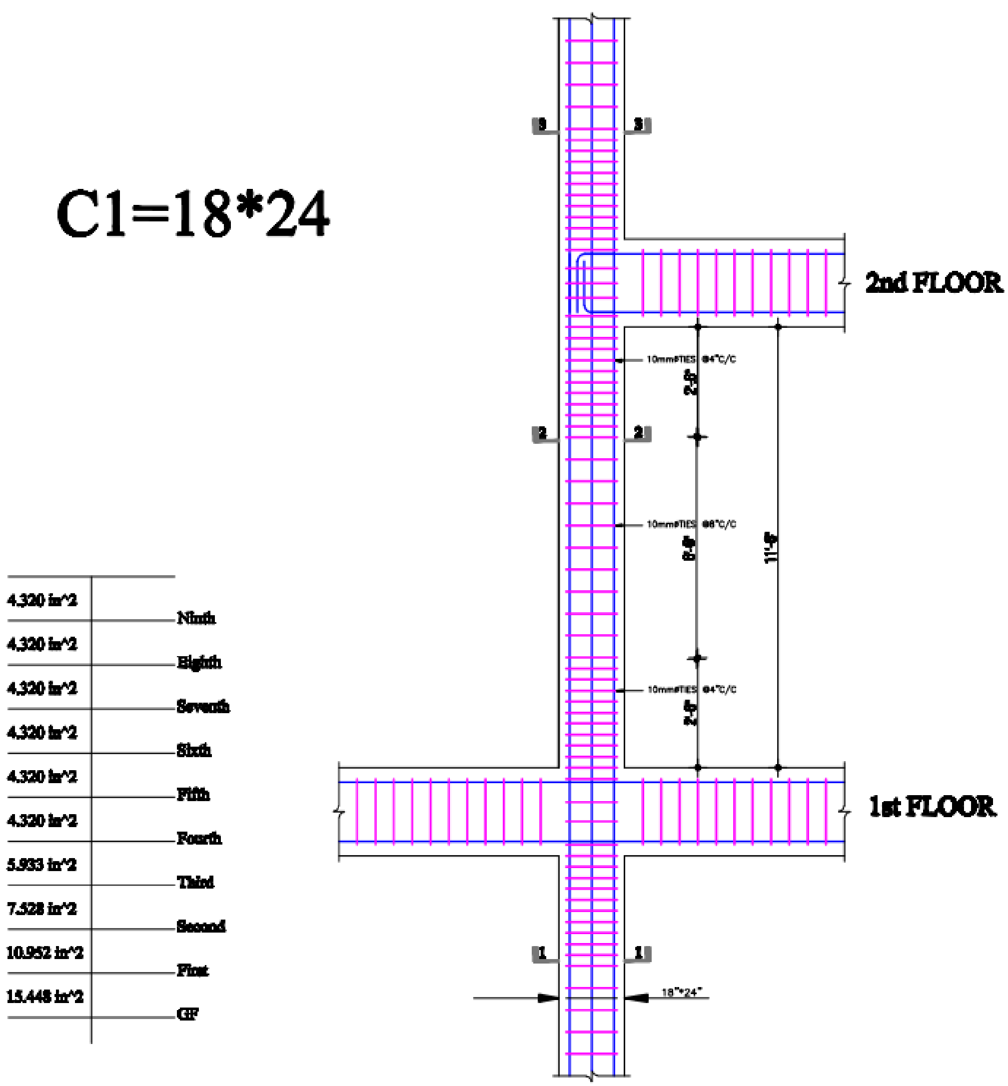


Figure 6.9 Column Detailing (C1)

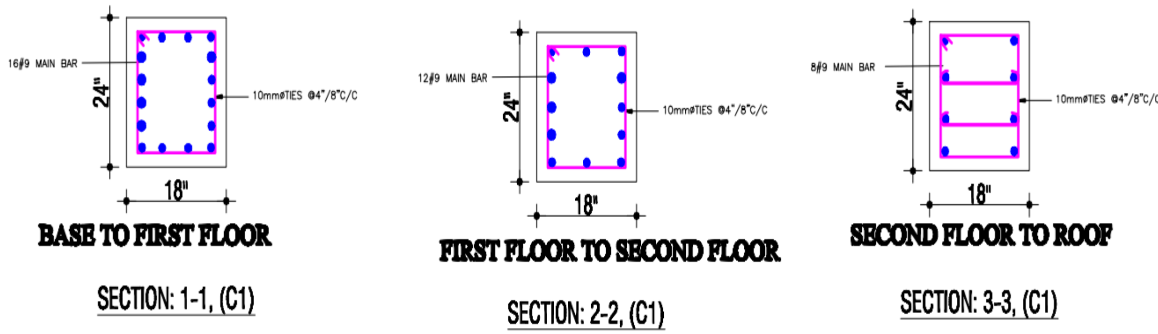


Figure 6.10 Cross Section (C1)

In this column base to first floor use number 16 main bar, first floor to second floor use number 12 main bar and second to roof use number 8 bar. All main bar is no.9 bar.

Column(C2): Steel area of Ground floor is 14.955 in^2,First Floor is 10.197 in^2, Second Floor is 8.197 in^2 Third floor is 6.350 in^2 and Fourth floor to Roof floor is 4.860 in^2.

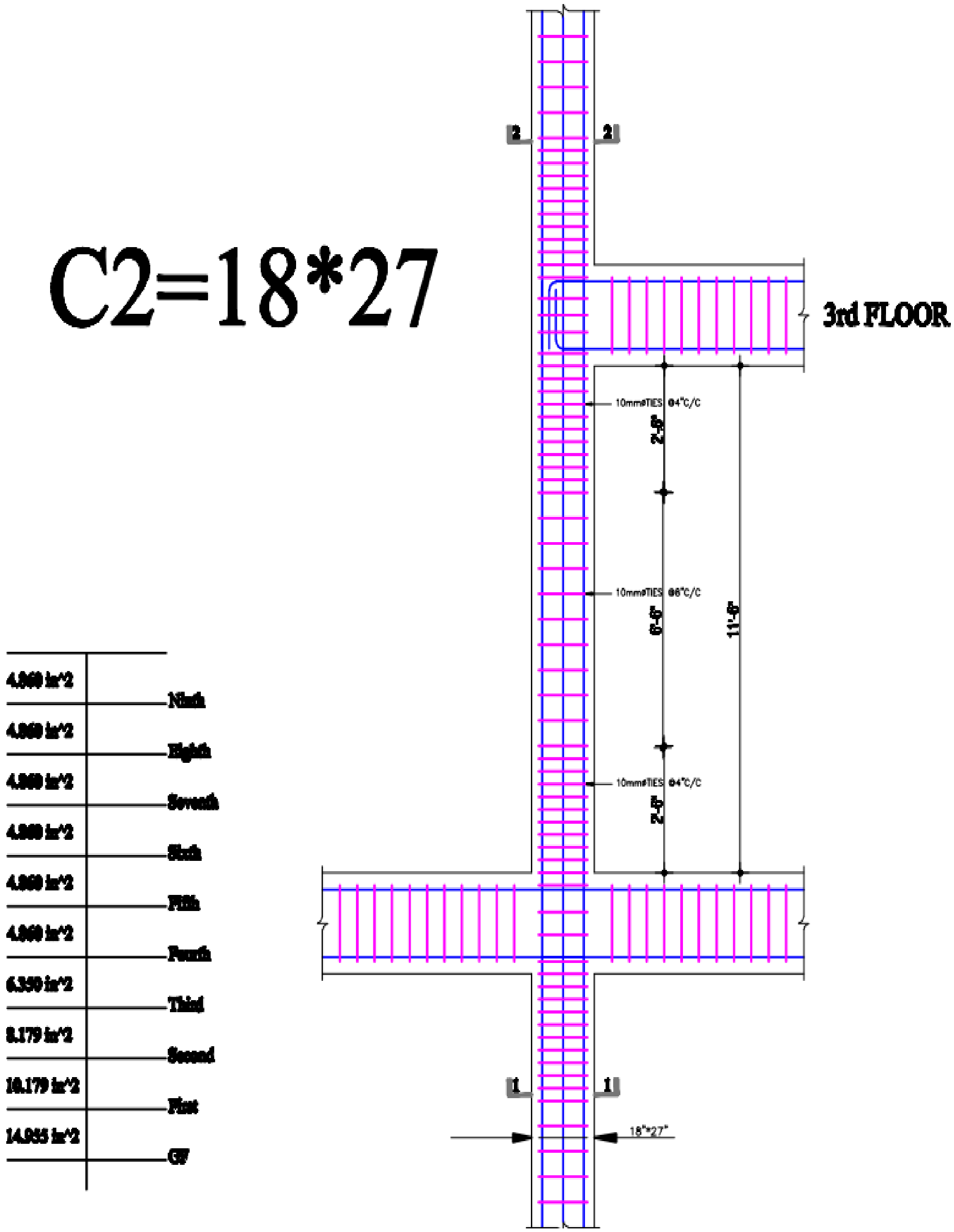


Figure 6.11 **Column Detailing (C2)**

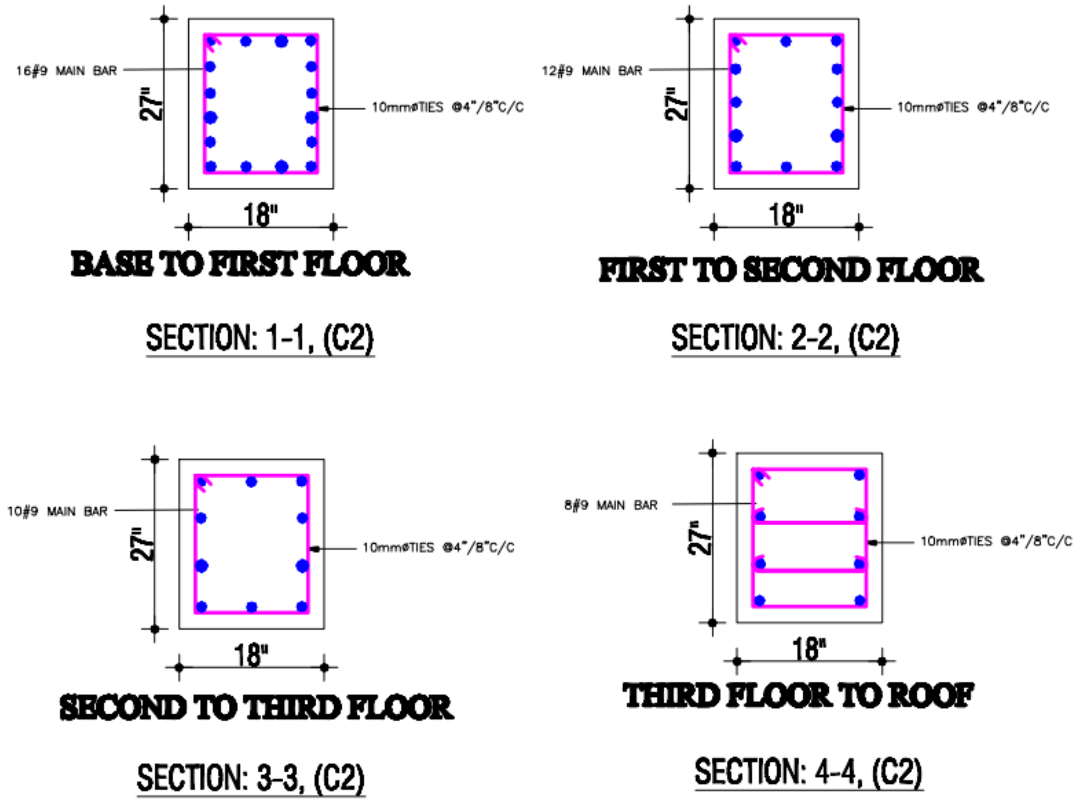


Figure 6.12 Cross Section (C1)

In this column base to first floor use number 16 main bar, first floor to second floor use number 12 main bar, second to third floor use number 10 bar and third floor to roof use number 8 bar, all main bar is no.9 bar.

Column(C3): Steel area of Ground floor is 13.894 in^2,First Floor is 12.146 in^2, Second Floor is 10.618 in^2 Third floor is 9.860 in^2 and Fourth floor is 8.090 ,fifth floor is 6.80 and sixth to Roof floor is 4.860 in^2.

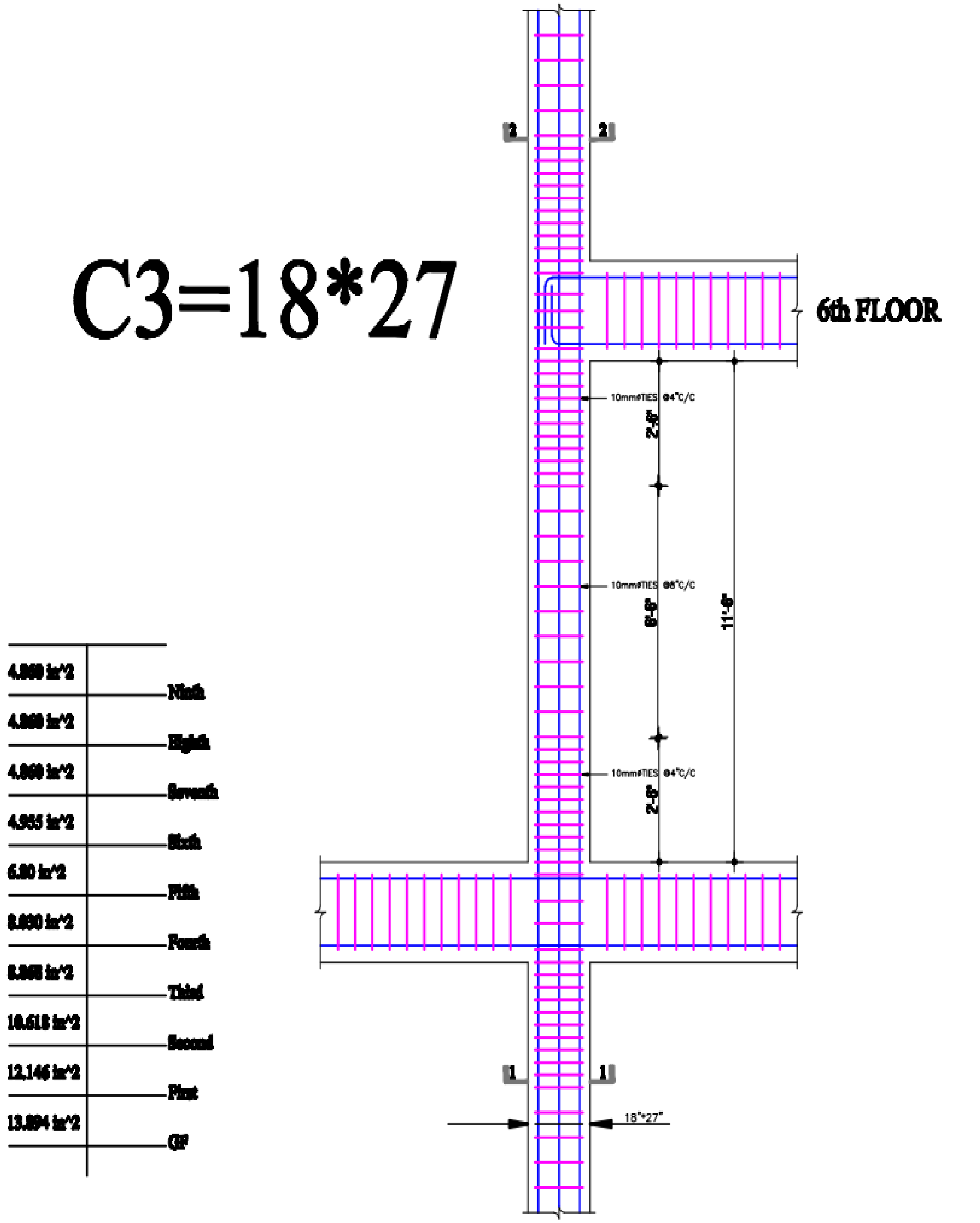


Figure 6.13 Column Detailing (C3)

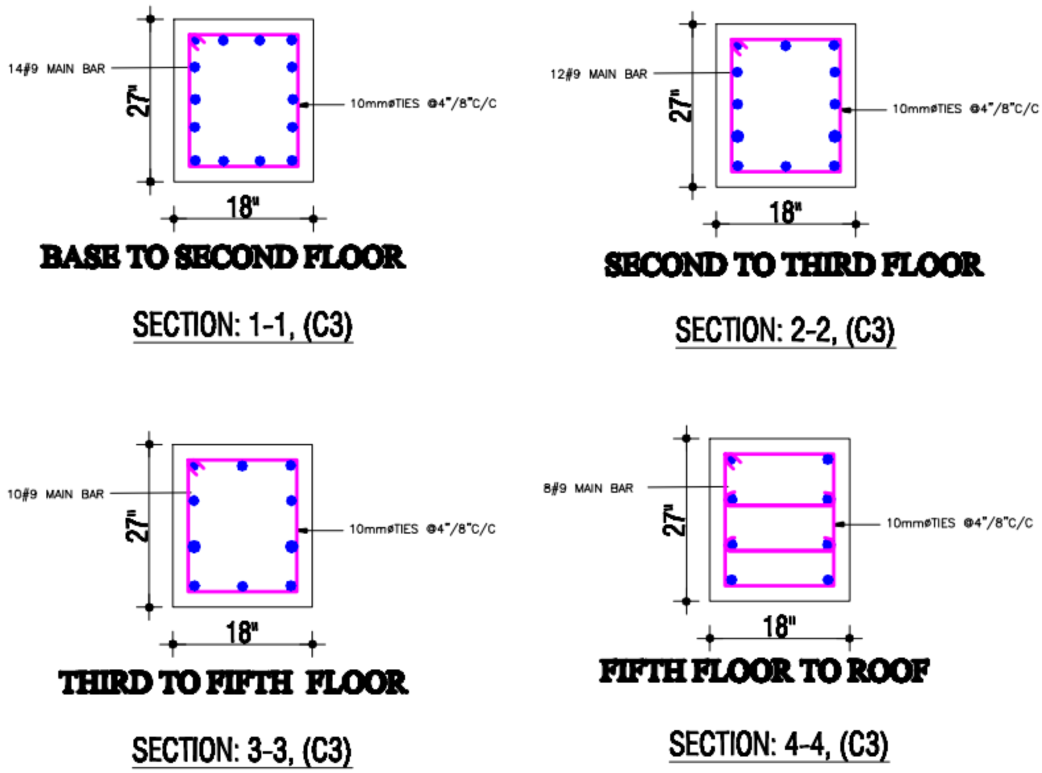


Figure 6.14 Cross Section (C3)

In this column base to first floor use number 14 main bar, first floor to second floor use number 12 main bar, second to third floor to fifth floor use number 10 bar and fifth floor to roof use number 8 bar, all main bar is no.9 bar.

Column(C4): Steel area of Ground floor is 13.581 in^2,First Floor is 10.813 in^2, Second Floor is 10.231 in^2 Third floor is 9.594 in^2 and Fourth floor is 8.485 ,fifth floor is 6.744 in^2 and sixth to Roof floor is 5.400 in^2.

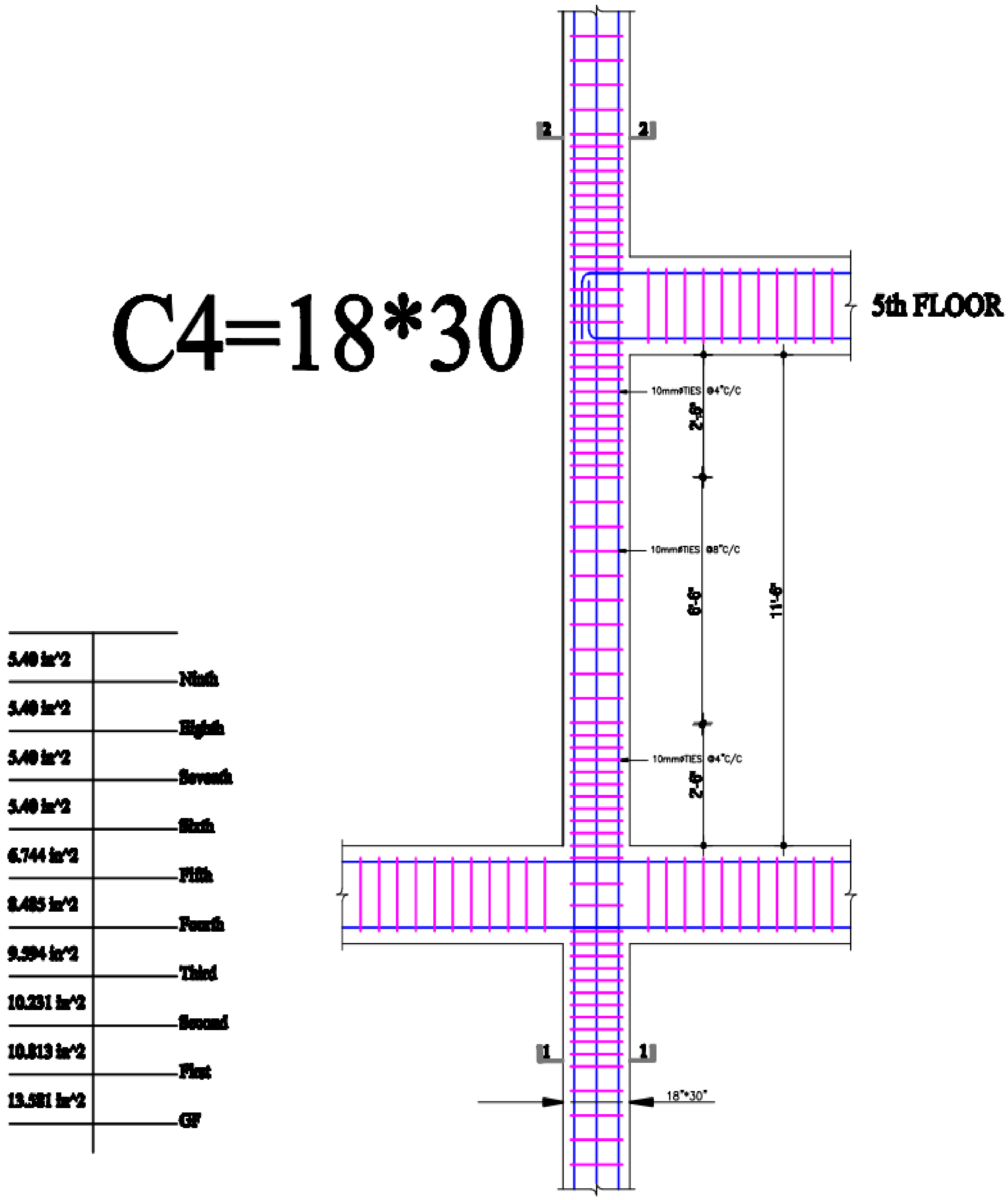


Figure 6.15 **Column Detailing (C4)**

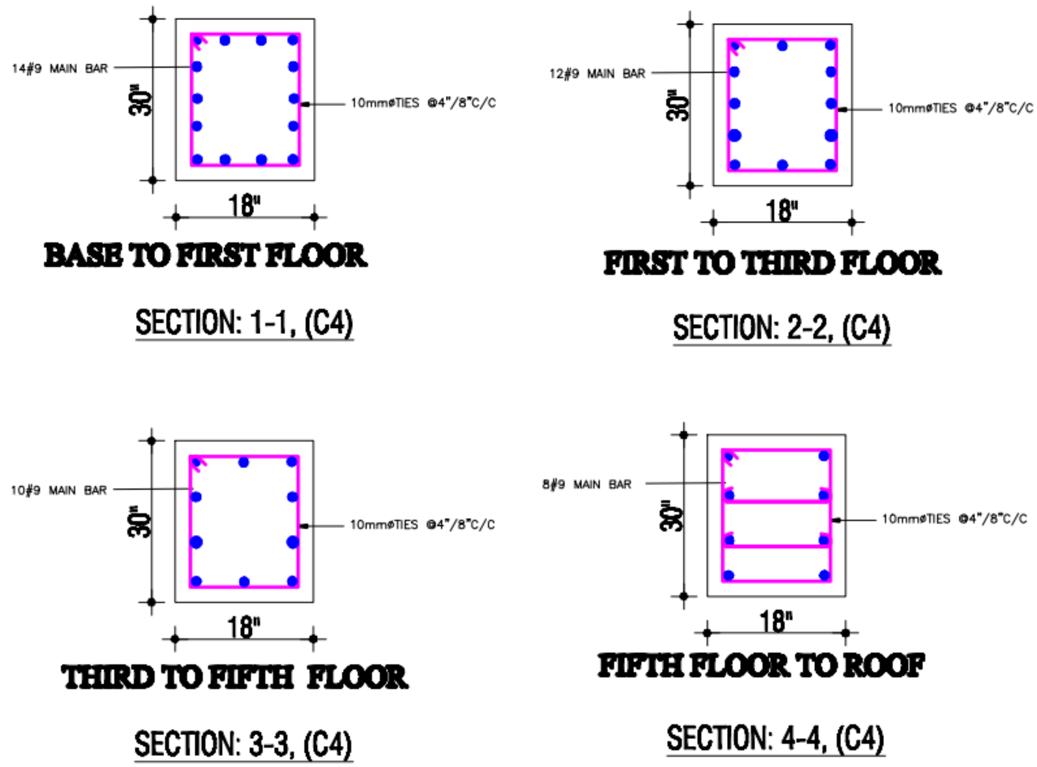


Figure 6.16 Cross Section (C4)

In this column base to first floor use number 14 main bar, first floor to second floor use number 12 main bar, second to third floor to fifth floor use number 10 bar and fifth floor to roof use number 8 bar, All main bar is no.9 bar.

CHAPTER -07

7.0 SLAB DESIGN FOR SIX STORIED

7.1 A slab is a structural element, made of concrete, that is used to create flat horizontal surfaces such as floors, roof decks and ceilings. A slab is generally several inches thick and supported by beams, columns, walls, or the ground. To design our slabs, we have collected the necessary data from ETABS outputs.

So, Thickness of slab:

Fy =60000	f′c=3500

Thickness=$\frac{\text{long length}(0.8+\frac{fy}{200000})}{36+9\beta}$

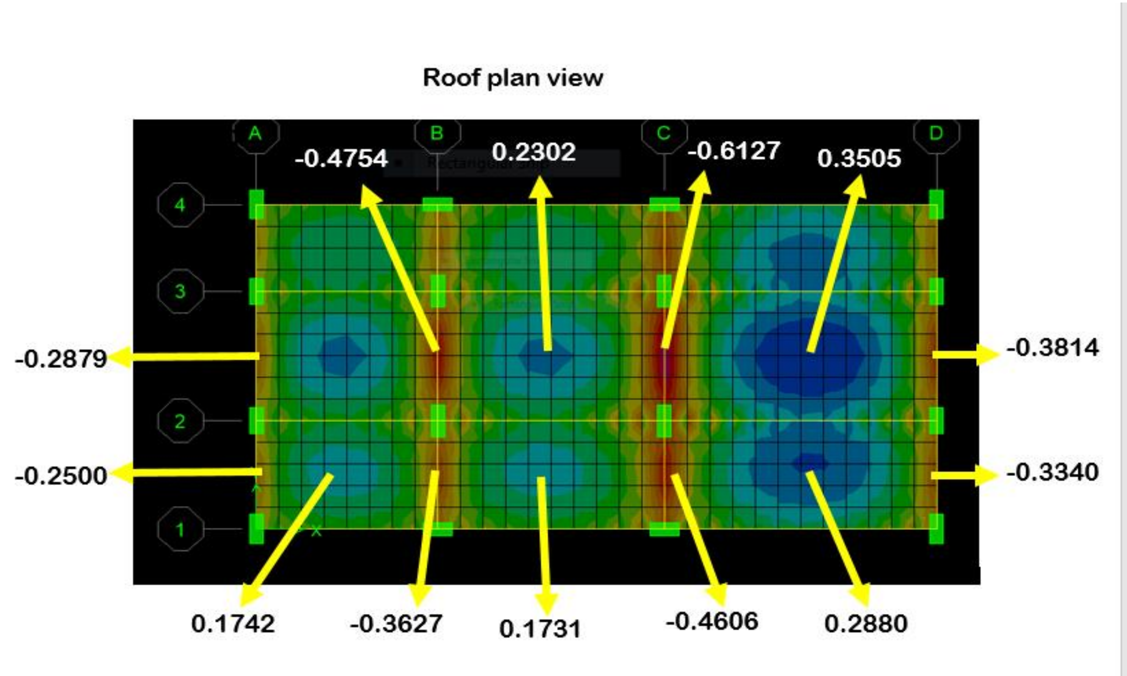
Considering the largest panel for slab thickness,

So,$\beta=\frac{20}{10}=2$

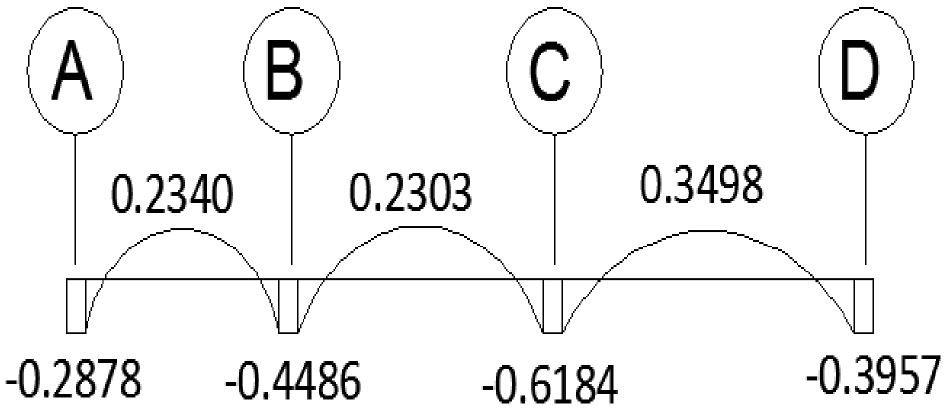
$\therefore$ Thickness=$\frac{20*12(0.8+\frac{60000}{200000})}{36+9*2}$

= 4.88= 5 inches

MOMENT ZONE OF SLAB

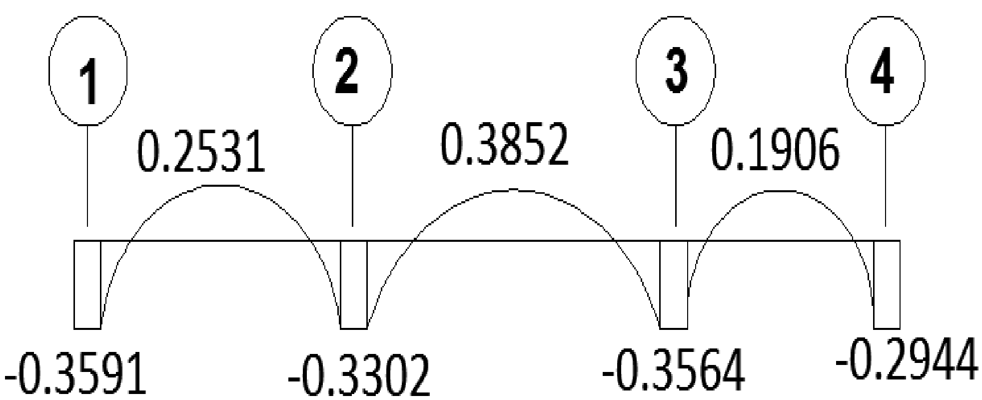


Maximum moment M-11 for each floor



Plan View-Roof

Maximum moment M-22 for each floor

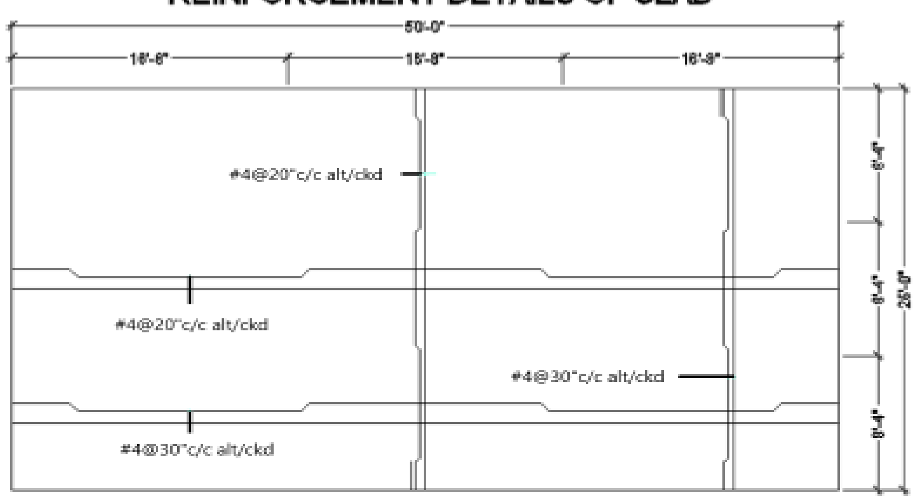


Plan view-Roof

REINFORCEMENT OF SLAB

Location	Moment (k-ft/ft)	As(min) (in^2/ft)	As (in^2/ft)	Middle strip	Corner strip
Shorter span(M-22)	+m=0.3858	=0.0018bt =0.0018*12*5 =0.12in^2/ft	0.02	#4@20" c/c alt/ckd	#4@30" c/c alt/ckd
	-m=-0.3584		0.02	No extra top needed	No extra top needed
Longer span(M-11)	+m=0.3455		0.02	#4@20" c/c alt/ckd	#4@30" c/c alt/ckd
	-m=0.5899		0.03	No extra top needed	No extra top needed

REINFORCEMENT DETAILS OF SLAB



7.00 SLAB DESIGN FOR TEN STORIED

In term of ten storied building the moment area is larger due to loading condition. According to thumbnail and output of ETABS data the thickness of slab:

Fy=60000psi	f'c=3500psi

Thickness $= \frac{\text{long lenght}(0.8+\frac{fy}{200000})}{36+9\beta}$

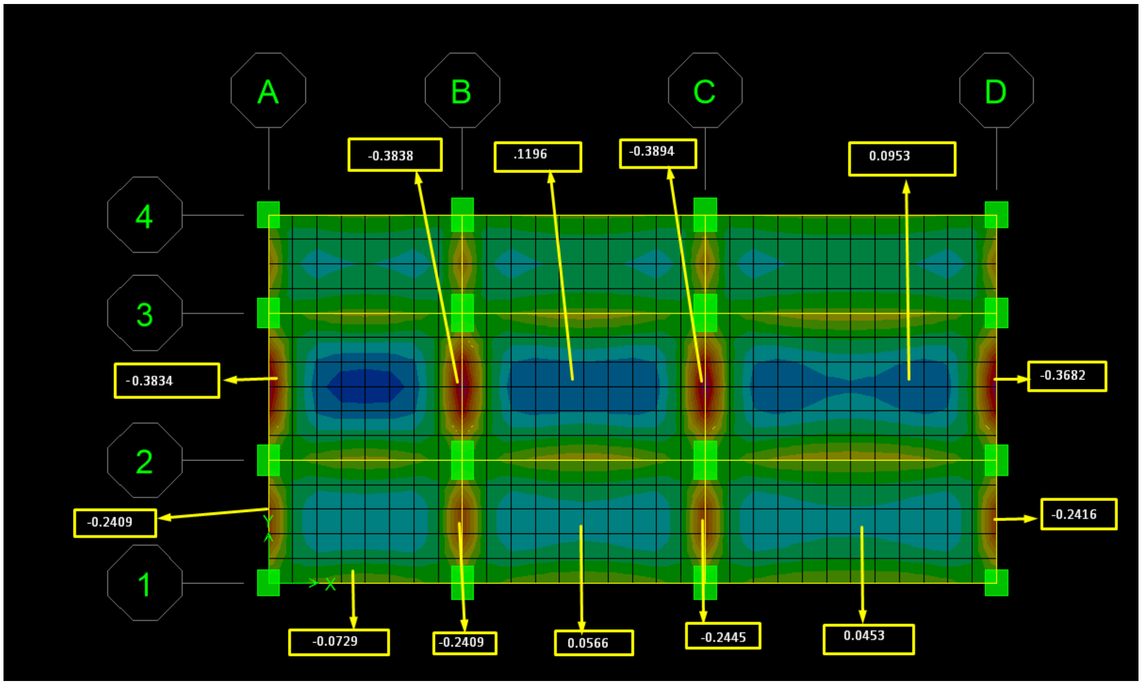
Considering the largest panel for slab thickness,

So,$\beta = \frac{20}{10} = 2$

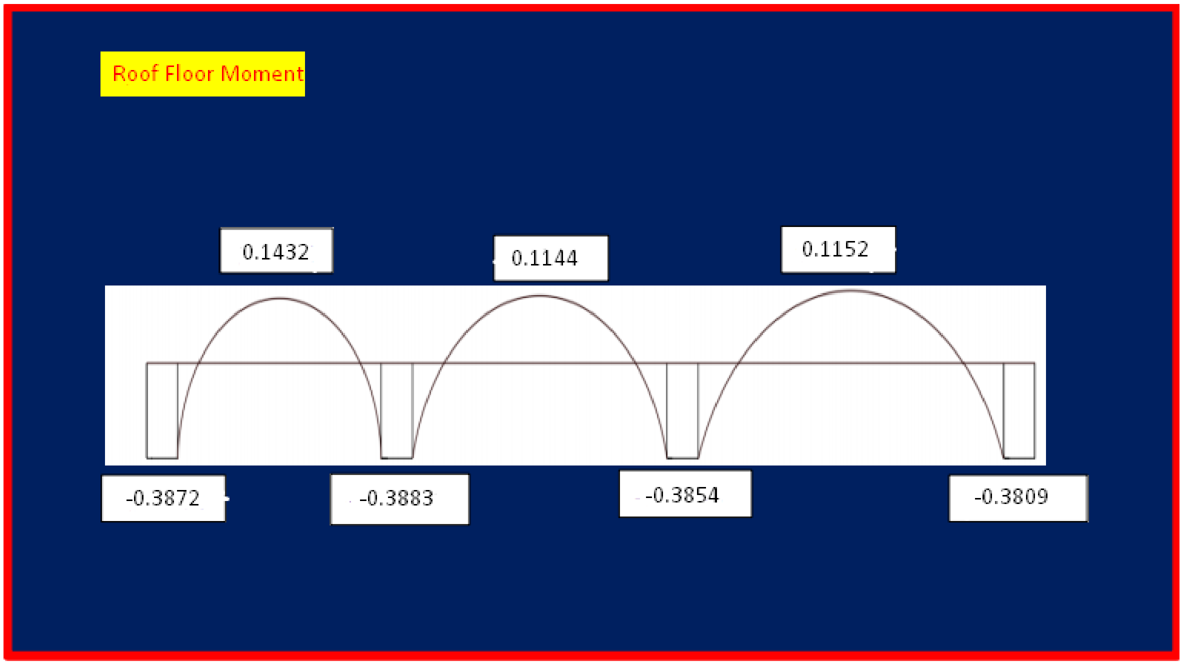
Thickness $= \frac{20*12(0.8+\frac{60000}{200000})}{36+9*2}$

=4.88̃≈5 inches

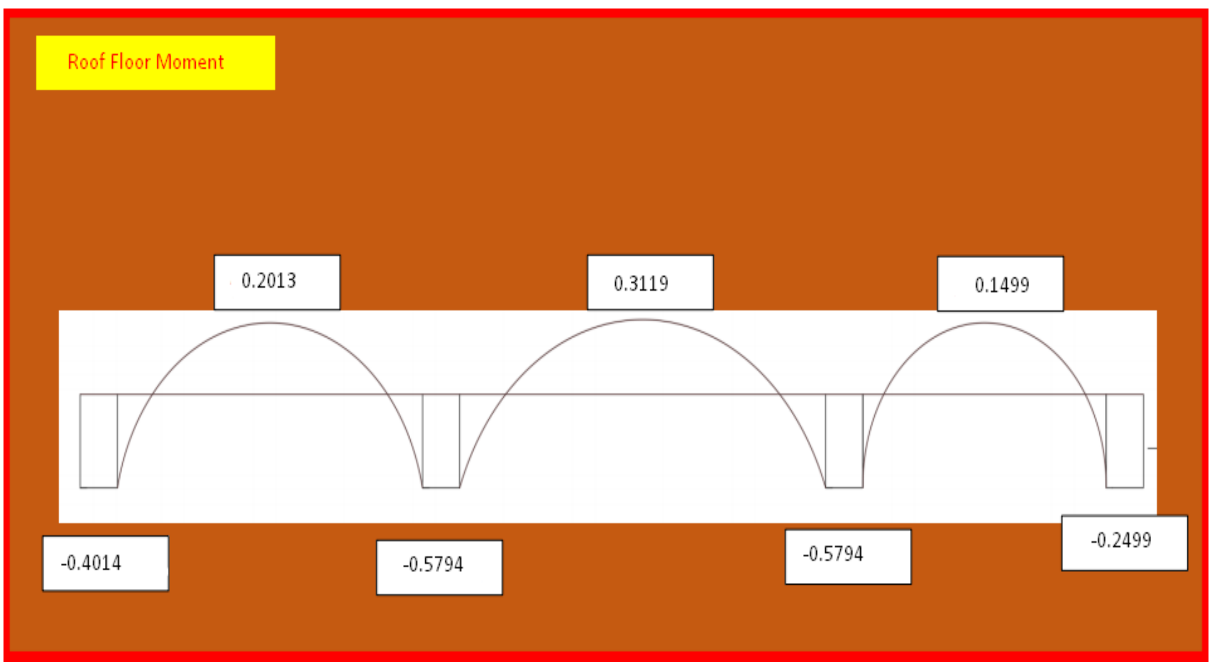
MOMENT ZONE OF SLAB



Maximum moment M-11 for each floor



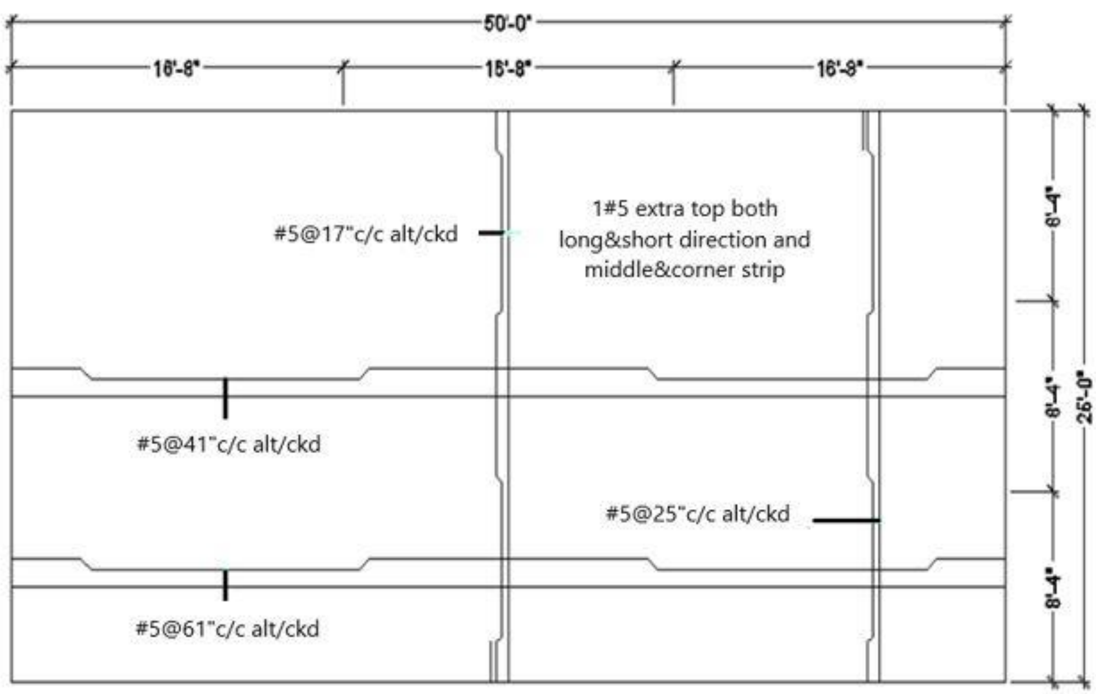
Maximum moment M-22 for each floor



REINFORCEMENT OF SLAB

Location	Moment (k-ft/ft)	As(min) (in^2/ft)	As (in^2/ft)	Middle strip	Corner strip
Shorter span(M-22)	+m=0.3119	=0.0018bt =0.0018*12*5 =0.12in^2/ft	0.21	#5@17” c/c alt/ckd	#5@25” c/c alt/ckd
	-m=-0.5794		0.42	1#5 extra top	1#5 extra top
Longer span(M-11)	+m=0.1432		0.09	#5@41” c/c alt/ckd	#5@61” c/c alt/ckd
	-m=0.3883		0.27	1#5 extra top	1#5 extra top

REINFORCEMENT DETAILS OF SLAB



CHAPTER -08

COMPARISON

In this work, our aim was to find out the amount of steel which varied from six to ten storied building. For that we have designed the buildings and took first floor of both building to estimate the reinforcement area.

In general, it is common phenomena that ten storied building need more reinforcement than six storied. It occurs due to the Dead load, Earthquake load, Wind load variation of the buildings. But we don't know how much more reinforcement required. Here the estimated values will clarify the seekers mind. That was the main theme of our thesis.

8.1: - Comparison of Column Reinforcement:

From ETABS output we got that different sizes of column for two buildings also their steel area was different. In terms of six storied building the required steel area for column is 667 kg. On the other hand, it is 1003 kg for ten storied at a same floor. 336 kg more reinforcement needed for 10 storied building comparable to 6 storied. That means 50.4% more reinforcement required. In amount, 25,200 BDT more needed in that case.

8.2: - Comparison of Beam Reinforcement:

These two buildings beam do not have a change in size but have a big change in steel area. According to ETABS data six storied building beam required 2268 kg reinforcement and the ten storied building required 3088 kg reinforcement. That means 820 kg as well as 36.16% more reinforcement needed for ten story building than six storied. That's why 61,500 BDT more required at ten storied than six.

8.3: - Comparison of Slab Reinforcement:

Though the thickness of both buildings slab is same but we used #4 bar at six storied building and #5 bar at ten storied building. We also used extra bars in terms of ten storied buildings. 6 storied building slab required 758 kg reinforcement and 10 storied building required 2414 kg reinforcement. 1656 kg more steel needed for ten storied than six. It is near 218.5% of six storied. It seems there is a huge moment in ten storied slab. So, 124,200 BDT more needed in term of ten storied.

Note: Total steel required on first floor of six storied buildings is 3673 kg and ten storied building is 6505 kg. In percentage, 77.10% more reinforcement required at ten storied first floor than six storied. In amount, it is 210,900 BDT more needed due to changes of reinforcement quantity at six to ten.

CHAPTER -09
CONCLUSION AND RECOMMENDATION

Conclusion

The main aim of studies within this project was to develop the design of a six and ten storied residential buildings and find out the variation of steel area for first floor.
We have successfully reached our goal and found out the quantity of steel which is required in first floor for both six & ten storied buildings.
By our study we got 77.10% more reinforcement required at first floor for ten storied buildings than six story.
If we consider this value in amount by 75BDT/kg, then we can see that first floor of ten storied is 2,12,400 BDT costlier than first floor of six floor in terms of reinforcement.

Many changes have been made to the same floor only for the height of the building. Increasing the number of floor and the height of a building may gather more environmental load, dead load and live load. That's why we need to provide the load resisting strength to the structure. So we used more reinforcement at our building to satisfy with more pressure. We got to know about the basic & advanced techniques of design as well as saw the challenges which a civil engineer has to face during this period.

Recommendation

From our point of view there are some places where further study may perform.

- Here two buildings are in a same zone, so changes of zone for the buildings will be interesting.
- In future, latest possible software and codes can be use.
- Variation of number of floors can be a good practice.
- WSD method can be use.

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CHAPTER -10

APPENDICES

Appendices-I

BNBC for wind load

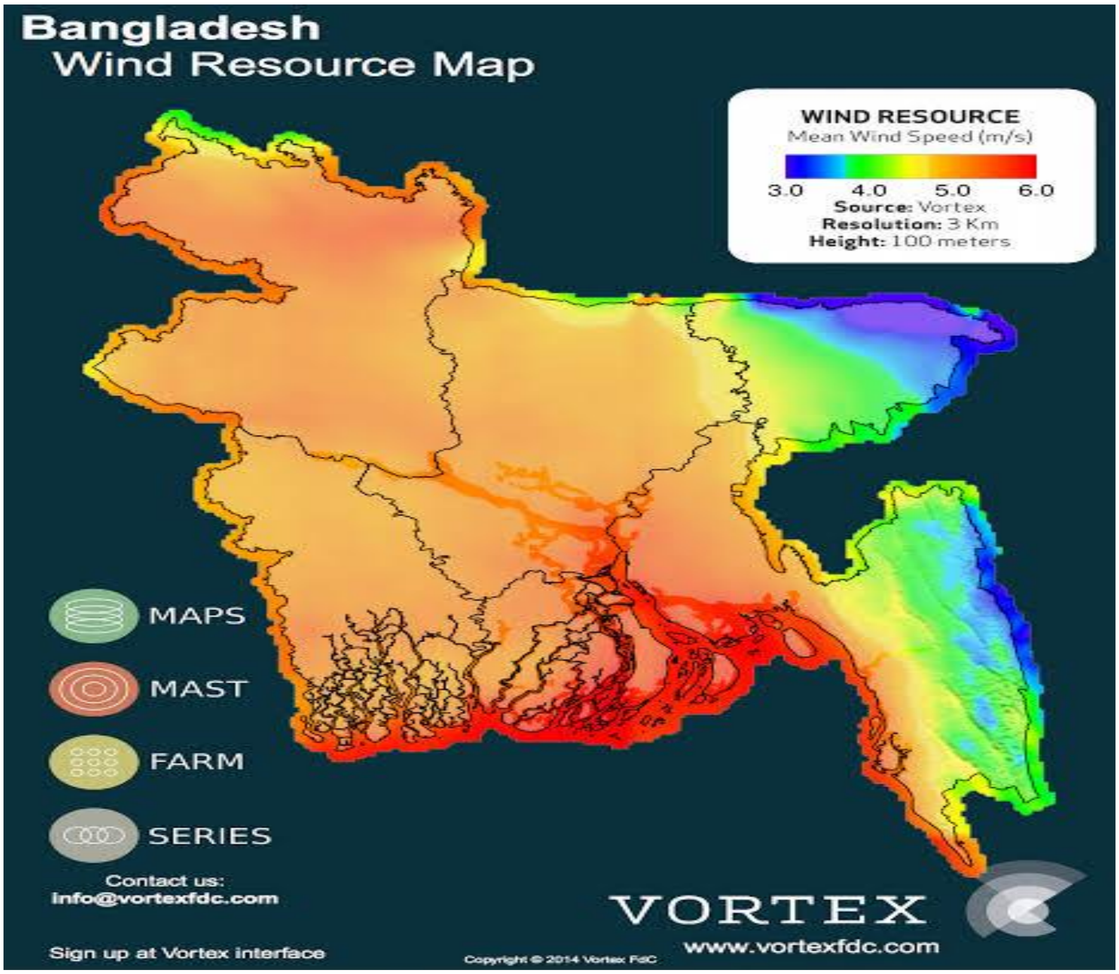

TABLE 10.1 (Wind Speed in Different Place of Bangladesh)

Location	Basic Wind Speed km/h	Location	Basic Wind Speed km/h
Angarpota	150	Lalmonirhat	204
Bagerhat	252	Madaripur	220
Bandarban	200	Magura	208
Barguna	260	Manikganj	185
Barisal	256	Meherpur	185
Bhola	225	Maheshkhali	260
Bogra	198	Moulvibazar	168
Brahmanbaria	180	Munshiganj	184
Chandpur	160	Mymensingh	217
Chapai Nawabganj	130	Naogaon	175
Chittagong	260	Narail	222
Chuadanga	198	Narayanganj	195
Comilla	196	Narsinghdi	190
Cox’s Bazar	260	Natore	198
Dahagram	150	Netrokona	210
Dhaka	210	Nilphamari	140
Dinajpur	130	Noakhali	184
Faridpur	202	Pabna	202
Feni	205	Panchagarh	130
Gaibandha	210	Patuakhali	260
Gazipur	215	Pirojpur	260
Gopalganj	242	Rajbari	188
Habiganj	172	Rajshahi	155
Hatiya	260	Rangamati	180
Ishurdi	225	Rangpur	209
Joypurhat	180	Satkhira	183
Jamalpur	180	Shariatpur	198
Jessore	205	Sherpur	200
Jhalakati	260	Sirajganj	160
Jhenaidah	208	Srimangal	160
Khagrachhari	180	St. Martin’s Island	260
Khulna	238	Sunamganj	195
Kutubdia	260	Sylhet	195
Kishoreganj	207	Sandwip	260
Kurigram	210	Tangail	160
Kushtia	215	Teknaf	260
Lakshmipur	162	Thakurgaon	130

TABLE: 10.2 (Combined Height and Exposure Coefficient, Cz)

Height above ground level, z (metres)	Coefficient, Cz (1)		
	Exposure A	Exposure B	Exposure C
0-4.5	0.368	0.801	1.196
6.0	0.415	0.866	1.263
9.0	0.497	0.972	1.370
12.0	0.565	1.055	1.451
15.0	0.624	1.125	1.517
18.0	0.677	1.185	1.573
21.0	0.725	1.238	1.623
24.0	0.769	1.286	1.667
27.0	0.810	1.330	1.706
30.0	0.849	1.371	1.743
35.0	0.909	1.433	1.797
40.0	0.965	1.488	1.846
45.0	1.017	1.539	1.890
50.0	1.065	1.586	1.930
60.0	1.155	1.671	2.002
70.0	1.237	1.746	2.065
80.0	1.313	1.814	2.120
90.0	1.383	1.876	2.171
100.0	1.450	1.934	2.217
110.0	1.513	1.987	2.260
120.0	1.572	2.037	2.299
130.0	1.629	2.084	2.337
140.0	1.684	2.129	2.371
150.0	1.736	2.171	2.404
160.0	1.787	2.212	2.436
170.0	1.835	2.250	2.465
180.0	1.883	2.287	2.494
190.0	1.928	2.323	2.521
200.0	1.973	2.357	2.547
220.0	2.058	2.422	2.596
240.0	2.139	2.483	2.641
260.0	2.217	2.541	2.684
280.0	2.910	2.595	2.724
300.0	2.362	2.647	2.762
Note : (1) Linear interpolation is acceptable for intermediate values of z.			

Appendices-II

BNBC for Earth Quake

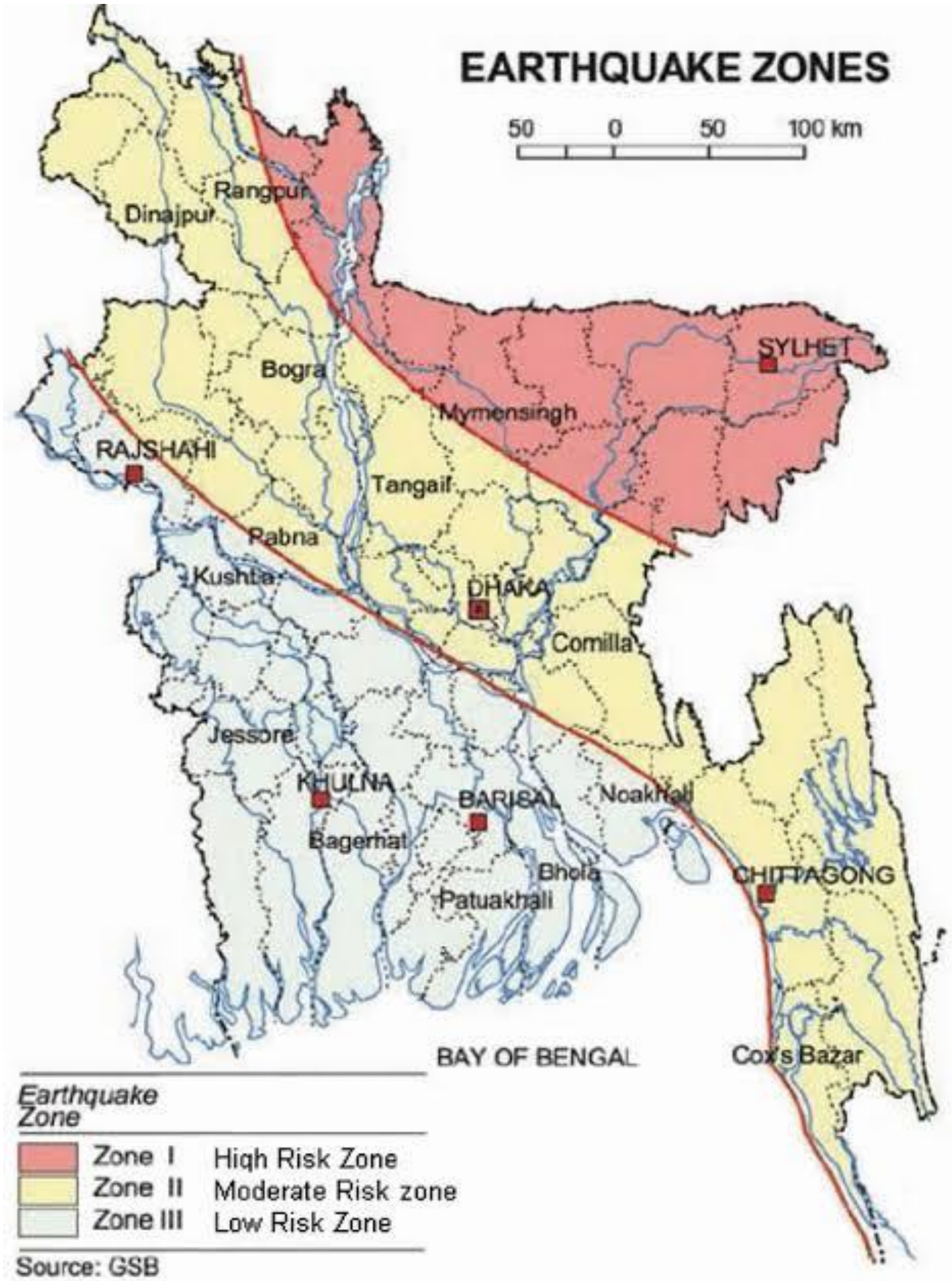

TABLE 10.3 (Seismic Zone Coefficient, Z)

Seismic Zone	Zone Coefficient
1	0.075
2	0.15
3	0.25

TABLE 10.4 (Structure Importance Coefficients, CI for Wind Loads)

Structure Importance Category (see Table 6.1.1 for Occupancy)		Structure Importance Coefficient, CI
I	Essential facilities	1.25
II	Hazardous facilities	1.25
III	Special occupancy structures	1.00
IV	Standard occupancy structures	1.00
V	Low-risk structures	0.80

TABLE: 10.5 (Site coefficient, S for Seismic Lateral Forces)

Site Soil Characteristics		
Type	**Description**	**Coefficient**
S1	A soil profile with either a) a rock-like material characterized by a shear-wave velocity greater than 762 m/s or by other suitable means of classification, or b) Stiff or dense soil condition where the soil depth is less than 61 meters.	1.00
S2	A soil profile with dense or stiff soil conditions, where the soil depth exceeds 61 meters.	1.20
S3	A soil profile 21 meters or more in depth and containing more than 6 meters of soft to medium stiff clay but not more than 12 meters of soft clay.	1.50
S4	A soil profile containing more than 12 meters of soft clay characterized by a shear wave velocity less than 1. 52 m/s	2.00

Note: (a) The site coefficient shall be established from property substantiated geotechnical data. In locations where the soil properties are not knowing in sufficient details to determine the soil profile type, soil profile S3 shall be used. Soil profile S4 need to be assumed unless the building official determines that soil profile S4 may be present at the site or in the event that soil profile S4 is established by geotechnical data.