A RESEARCH ON STUDY AND ANALYSIS OF MULTI-STOREY STEEL BUILDING USING E-TAB SOFTWARE

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***ABSTRACT*: Multi story building ranges from 23 m to 150 m height (high rise buildings) and Building above 150 m height (skyscrapers). High-rise steel structure can be made for any height as per project requirement and governing laws. Multi-storey Steel Framing System offered as a bolted structure made off site (from the factory) using beam joist cold form deck slab and steel columns or composite columns. All steel construction uses pre-fabricated components that are rapidly installed on site. Short construction periods lead to savings in site preliminaries, earlier return on investment and reduced interest charges. Time related savings can easily amount to 3 to 5% of the overall project value, reducing the client's requirements for working capital and improving cash flow. In many inner-city projects, it is important to reduce disruption to nearby buildings and roads. Steel construction dramatically reduces the impact of the construction operation on the locality. Steel offers better 'elasticity'. Concrete is more brittle and thus less suited for skyscrapers which are designed to sway with the wind. Steel concrete composite construction has gained wide acceptance worldwide as an alternative to pure steel and pure concrete construction. The use of steel in the construction industry is very low in India compared to many European countries. There is a great potential for increasing the volume of steel in construction, especially in the current development needs India and not using steel as an alternative construction material and not using it where it is economical is a heavy loss for the country. This report represents plain office steel building located in Delhi with different masses which is situated in seismic zone IV. In this study, computer–aided analysis and design of superstructure for this building is carried out by using ETABS/STAAD PRO software. In these cases, mass irregularity is considered on the bottom floor, middle floor and top floor of the proposed building. It is composed of a special moment resisting frame (SMRF). Dead loads, superimposed dead loads, live loads, wind loads and earthquake loads are considered. All structural members are designed according to IS-Code. Wide I-sections are used for frame members. Structural steel used in the building is 350 Grade steels. A regular floor plan of 3370 sq.m size is considered in this report.**

***Keywords*: High rise, ETAB, live load, Earthquake load, dead load**

<u>**Chapter -1**</u>

<u>Introduction</u>

1.1 General

Nowadays, like other countries, the growth of the population of Delhi is getting more and more. The requirements of increased population and natural geology of country highly demands the high-rise building. Delhi is situated in IV seismic zone. It is likely to meet highly destructive damage of earthquake to the buildings in some areas. Therefore, high-rise building should be designed to resist the earthquake effects. To save the construction time and other several factors, steel structures are commonly designed. Steel structures are more preferable than other structural materials like RCC. Steel members are widely used all over the world because of high strength, long life, ease of construction and fire resisting. So, most people like steel structured buildings because of the faster construction period and many others. And they can resist seismic force more than reinforced concrete buildings. The design of steel structure is done with the aid of computer software program named ETAB/STAAD PRO.

1.2 DATA PREPARATION FOR DESIGN OF STRUCTURE

Project Name : Office Building
Usage : Office Building
Location : Delhi

This report covers the structural design basis criteria for the design of office Building at Delhi. This report is dynamic in nature, will be updated at various stages of a project to document the design criteria being followed. The design has been done on the basis of client inputs and all relevant approvals should be done by the client.

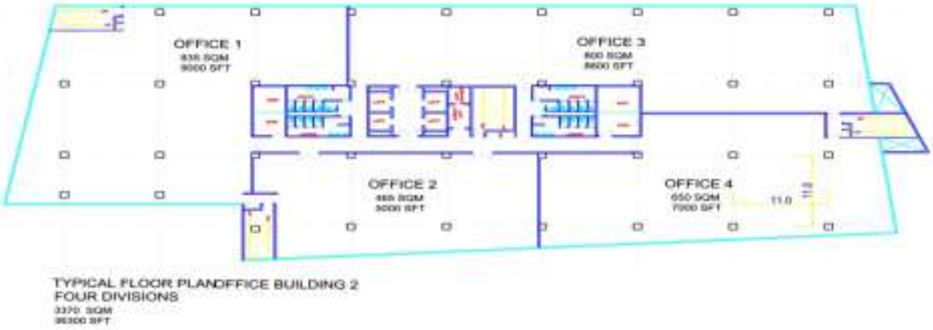

Figure 1.1 Typical Floor Plan of Building

1.3Description of Project:

A high-rise steel building is proposed to be constructed in composite Steel frame structure using fabricated section with yield strength of plate 300N/mm^2.

1.4Design lateral Loads

1.4.1 Seismic Loads

The seismic load is calculated as per IS1893-Part1 – 2002, using the input parameters as provided below

Zone factor (Z) = 0.24

Importance Factor (I) = 1.2

Response Reduction Factor (R) = 5

1.5 Load Combinations

For design of the structure all possible load combinations shall be checked for getting the highest possible stresses in members. The factor of safety on various load combinations is used as per Indian code for limit state design. The minimum mandatory load combinations as per guidelines of design codes are listed below for limit state design

1.5 DL +1.5 LL

1.5 DL ±1.5 EQ or WL

1.2 DL +1.2 LL ±1.2 EQ or WL

0.9 DL ± 1.5 EQ or WL

While considering the effect of EQ / WL, the load is applied from all four principal directions and load combinations accordingly used in the analysis

To check the deflections and drift service load combinations are used as mentioned below

1 DL + 1 LL

1 DL +1 LL ±1 EQ or WL

The various load combination used in the analysis is defined in ETABS Model.

1.6 Structure modeling & Computer Programs

3-D Analysis of all the building structures is being done using ETABS, for gravity and lateral loads. The design of columns and beams is done using ETABS for all possible load combinations and governing design for the critical load is adopted for reinforcement detailing. Analysis and design of foundation systems are being carried out using SAFE. The slabis being designed manually using excel sheet.

Computer Programs used for Engineering Calculations

ETABS

AUTOCAD

MS EXCEL

Chapter-2

Feasibility

1. Steel has the highest strength to weight ratio of any construction material, so it can provide large spans, more space with smaller size sections compared to concrete.

2. Steel provides a better cycle which enhances the schedule compared to concrete.

3. Steel materials available with no shortage despite the huge demand especially in the lastfew years also the steel construction is depending only on one type of raw material compared to RC which needs to source different types (cement, steel bars, sand, aggregates, etc.).

4. Steel is an eco-friendly building material.

5. Prefabricated Steel units have an advantage over RCC.
6. Easy installation of steel made it preferable over the other mode and material of construction.
7. Due to rapid increase in population, the growth of construction in horizontal land is restricted in mega cities so it is necessary to move in vertical direction in form of multi-storey building.

Chapter 4

Manual Calculations for Design of Columns

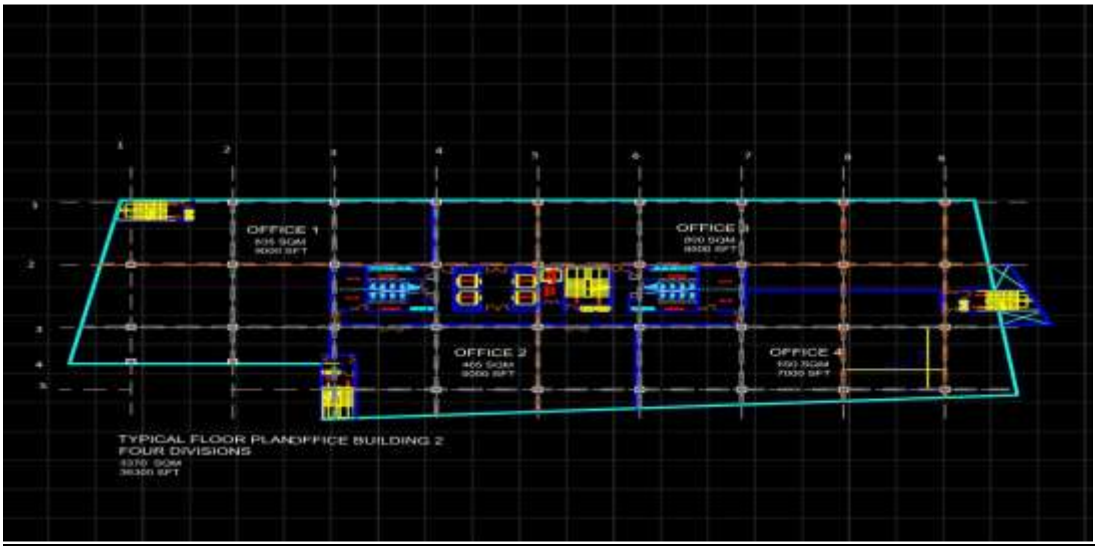

Figure.4.1 Column Numbering

For Column C_{11}
Area of Grid = 3.35×3 = 10.05 m^2
Load on Column = 362 KN
Area Required = 362000 ÷ 280 =1290 mm^2
Provided Square Section of (95*95) mm2
Check
Sectional Area = 2136 mm^2
R_{min} =36.41 mm
Slenderness Ratio =82.4
Fcc =290.5 N/mm2 where, fcc= (3.14^2*2*10^5)/ (slenderness ratio) ^2
Allowable Compressive Stress = (0.6*fcc*steel grade)/ ((steel grade^1.4+fcc^1.4) ^ (1/1.4)) = 170.73 KN/m^2
Allowable Compressive Load =364.69 KN

For Column C_{12}, C_{13}, C_{14}, C_{15}, C_{16}, C_{17} and C_{18}
Area of Grid = 5.4*3 =16.2 m^2
Load on Column = 583.2 KN
Area required = 2080 mm^2
Provided Square Section of (120*120) mm2
Check
Sectional Area = 2736 mm^2
R_{min} =46.6 mm
Slenderness Ratio =64.4
Fcc =475.8 N/mm2
Allowable Compressive Stress = 218.99 KN/m^2
Allowable Compressive Load =599.17 KN

Chapter 5

Earthquake & its consequences on structure

An earthquake is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that Create seismic waves.

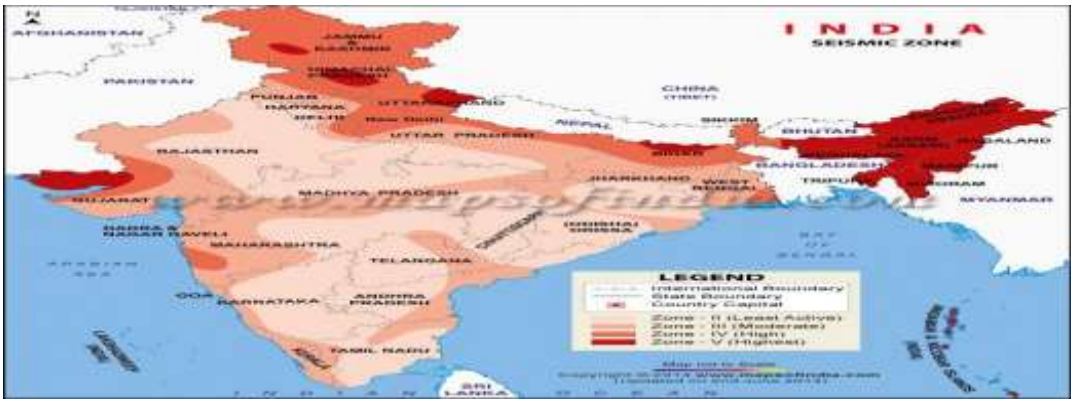

Figure 5.1 Seismic Map of India

5.1 Manual calculation of seismic loads for project structure

Given: -

G+2 floor office building

Total no. of columns=36

Total Area of Plan =2700 sq. Metre

Dead load: -

Structure steel=78.5 kN/cubic metre

Floor Finish (75 mm thickness) =1.0 KN/sq.m

On terrace in general=5 kN/sq.m

Masonry Work-AAC block=8 kN/cubic metre

Zone factor (Z)= 0.24

Importance Factor (I) = 1.2

Response Reduction factor (R) =5

Assume: -

Live Load for office =7.5 KN/sq.m

Wall thickness=12 cm

Spacing between columns=5.4 metre

Column height=3.0 m

Column size= (0.25*0.25) sq.m

Beam size= (0.55*0.19) sq.m

Solution: -

5.1.1 Calculation for D.L: -

Wt. of beams = (32+27) *78.5*(5.4*0.55*0.19)

= 2613.55 KN

Wt. of Columns =36*3.0*78.5*(0.25*0.25)

=52.9875 KN

Wt. of Slab =2700*0.075*1.5

=303.75 KN

Wt. of walls =perimeter of plan*3.5*0.12*8

= (30.33+90.41+34.59+73.88+8.31+26.76) *3.5*0.12*8

=888 KN

5.1.2 Calculation for LL: -

L.L at all floor except roof floor =7.5 KN/Sq.m

=7.5*2700

=20250 KN

5.1.3 Lumped Mass at floor levels: -

W_1=W_2 = (2613.55+52.9875+303.75+264.28+888+20250)

= 24372.56 KN

And, W_3= 24372.56-20250

= 4122.56 KN

5.1.4 Calculation for base shear: -

$V_b = A_n W$, where, W= Total seismic wt. Of building

A_n= Seismic Horizontal Coefficient

A_n= Z/2*I/R*S_a/g (For value of S_a/g, T= 0.1*n = 0.1*14 = 1.4, So, S_a/g= 2.5)

=0.24/2*1/5*2.50

= 0.06

So,

Total Seismic Wt. Of building (W) = (2*24372.56) + 4122.56

= 52867.68 KN

Therefore,

V_b= 52867.68 *0.06

= 3172.06 KN

5.1.5 Distribution of Lateral Seismic Force: -

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{i=1}^{n} W_i h_i^2}$$

Storey level	W_i (KN)	h_i (m)	$W_i h_i^2$ (KN-m²)	Q_i	v_i
3	4122.56	9	333927.36	740.36	740.36
2	24372.56	6	877412.16	1945.35	2685.71
1	24372.56	3	219353.04	486.34	3172.05

$\sum W_i h_i^2$=1430692.56

Table-5.1 Calculations of lateral seismic forces

So, these are the values of horizontal shear force at different floor levels, hence the structure should be designed for these respective values of horizontal shear force.

Chapter -6

Manual Calculations of Slab Designed

6.1 Depth of slab: -

$\frac{\text{Span}}{\text{d}} = 26 \times \text{M.F}$

Assume Percentage steel = 0.3 %

So, M.F = 1.5

$\frac{2700}{\text{d}} = 26 \times 1.5$

d = 69.23 m

d ≅ 70 m

Assume cover of 15m and 8mm dia. Bar,

So, D = d + $\frac{\phi}{2}$ + cover

= 70 + 4 + 15

= 90 mm

L_e = L + d

Or

L_e = L + b

(Whichever is less)

So,

L_e = 2700 + 70

Or

L_e = 2700 + 230

So, L_e = 2770 mm or 2.77 m

6.2 Ultimate Load: -

Dead load = 4.75 KN/m

Live Load = 4 KN/m

W = 8.75 KN/m

W_u = 13.125 KN/m

6.3Factored Bending Moment: -

$M_u = W_u L^2 / 8$

$= \frac{13.125 \times 2.77 \times 2.77}{8}$

= 12.588 KN.m

Required Depth: -

$d = \sqrt[2]{\frac{Mu}{0.138 \text{ fck b}}}$

$d = \sqrt[2]{\frac{12.588 \times 1000000}{0.138 \times 20 \times 1000}}$

$d = 67.53$ m $< d_{provided}$ (OK)

6.4 Main Reinforcement: -

$A_{st} = \frac{0.5 \text{ fck}}{\text{fy}}\left[1 - \sqrt[2]{1 - \frac{4.6 \text{ Mu}}{\text{fck} \times b \times d \times d}}\right] d$

$A_{st} = 173.66$ mm^2

≅ 180 mm^2

6.5 Minimum Steel: -

A_{st} min $= \frac{0.12}{100} \times 1000 \times 90$

= 108 mm^2

OK.

So, Provide 8 mm dia. bars.

6.6 Spacing: -

$S = 1000\, A_{\phi} / A_{st}$

$= (1000 \times 50.24) / 180$

= 279.3

= 280 mm

6.7 Distribution Steel: -

$A_{st} = 108$ mm^2

Spacing, S = $(1000 \times 50.27) / 108$

$= 465.46 \geq 5d$

= 350 mm

6.8 Check for deflection: -

A_{st} Provided = $1000\, A_{\phi} / S$

$= \frac{1000 \times 50.27}{280}$

= 180 mm^2

A_{st} Req. = 173.8 mm^2,

$F_s = 0.58\, f_y \frac{\text{Ast req}}{\text{Ast provided}}$

$= 0.58 \times 415 \times \frac{173.8}{180}$

= 232.4 N/mm^2

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% pt Provided = $100\, A_{stp}$ / (bd)

$= \frac{100 \times 180}{1000 \times 70}$

= 0.257

So, for pt. % = 0.257, fs = 232.5

M.F = 2.40

Hence, Actual deflection = Span / d

= 2700 / 70

= 38 mm

Permissible Deflection = $\text{B.V} \times \text{M.f}$

$= 20 \times 2.48$

= 48 mm

So, Actual deflection $<$Permissible Deflection

Chapter -7
Manual Calculation for Design of Beam

7.1 Design

Flange Width provided by Slab = 270 cm

Thickness of Slab= 10 cm

Span of Beam = 5.4 cm

Total Load = 13×5.4×100

= 7020 kg/m

Compressive Force(c) = 70 kg/cm^3

Tensile Force = 1400 kg/cm^3

Modular Ratio = $\frac{2800}{3\times c}$

= 13.33

Maximum Bending Moment (M) = $\frac{7020\times 5.4\times 5.4\times 100}{8}$

Section Modulus (Z) = $\frac{M}{1400}$

=1827.707 cm^3

Let us try ISMB 550 with cover plate 120×25 mm

Area of Steel = Joist + Plate

= 132.11 + 12×2.5

= 162.11 cm^2

Area of Slab = 270×10

= 2700 cm^2

$Y_t = \frac{132.11\times 27.5+12\times 2.5\times 56.25}{162.11}$

Y_b = 57.5 – 32.82

= 24.67

I_s = Moment of inertia of steel section about its own neutral Axis

$I_s = 64893.6 + 132.11(32.82 - 27.5) + \frac{12\times 2.5\times 2.5\times 2.5}{12} + 12\times 2.5\,(24.67 - 1.25)^2$

= 85103.147 cm^4

I_C = Moment of inertia of concrete

$= \frac{270\times 1000}{12}$

= 22500 cm^4

Y_{cs} = Distance between C.G of Concrete and C.G of steel

$= A_s + \frac{1}{m}\times A_s$

$= 162.11 + \frac{2700}{13}$

= 369.8 cm^2

Y_o = Distance of C.G of concrete from Neutral Axis of Compression Section

$= \frac{Ycs\times As}{Asc}$

$= \frac{162.11 \times 37.82}{369.8}$

16.57 cm

Y_c = Distance between N.A of Compression Section and C.G of Steel Section = ycs - y_o

= 37.82 – 16.57

= 21.24 cm

I_{cs} = Moment of inertia of equivalent section about N.A of compression section

$= I_s + \frac{Ic}{m} + A_s \times y_c \times y_{cs}$

$= 85103.147 + \frac{22500}{13} + 162.110 \times 21.24 \times 37.82$

= 217056.36 cm^4

7.2 Check for Bending Stress: -

Max. Tensile Stress in steel = $\frac{2558790}{217056.36} \times (37.82 + 2.5)$

= 475.31 kg/cm^2

Max. Compressive Stress in steel = $\frac{2558790}{217056.36} \times (16.57 - 5)$

= 136.39 kg/cm^2

Max. Tensile Stress in Concrete = $\frac{1}{13} \times \frac{2558790}{217056.36} \times (11.57 + 10)$

= 19.56 kg/cm^2

7.3 Analysis for Shear:

Horizontal Shear per cm (S_h) = $\frac{V \times Mo}{Ics}$

Maximum Shear Force at support (V) = $\frac{7020 \times 5.4}{2}$

= 18954 kg

Static Moment of Transformed area of Slab about Neutral Axis of Composite Section (M_o)

$= \frac{270 \times 10 \times 16.57}{13}$

= 3441.46 cm^3

$S_h = \frac{18954 \times 3441.46}{217056.36}$

= 300.518 kg/cm

Let 20 mm diameter (d) studs to be provided

Let Height (H) of studs be 80 mm

$\frac{H}{d}$ = 4 (ratio less than 4.2)

Safe Shear Resistance of one Stud (Q) = $4.8 \times H \times d \times \sqrt{\sigma cs}$

$= 4.8 \times 8 \times 2 \times \sqrt{200}$

= 1086 kg

If single row of Stud be provided,

Pitch of studs = $\frac{1086}{300.518}$

= 3.613 cm = 4 cm (approx.)

Chapter 8

Etab Model Analysis

8.1 Structure Data

This chapter provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

8.2 Story Data

Name	Height mm	Elevation Mm
third	3000	9000
second	3000	6000
first	3000	3000
ground	0	0

Table 8.1 Story Data

8.3 Reinforcement Sizes

Name	Diameter mm	Area mm^2
10	10	79
18	18	255
20	20	314

Table 8.4 Reinforcing Bar Sizes

8.4 Frame Assignments

Story	Label	Unique Name	Design Type	Length mm	Analysis Section	Design Section
third	C2	122	Column	3000	C22 175X175	C22 175X175
third	C3	99	Column	3000	C22 175X175	C22 175X175
third	C4	100	Column	3000	C22 175X175	C22 175X175
third	C5	101	Column	3000	C22 175X175	C22 175X175
second	C34	217	Column	3000	C22 180X180	C22 180X180
second	C35	230	Column	3000	C22 180X180	C22 180X180
second	C36	232	Column	3000	C22 180X180	C22 180X180
second	C39	250	Column	3000	C22 180X180	C22 180X180
first	C2	24	Column	3000	C39 250X250	C39 250X250
first	C3	1	Column	3000	C39 250X250	C39 250X250
first	C4	2	Column	3000	C39 250X250	C39 250X250
first	C5	3	Column	3000	C39 250X250	C39 250X250
third	B1	136	Beam	5400	comp beam	comp beam
third	B2	137	Beam	5400	comp beam	comp beam
third	B3	138	Beam	5400	comp beam	comp beam
third	B4	139	Beam	5400	comp beam	comp beam
third	B5	140	Beam	5400	comp beam	comp beam
second	B1	234	Beam	5400	comp beam	comp beam
second	B2	235	Beam	5400	comp beam	comp beam
second	B3	236	Beam	5400	comp beam	comp beam
second	B4	237	Beam	5400	comp beam	comp beam

second	B5	238	Beam	5400	comp beam	comp beam
first	B1	38	Beam	5400	comp beam	comp beam
first	B2	39	Beam	5400	comp beam	comp beam
first	B3	40	Beam	5400	comp beam	comp beam
first	B4	41	Beam	5400	comp beam	comp beam
first	B5	42	Beam	5400	comp beam	comp beam

Table 8.6 Frame Assignments – Summary

8.5 Auto Seismic Loading

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQX+ according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = X + Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 2] $Z = 0.24$

Response Reduction Factor, R [IS Table 7] $R = 5$

Importance Factor, I [IS Table 6] $I = 1.2$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.5] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 1.800331$

Equivalent Lateral Forces

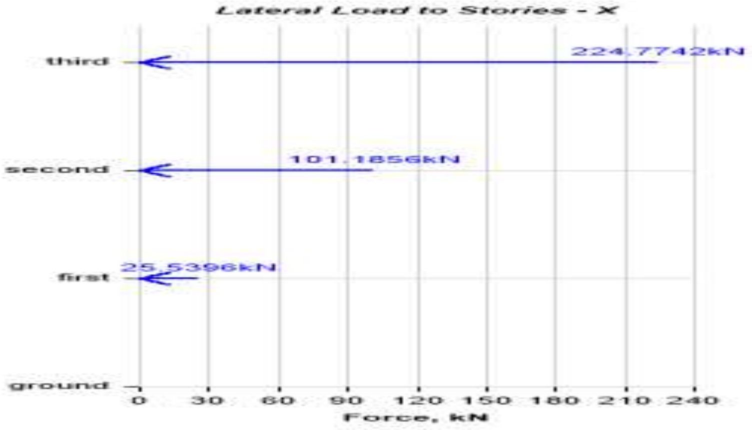
Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	**Period Used (sec)**	**W (kN)**	**V_b (kN)**
X + Ecc. Y	0.755	6779.2212	351.4994

Table 8.9 Base Shear

Applied Story Forces



Story	Elevation (m)	X-Dir KN	Y-Dir KN
third	9	224.7742	0
second	6	101.1856	0
first	3	25.5396	0
ground	0	0	0

Table 8.10 Storey load

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQX- according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = X - Eccentricity Y

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

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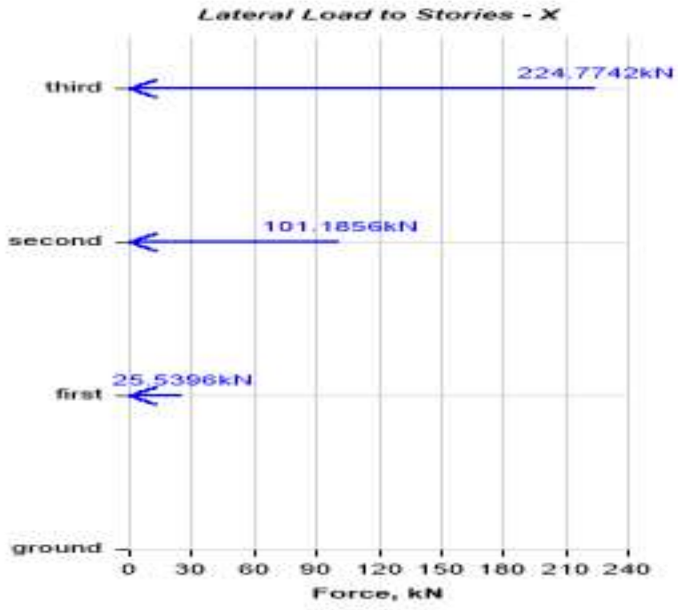
Direction	Period Used (sec)	W (kN)	V_b (kN)
X - Ecc. Y	0.755	6779.2212	351.4994

Table 8.11 Base Shear

Applied Story Forces



Story	Elevation (m)	X-Dir KN	Y-Dir KN
third	9	224.7742	0
second	6	101.1856	0
first	3	25.5396	0

Table 8.11 Storey Forces

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQY+ according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = Y + Eccentricity X

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 2] $Z = 0.24$

Response Reduction Factor, R [IS Table 7] $R = 5$

Importance Factor, I [IS Table 6] $I = 1.2$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.5] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 1.768826$

Equivalent Lateral Forces

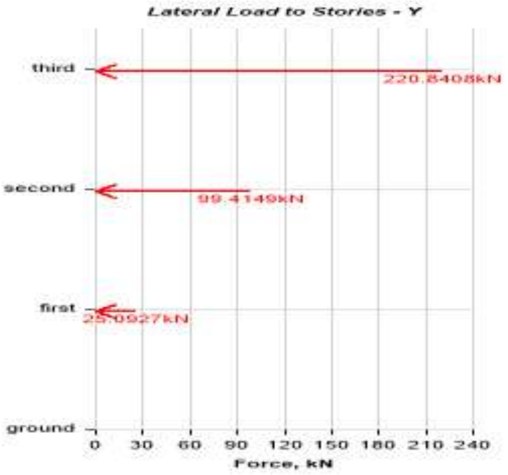
Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{ZI\frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y + Ecc. X	0.769	6779.2212	345.3485

Table 8.12 Base Shear

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	M	kN	kN
third	9	0	220.8408
second	6	0	99.4149
first	3	0	25.0927
ground	0	0	0

Table 8.13 Storey Forces

IS1893 2002 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQY- according to IS1893 2002, as calculated by ETABS.

Direction and Eccentricity

Direction = Y - Eccentricity X

Eccentricity Ratio = 5% for all diaphragms

Structural Period

Period Calculation Method = Program Calculated

Factors and Coefficients

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Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2]

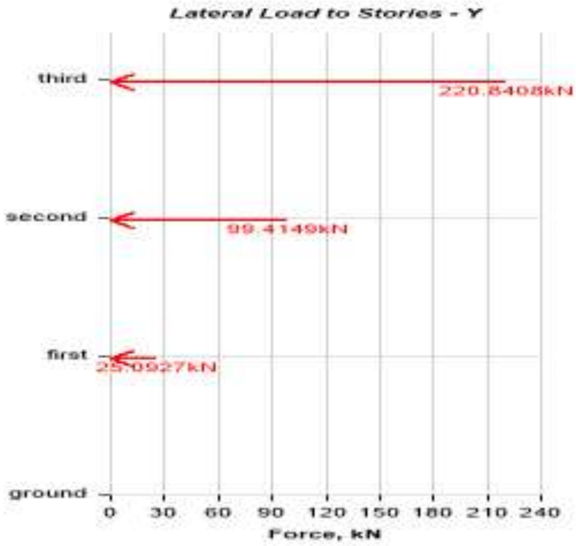
$$A_h = \frac{ZI\frac{S_a}{g}}{2R}$$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y - Ecc. X	0.769	6779.2212	345.3485

Table 8.8 Base Shear

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	M	kN	kN
third	9	0	220.8408
second	6	0	99.4149
first	3	0	25.0927
ground	0	0	0

Table 8.8 Storey Forces

8.6 Applied Loads

The applied loads are given below

8.6.1 Area Loads

Story	Label	Unique Name	Load Pattern	Direction	Load kN/m^2
Third	F5	25	Live	Gravity	7.5
Second	F28	72	Live	Gravity	7.5
First	F27	23	Live	Gravity	7.5
Third	F28	48	FLOOR FINISH	Gravity	1
Second	F5	49	FLOOR FINISH	Gravity	1
First	F26	22	FLOOR FINISH	Gravity	1
Third	F23	43	WALL LOAD	Gravity	2
Second	F18	62	WALL LOAD	Gravity	2
First	F5	1	WALL LOAD	Gravity	2

Table 8.9 Shell Loads - Uniform

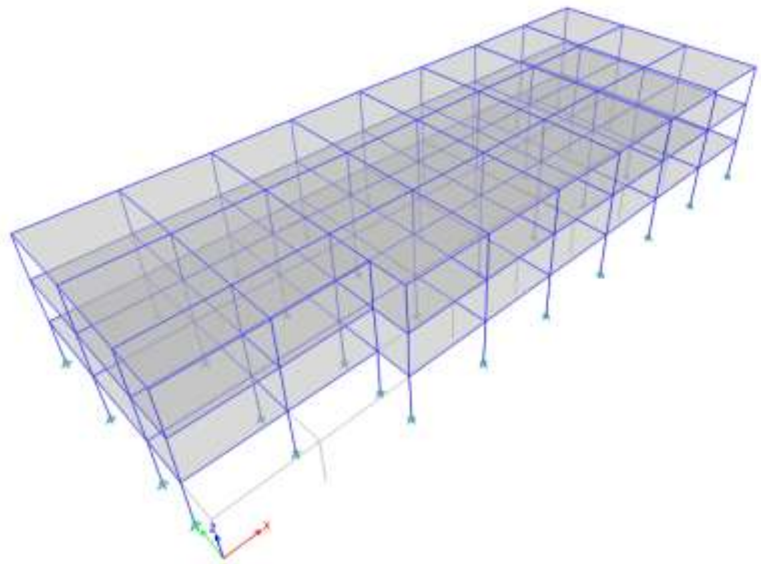


Figure.8.22 E-TAB MODEL

8.7 Result Analysis by E-tab Model diagram

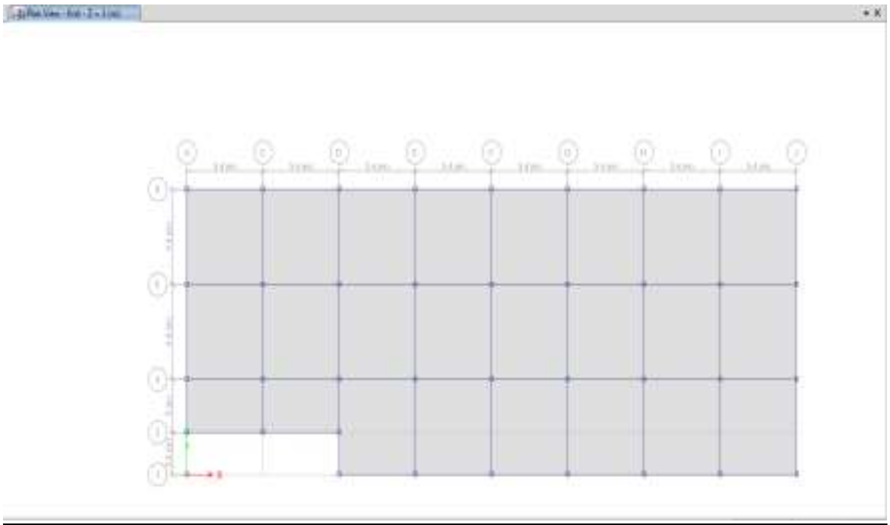


Figure.8.1 Plan view

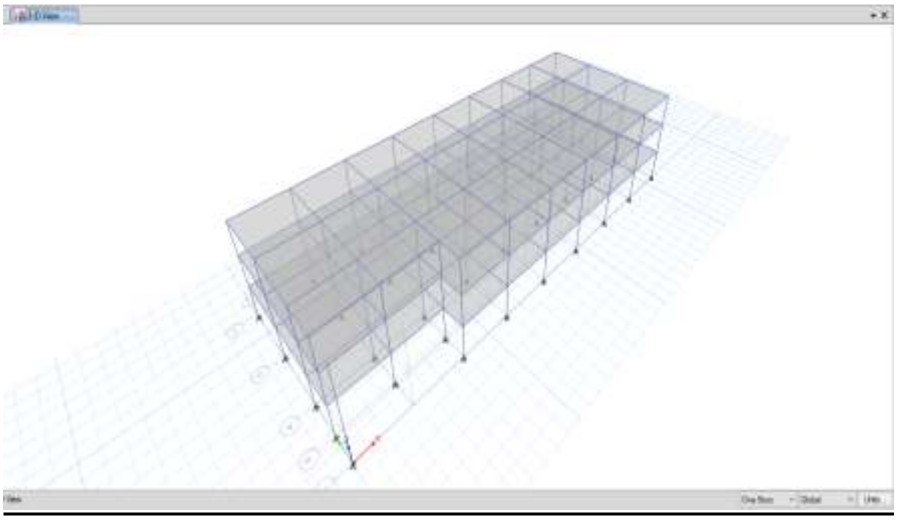


Figure.8.2 3-D view

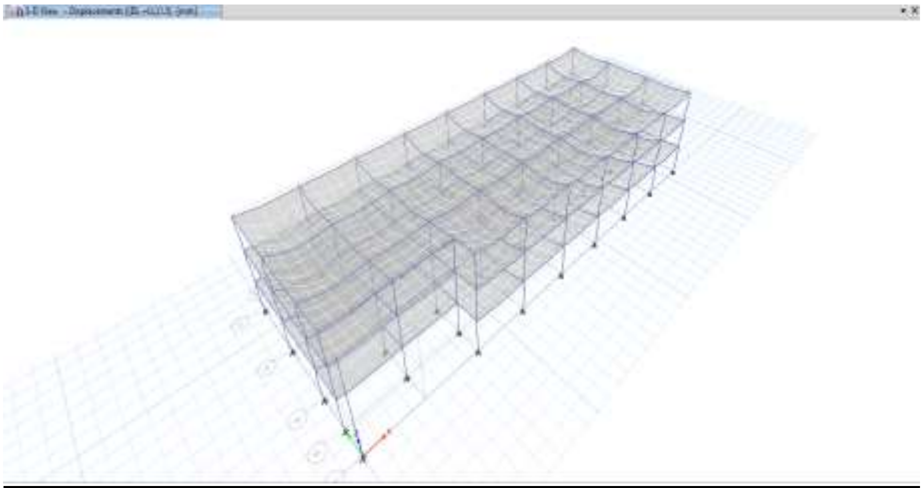


Figure.8.3 Displacement diagram

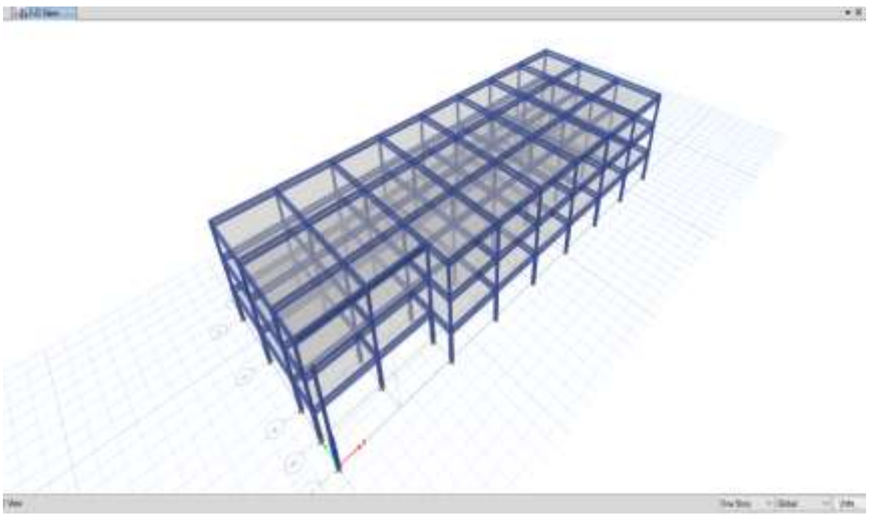


Figure.8.4 3-D view with Extrude view

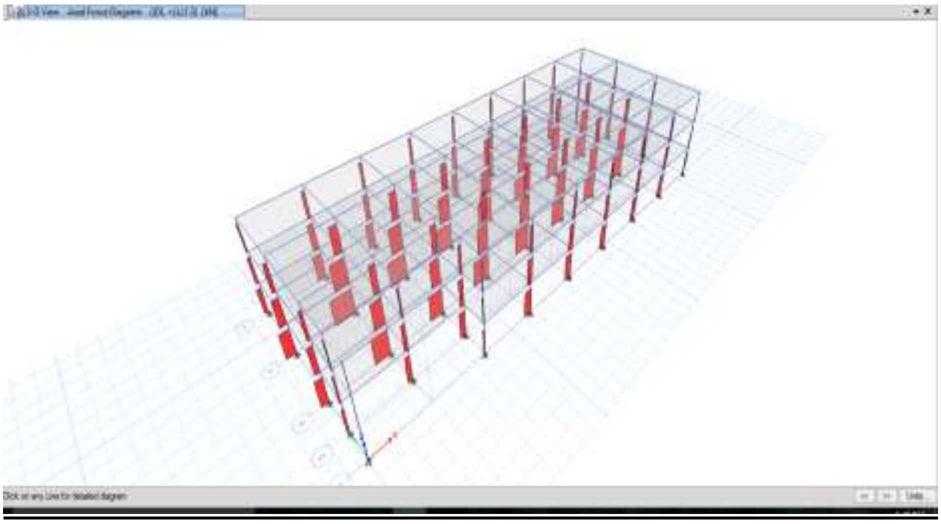


Figure.8.5 Axial Force Diagram

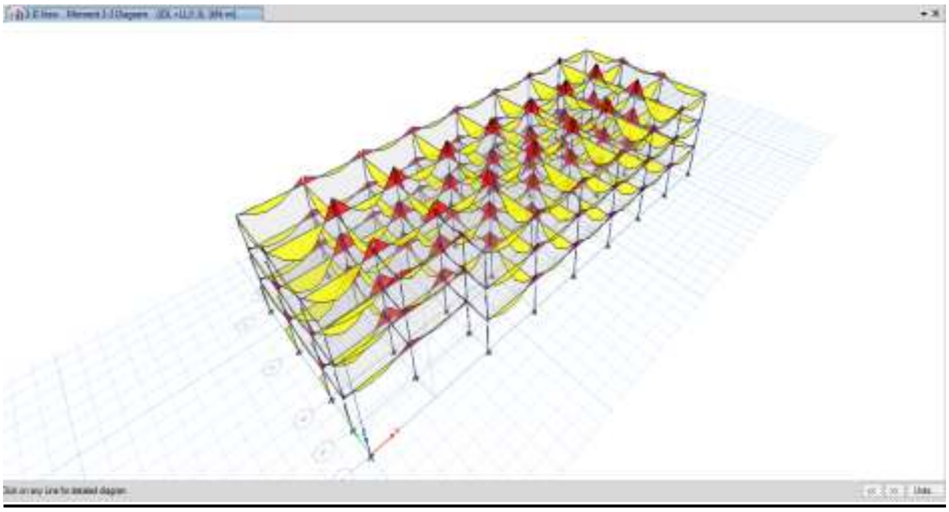


Figure.8.6 3-D View Moment 3D Diagram

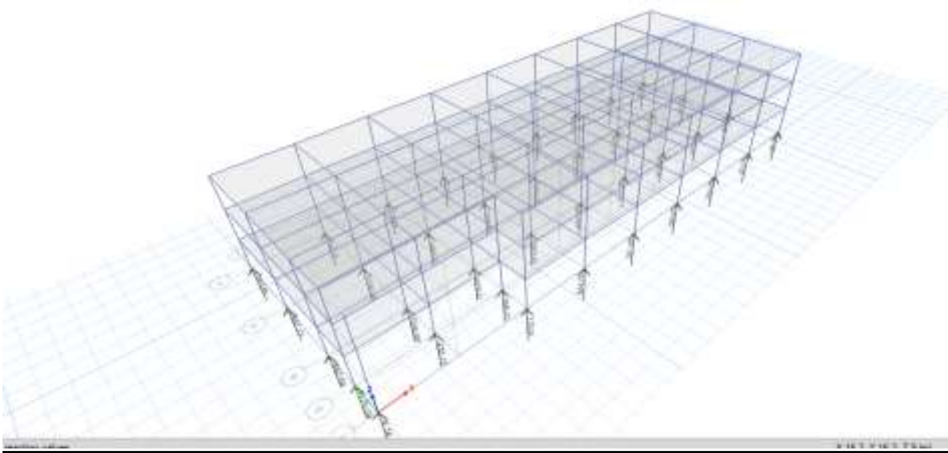


Figure.8.7 3-D Support Reaction

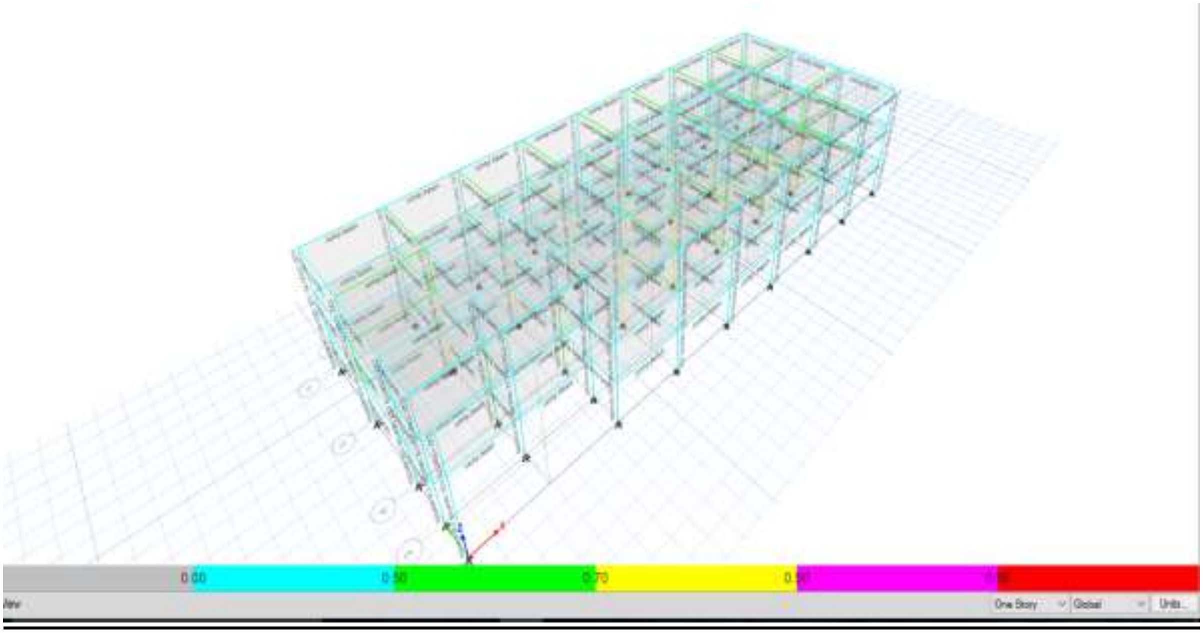


Figure.8.8 Run Analysis diagram

Conclusion

From the data revealed by the manual design as well as software analysis for the structures following conclusions are drawn:

1. Analysis was done by using ETABS software and successfully verified manually as per IS codes.

2. Calculation by both manual work as well as software analysis gives almost same result.

3. Further the work is extended for a 3 storey building and found that the results are matching.

4. As the 3-storey building has similar floors ETABS is the perfect software which can be adopted for analysis and design.

5. Usage of ETABS software minimizes the time required for analysis and design.

6.All the list of failed beams, columns, joint can be obtained and also better section is given by the software.

7.It is observed that longer span of beam has more shear forces and bending moments when compared to shorter span.

8. The interior column carries more loads than the exterior column.

9. Shear force and bending moment increases for both beams and columns as the storey height increases.

10. To resist these seismic forces either the beam & column dimensions are increased or the shear walls should be provided to oppose the lateral forces instead of masonry walls.

11.Comparison of Manual and E-tab model calculation

Design parameter	Manual Calculation	E-tab Analysis Result
1. Column (180*180) without Seismic Load	Sustain	Sustain
2. Column (250*250) with Seismic Load	Sustain	Sustain
3. Composite Beam of grade M20	Sustain	Sustain
4. Concrete Slab	Sustain	Sustain

Table 9.1 Comparison of Manual and E-tab model calculation

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IS-Code Books

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IS: 875 (Part-2)-1987: - Code of Practice for Design Loads (Other than Earthquake) for Building and Structures-Imposed loads

IS: 456 -2000: - Code of Practice for Plain and Reinforced Concrete.

IS: 1893 (Part-1)-2002: - Indian Standard Criteria for Earthquake Resistant Design of Structures

IS 800-2007: - General Construction in Steel – Code of Practice.

SP 6 part 1 For design of column