Analysis & Design of G+10 Steel Framed Structure using Staad.Pro

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Abstract - *The study of this paper reviews to analysis and design of G+10 steel framed building using software STAAD.Pro. India being a developing country the use of the steel structure is less than other countries. In the cities where we have shortage of land the horizontal expansion of buildings is not possible so we have to expand building in the vertical direction. And in order to do that we have to replace the conventional RCC structures by the steel buildings as its easily and quick to expand them. Also, the experiences of other countries that use steel for making the buildings suggest us that it has many positive factors wiz strength, durability, biodegradable, and recyclable. In the present work we are building a G+10 steel framed building which is situated in Noida. Noida comes in the seismic zone-* ***IV.*** *The design is carried out using IS: 800-2007 for steel work. This study comprises study of different structural parameters such as moments, reactions, bending moments, shear force, axial force, displacements etc. at the various intersections of the building. This study will give us the clear idea regarding the stability of the building.*

***Key Words*: Staad pro, Analysis of Structure (Bending moment, shear force, axial force)**

1. INTRODUCTION

From the very beginning of the human civilization shelter has been the basic need of the human to purse their lives. And with need of the shelter humans began to make different structures under which they can live and save themselves form the various climatic, natural and manmade changes. In today's world the need of structures remains same but the design and pattern of building the structures has changed. With growing population mostly new high-rise buildings are made steel structures. Also, in present era we want such a building that needs less space to build and can accommodate maximum persons. So, in order to do that we use steel structures which are having high strength and can be expanded easily according to our need. In India where the population is very high the need of such types of buildings which needs less land and can accommodate many persons has become the need. Also, for the other buildings the shelter we need buildings and structures for industrial and commercial purposes. Steel structure is durable, fire resistant, biodegradable and time saving. Steel industry is becoming dominant with time as the steel structure takes was very less time and they provide better response in case of earthquake. In this present work we are working on analysis of G+10 steel framed structure using the software Staad.Pro. And is situated in Noida which comes under seismic zone**-IV.**

Staad.Pro stands for STRUCTURAL AIDED ANALYSIS AND DESIGN and is a structural analysis and design software application originally developed by Research Engineers International in 1977.

1.1 STRUCTURAL STEEL

The following general categories of steels that are going to use while designing the structure are

a) Carbon steel (IS 2062):

Carbon and manganese are the main strengthening elements. The specified minimum ultimate tensile strength for these varies about 380 to 450 MPa and their specified minimum yield strength from about 230 to 300MPa (IS 800:2007)

b) High –strength carbon steel:

This steel specified for structures such as transmission lines and microwaves towers. The specified ultimate tensile strength, is ranging from about 480-550 MPa, and a minimum yield strength of about 350-400 MPa.

a) Medium-and-high strength micro alloyed steel (IS 85000):

This steel has low carbon content but achieves high strength due to the addition of alloys such as niobium, vanadium, titanium, or boron. Ultimate tensile strength, is ranging from about 440-590 MPa, and a minimum yield strength of about 300-450 MPa

b) High –strength quenched and temperature steels (IS 2003): This steel is heat treated to develop high strength. The specified ultimate tensile strength, is ranging from about 700- 950 MPa, and a minimum yield strength of about 550- 700 MPa.

2. LITERATURE REVIEW

Bijan Samali, Ulrike Dackermann and Jianchun Li presented a vibration-based damage identification method and utilized the damage fingerprints embedded in frequency response functions to identify location and severity of damage in notch type in a framed structure of G+2. Damages and severities of different locations are investigated using experimental and numerical investigations and proposed the effective damage detection method

P.Jayachandran: The design and analysis of multistoried G+4 building at Salem, tamilnadu, India. The study includes design and analysis of footings, columns, beams and slabs by using two software's named as STAAD.PRO and RCC Design Suit.

K.K.Sangle,K.M.Bajori,V.Mhalungkar (2012) Has done research work on "Seismic Analysis of High-Rise Steel Frame Building with And with Out Bracing" The Aim of study was to compare the results of seismic analysis of high- rise steel building with different pattern of bracing system and without bracing system.

C.Y. Ho and G.G. Schierele (1990) Published a journal paper Effect of configuration and lateral drift on High rise space frames. Excessive lateral drift in high-rise frames can damage secondary systems, such as partitions walls; generate secondary column stress due to P-δ moments; and cause discomfort to building occupants under prolonged cyclical drift. Damage to secondary system can be controlled by reducing drift. The P-δ effect is most severe in moment resistthe Uniform Building Code allows smaller seismic drift for moment resisting frames (0.3% story drift vs. 0.5 % for other systems). Design for wind or seismic forces are usually based on objectives to minimize lateral drift. To reduce lateral drift of high-rise buildings is an important design consideration in areas of high wind and/or seismic activity framing.

3. METHODOLOGY

The three-dimensional, G+10- Storey 3 bays along the width each bay of length 7.5m considered as main beams and 3 bays along the length each bay of length 7.5m considered as joists. The total width is 22.5m and length is 22.5m. The steel building shown in Figure is used to analyze the different load combination response on the structure in different condition i.e., Bending moment, shear force etc, by method of analysis.

3.1 MODELLING & ANALYSIS

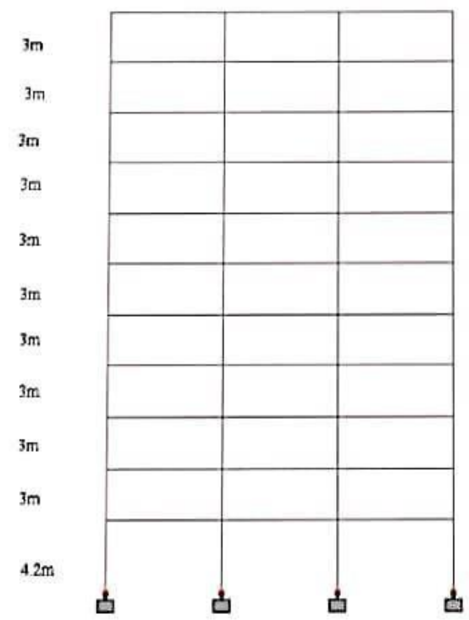

Fig:1 G+10 Storey Model Structure for analysis

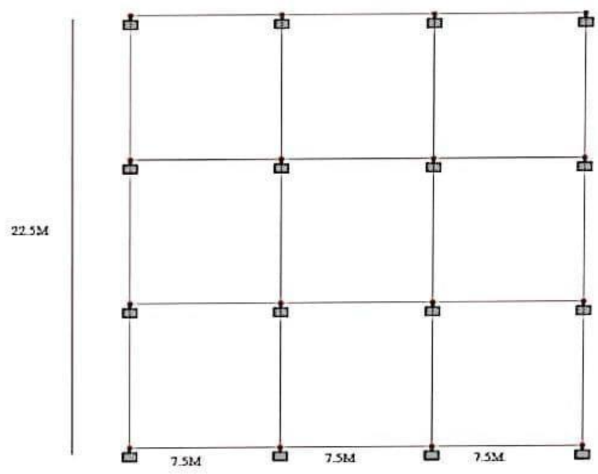

Fig: 2 Plan view of the Structure

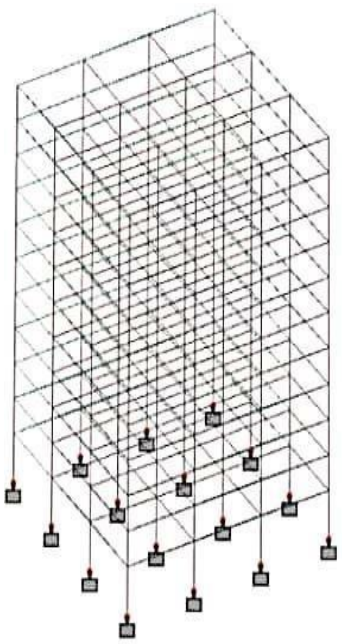

Fig:3 3D-View of the Building

3.2 BUILDING DATA

Type of the Building	Office Building (G+10)
Width	7.5 + 7.5 + 7.5 m C/C
Length	7.5+7.5 + 7.5 m C/C
Clear Height	34.2 m from FFL
Roof Slope	FLAT ROOF
Main Frame Column Spacing	7.5+7.5 + 7.5 m
Bay Spacing	3 @ 7.5 M
End Wall Column Spacing	3 @ 7.5 M
Beam	IW500 350*2040
Column	IW 600 400*2040
Grade of Concrete	M30
Slab thickness	150mm

3.3 Assigning Loads

i. Seismic Load
ii. Dead Load
iii. Live Load
iv. Combination of Loads

- D.L + L.L
- 1.5 (D.L + L.L)
- 1.2 (D.L + L.L ± EQ)
- 1.5 (D.L ±EQ)
- 0.9D.L ± 1.5EQ

3.3.1 Seismic Load (IS: 1893-2002/2005)

Zone	IV
Zone Factor	0.24
Damping Ratio	0.05
Period in X direction	0.68
Period in Z direction	0.68
Response Reduction Factor	5
Soil Type	2(medium)
Unit weight of Steel	78.5 KN/m^3

3.3.2 Dead load: (IS:875(PART

1)) **Due to self-weight of slab**:
Thickness of slab= 150mm
Slab load per m =thickness X unit weight =0.150 X 24 = 3.6 KN/m^2
Floor finished load per m = 1.25 KN/m^2 Total load = 4.85 KN/m

3.3.3 Live Load (IS:875(PART 2))

Live Load = 3KN/m^2 (office building)

3.3.4 Load combinations

For Superstructure	For Substructure
1.5(D. L+L.L)	D.L+L.L
1.2(D. L+L.L±EQ (X, Z))	D.L+0.5L. L±EQ (X, Z)
1.5(D. L±EQ (X, Z))	D.L±EQ (X, Z)
0.9D. L±1.5EQ (X, Z)	

3.4 Analysis & Interpret the result

3.4.1 Interpreting the Displacement

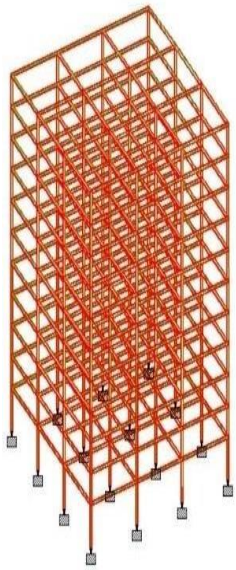

Fig 4 due to EQ in X-dirⁿ

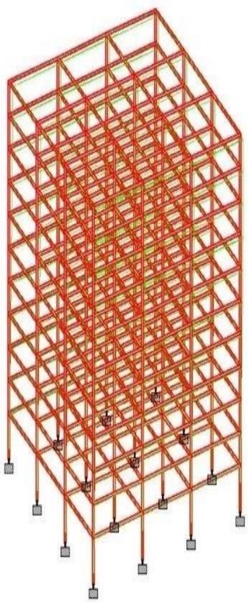

Fig.5: due to EQ in Z-dirⁿ

3.4.2 Interpreting the Bending Moment

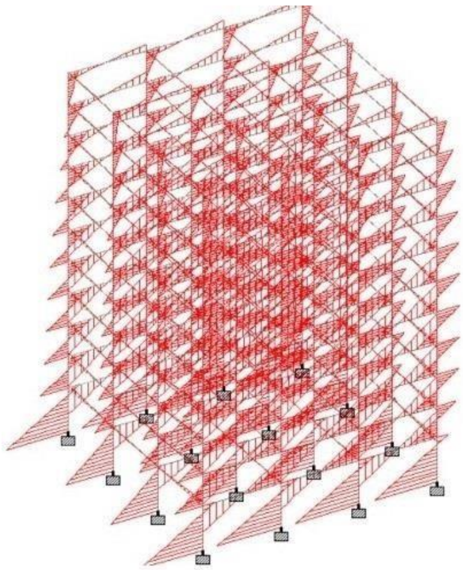

Fig 6; due to EQ in X-dirⁿ

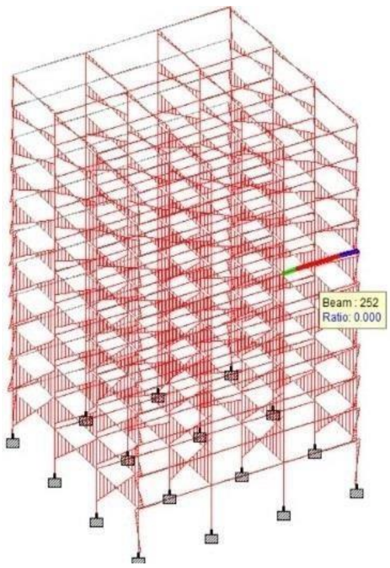

Fig.7; due to EQ in Zdir-ⁿ

3. 4.3Interpreting the Shear force

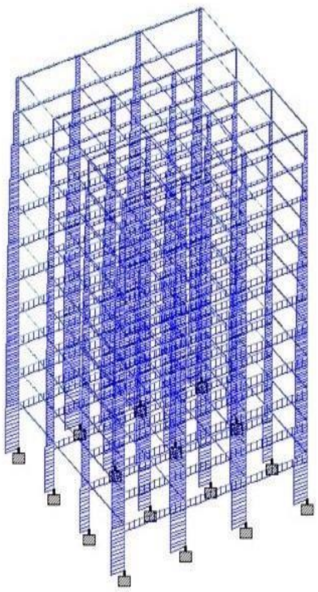

Fig 8; due to EQ in X-dirⁿ

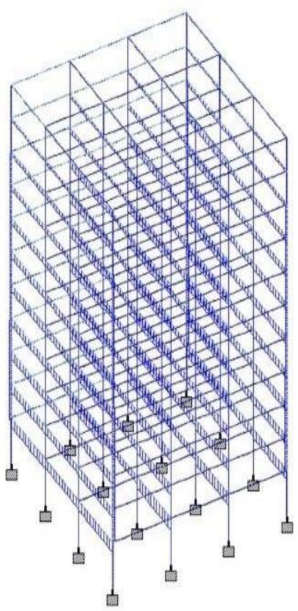

Fig.9; due to EQ in Z-dirⁿ

3.4.4Interpreting the Axial force

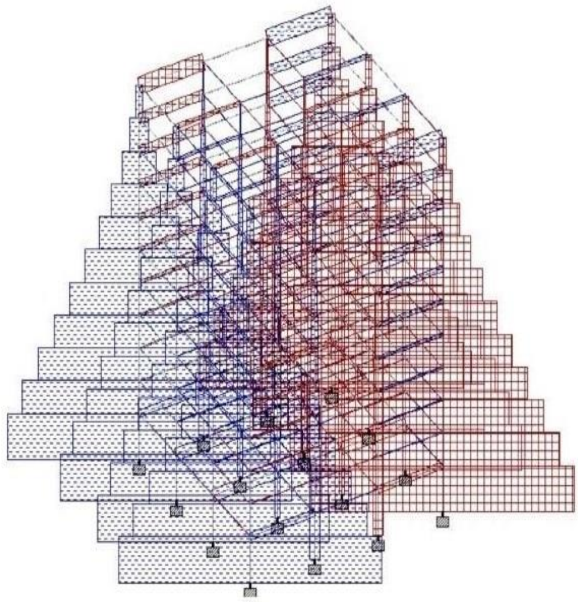

Fig.10; due to EQ in X-dirⁿ

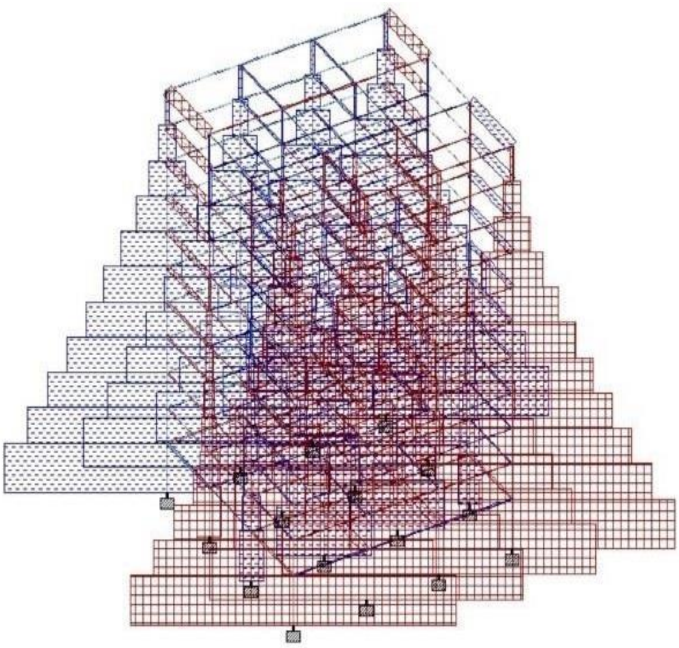

Fig.11; due to EQ in Z-dirⁿ

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3.5 Design of the structure

I. Design of Slab
II. Design of Beam
III. Design of Column

3.5.1 Design of Slab

Slab most widely used structural elements forming floor and roof of building. Slab supports mainly transverse load and transfer them to supports by bending actions in both the directions. On the basis of spanning direction, it is of two types.

- One-way Slab
- Two-way Slab

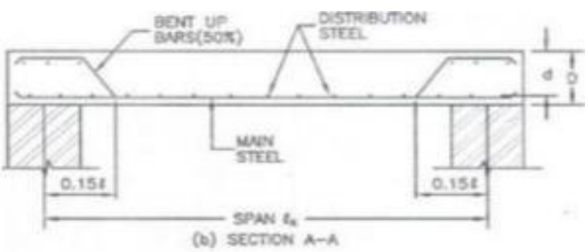


Fig 12 Slab reinforcement

Material Specification

Grade of Concrete, M30	30 N/mm^2
Grade of Steel, Fe415	415 N/mm^2
Clear Cover of Slab, Beam	25 mm

3.5.2 Design of Beam

- Singly reinforced beam
- Doubly reinforced beam

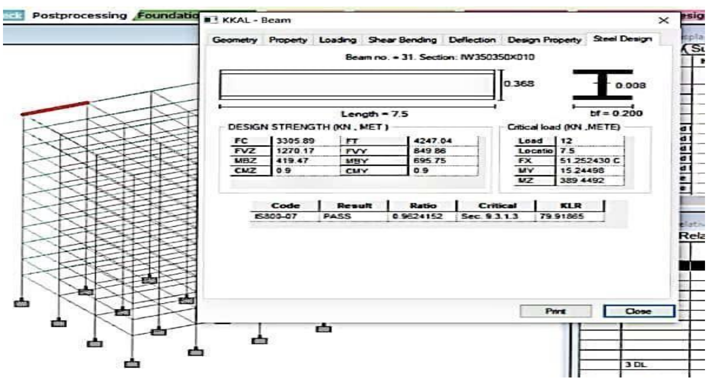
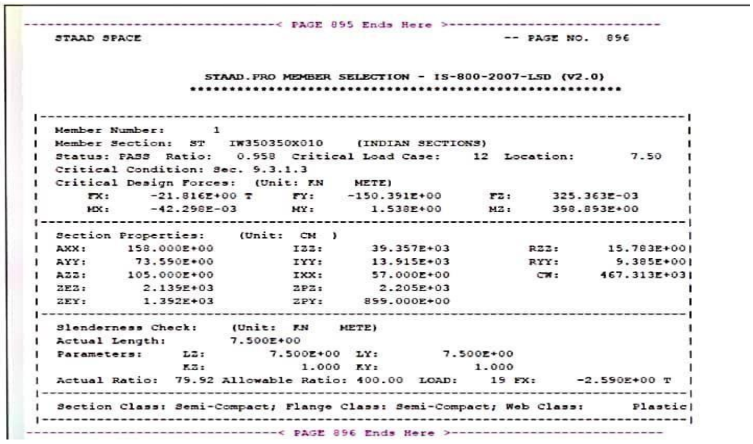


Fig 13 Beam design



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   STAAD SPACE                                                      -- PAGE NO.   896

                  STAAD.PRO MEMBER SELECTION - IS-800-2007-LSD (V2.0)
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|----------------------------------------------------------------------------------|
|  Member Number:        1                                                         |
|  Member Section:  ST   IW350350X010      (INDIAN SECTIONS)                       |
|  Status: PASS  Ratio:    0.958  Critical Load Case:    12  Location:      7.50   |
|  Critical Condition: Sec. 9.3.1.3                                                |
|  Critical Design Forces:   (Unit: KN     METE)                                   |
|      FX:      -21.816E+00 T      FY:    -150.391E+00      FZ:     325.363E-03    |
|      MX:      -42.298E-03        MY:       1.538E+00      MZ:     398.893E+00    |
|----------------------------------------------------------------------------------|
|  Section Properties:      (Unit:  CM  )                                          |
|  AXX:      158.000E+00          IZZ:      39.357E+03         RZZ:     15.783E+00|
|  AYY:       73.590E+00          IYY:      13.915E+03         RYY:      9.385E+00|
|  AZZ:      105.000E+00          IXX:      57.000E+00          CW:    467.313E+03|
|  ZEZ:        2.139E+03          ZPZ:       2.205E+03                             |
|  ZEY:        1.392E+03          ZPY:     899.000E+00                             |
|----------------------------------------------------------------------------------|
|  Slenderness Check:     (Unit:  KN    METE)                                      |
|  Actual Length:          7.500E+00                                               |
|  Parameters:       LZ:         7.500E+00  LY:        7.500E+00                   |
|                    KZ:             1.000  KY:            1.000                   |
|  Actual Ratio:  79.92 Allowable Ratio: 400.00  LOAD:    19 FX:    -2.590E+00 T   |
|----------------------------------------------------------------------------------|
|  Section Class: Semi-Compact; Flange Class: Semi-Compact; Web Class:      Plastic|
|----------------------------------------------------------------------------------|
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Fig13 : Detailing of beam

3.5.3 Design of Column

A column may be defined as an element used primary to support axial compressive loads and with a height of a least three times its lateral dimension. The strength of column depends upon the strength of materials, shape, size of cross section, length and degree of proportional and dedicational restraints at its ends.

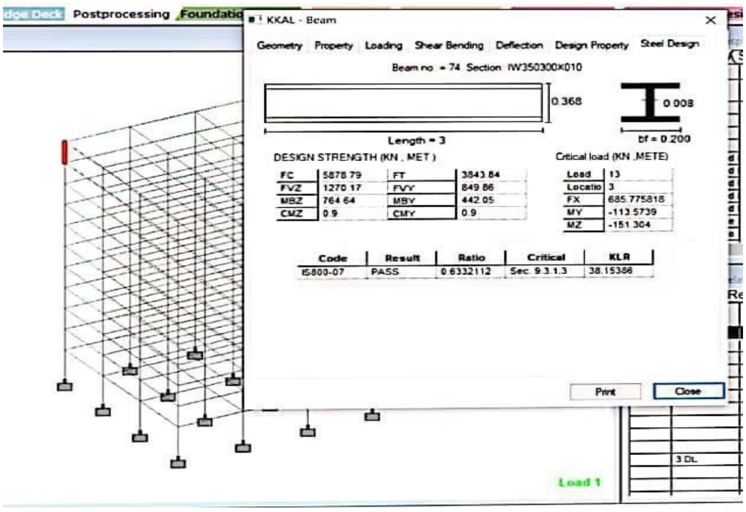

Fig14; Column Design

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                 STAAD.PRO CODE CHECKING - IS-800-2007-LSD (V2.0)
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 |  Member Section:  ST   IW500350X2040    (INDIAN SECTIONS)
 |  Status: PASS  Ratio:   0.217  Critical Load Case:    12  Location:        7
 |  Critical Condition: Sec. 9.3.1.3
 |  Critical Design Forces:  (Unit: KN    METE)
 |       FX:      -21.816E+00 T     FY:    -150.391E+00      FZ:     325.363E-03
 |       MX:      -42.298E-03       MY:       1.538E+00      MZ:     358.893E+00
 |-----------------------------------------------------------------------------
 |  Section Properties:    (Unit:  CM  )
 |  AXX:      353.000E+00          IZZ:     212.769E+03          RZZ:       24.5
 |  AYY:       56.800E+00          IYY:      26.523E+03          RYY:        8.6
 |  AZZ:       75.000E+00          IXX:     839.000E+00           CW:        2.9
 |  ZEZ:        7.492E+03          ZPZ:       7.732E+03
 |  ZEY:        2.122E+03          ZPY:       2.074E+03
 |-----------------------------------------------------------------------------
 |  Slenderness Check:     (Unit:  KN    METE)
 |  Actual Length:         7.500E+00
 |  Parameters:      LZ:        7.500E+00  LY:         7.500E+00
 |                   KZ:            1.000  KY:             1.000
 |  Actual Ratio:  86.52 Allowable Ratio: 400.00  LOAD:    19 FX:     -2.590E+
 |-----------------------------------------------------------------------------
 |  Section Class: Semi-Compact; Flange Class: Semi-Compact; Web Class:       P
 |-----------------------------------------------------------------------------
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Fig15 Detailing of column

4. CONCLUSIONS

On the following work carried out we conclude that,

1. Steel structures are expected to show superior performance under earthquake due to high ductility.
2. Axial forces are lower in steel structure due to lower weight of steel structure.
3. This project has given an opportunity to re-collect and coordinate the various methods of designing and engineering principles which we have learnt.
4. Analysis and designing were done by using STAAD.PRO software and successfully verified manually as per IS 800; 2007
5. Calculation by both manually as well as software analysis, gives almost same result.
6. Displacement Increases as the Story height increases.
7. Maximum deflection in Horizontal (X-direction) is 36.946 mm.
8. Maximum deflection in Horizontal (Z-direction) is 74.471mm.
9. Maximum deflection in Vertical (Y-direction) is 0.076mm.
10. Maximum rotation in X, Y, Z- directions are 0.002 rad, 0.001 rad, 0.001 rad respectively.
11. Bending Moment changes as we increase the height of structure.
12. Shear Force changes as we increase the height of structure.
13. Maxial Force changes as we increase the height of structure
14. Analysis and designing were done by using STAAD.PRO software and gives the results as expected.
15. Calculation by both manually as well as software analysis, gives almost same result.

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