3-D Based Analysis And Design Of High Rise Building Using Staad-Pro

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Abstract – In modern era of fast growing population in india and the world have been the reason for many multi-storey building due to less available land .previously population was less and people prefer to live in horizontal system as the land area was adequate. Since structure may fail either totally or partially due to disaster like earthquake and cyclone. In the case of seismic action damage on high rise building occurs at a week structure location,and the other reason behind failure of the building is irregularities. For example slab of the building damage due to effect of lateral load. So it is very much important to determine and construct a building which is efficient and will serve for a long time without collapsing.The project titled as " 3-D based analysis and design of high rise building using STAAD - Pro software ", aims at finding well technique for creating geometry , design of cross section element like beam ,column, slab etc . specification , support and the loads are created and defined. Then the model is analysed , after that reviewing is done whether beam and column pass in load or failed. Then after design are performed.

Keywords: Staad - pro ,earthquake,cyclone , high rise building.

1. INTRODUCTION

In these modern days buildings are made to fulfil our basic aspects and better seviceciability.To construct an efficient building we have to make sure that each and every building members should transfer load uniformly.it is beneficial to calculate load for building under seismic and wind for success of building for several years in future with better health facilities and economical. Here will analyse a building of G+29 floors of area 20m x 20m.In this project i had taken city as Bhopal which lies in seismic zone II which has seismic intensity of 0.10 and basic wind speed 39m/s as per given in IS code 1893 part I and IS code 875 part III respectively. Load taken under consideration are below:-

1) Dead load : as per IS code 875 part I
2) Live load : as per IS code 875 part II
3) Seismic load : as per IS code 1893 part I
4) Wind load :as per IS code 875 part III

In multi storey we should take care about designing of forces, its own weight acting on building. Building must counterpart with extreme forces acting at beam, column and reinforcement. Since human error can be occurred to calculate design of building manually and will take time. So staad pro can ease our work and will give result with accuracy**.**

2. STAAD-PRO SOFTWARE

It stands for structural Aided Design Program. STAAD Pro is capable of solving problems like static analysis , advanced steel design, advanced slab design etc. This type of analysis can be done in staad - Pro is much better then the manual technique As it gives result with accuracy. This software was developed by research international engineering in 1997 and was bought by Bentley system in 2005.

STAAD Pro includes 4 steps to achieve goals

a). Prepare the input file.
b). Analyse the input file.
c). Make the result and verify them.
d). The analysis result to staad pro and carry design.

3. METHODOLOGY

- Load calculation as per IS code.
- Analysis using stad-pro on G+29 building.
- Design using staad-pro of G+29 building.

A. Calculation of loads using IS codes -

Loads acting on structure are provided below.

a) **Dead load** : It consist of all member loads like self weight of building , slab load ,floor load . It is calculated by multiplying cross sectional area of beam by unit weight of concrete.

b) **Live load** : Live load are produced by the use and occupancy of building load by human ,furniture ,movable equipments. In staad we assign live load in terms of U.D.L. live load are calculated using is code 875 part 2.for residential building it is taken as 3 kN/m^2.

c) **Wind Load** : Wind load is present in both direction i,e vertical and horizontal loads. It is calculated by using IS 875 part 3.

$V_z = v_b x k_1 x k_2 x k_3 x k_4$
Where V_z = design wind speed at a height of z meter in m/s.
V_b = basic design speed at 10 m height.
Pz = design wind pressure at height z meter.
$Pz = 0.6V_z^2$.

d) **Seismic Load calculation** : According to is code1893 part 1 seismic calculation are done.

$A_h = Z \times I \times S_a / 2Rg$
Where A_h = seismic coefficient
Z = zone factor depending upon zone of structure belong to.
For zone ii (z = 0.1)

Zone iii (z = 0.16)
For zone iv (z=0.24)
For zone v (z=0.36).
I = importance factor .
R = response reduction factor.
S_a/g = average response acceleration coefficient.
We have taken zone 11 for our seismic analysis.

e) **Load Combination** :

1. For seismic load analysis

- 1.5(DL+LL)
- 1.2(DL+LL+EQx)
- 1.2(DL+LL+EQz)
- 0.9(DL+LL+EQx)
- 0.9(DL+LL+EQz)

2. For wind load analysis

- 1.5(DL+LL)
- 1.2(DL+LL+WLx)
- 1.2(DL+LL+WLz)
- 0.9(DL+LL+WLx)
- 0.9(DL+LL+WLz)

B. Assumption using Staad - Pro in 30 storey building -

The building consists of G+ 29 storey.The data considered is provided below.

Number of storeys – G+ 29 (30)
Plan of building – 20 m x 20 m
Height of building – 90m (each storey is of 3m)
Size of beam – 300mm x 500 mm
Size of column – 750 mm x 750 mm
Thickness of slab – 125 mm

C. Design performed in staad - pro for G+29 residential building -

step 1- nodal point are created based on Floor plan and position of column we entered into Staad pro file.

Step 2 - design of plate that is nothing but inserting of slab up to 30 floor.

Step 3 - Beams and columns are represented using at beam command for beam of column between corresponding node point.

Step 4 - 3D view of a structure is generated using 3D rendered icon present in to toolbar of StaadPro.

step 5 - support and property are assigned. after the creation of support at the the beam of a structure are specified as fixed support.

Step 6 - the seismic load and wind load are defined in load and definition as per 1893; 2005 and IS 875 part 3 respectively.

Step 7 - dead load are calculated as per IS 875 part 1 for member load and self weight of structure.

Step 8 - assigning of live load are done. live load for every floor is assigned 3k N/m2 based on IS 875 part 2.

Step 9 - addition of load combination are done.after the load are assigned load combination is given with the factor of safety as per IS 875 part 3.

Step 10 - the analysis is performed after completion of every steps and checked for errors.

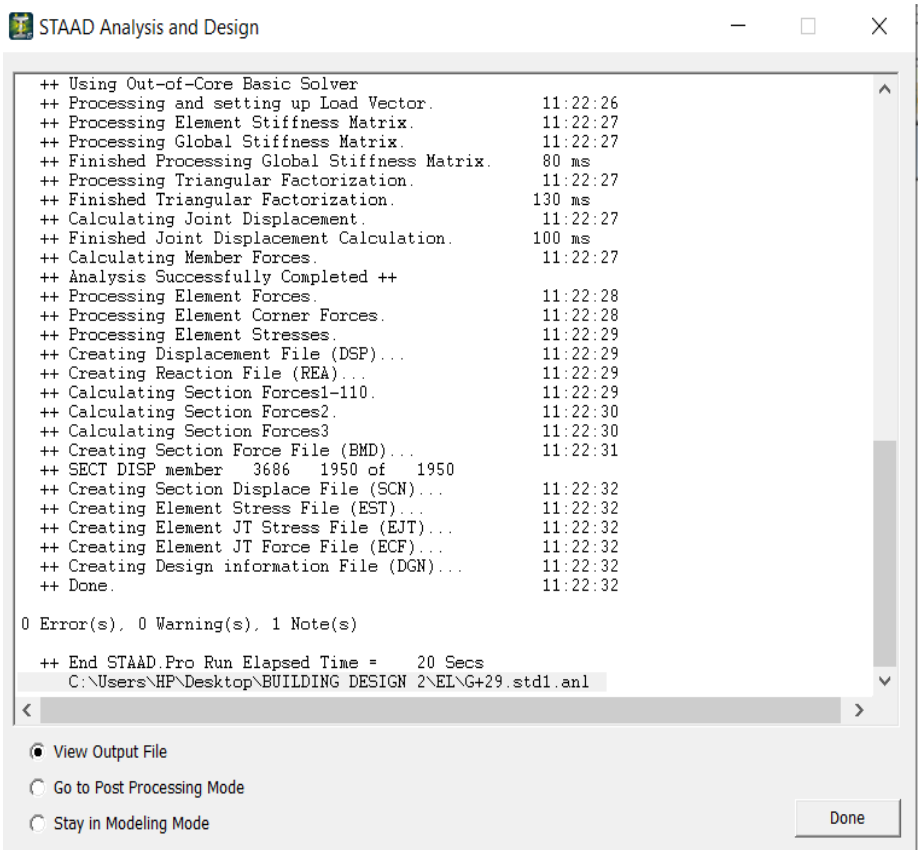


Fig 1. Run analysis result

Step 11 - at last concrete design is performed as per IS 456 2000 by entering design command for different structural component.

Step 12 - after assigning commands again analysis is performed to check any errors.

4. RESULT

Based on the present study of the given project, we came across following result. Following are the result obtained by analysis of the structure for applied forces:-

A. Reaction and moment due to EL -

Table 1: Max reaction and moments

NODE	L/C	MAXIMUM REACTION AND MOMENT
311	1.5(DL+LL)	F_X = 16.678 KN
313	1.5(DL+LL)	F_Y = 11508.505 KN
3	1.5(DL+LL)	F_Z = 16.678 KN
3	1.5(DL+LL)	M_X = 11.837 KN-m
621	1.2(DL+LL+ELX)	M_Y = 0.09 KN-m
315	1.2(DL+LL+ELX)	M_Z = 94.154 KN-m

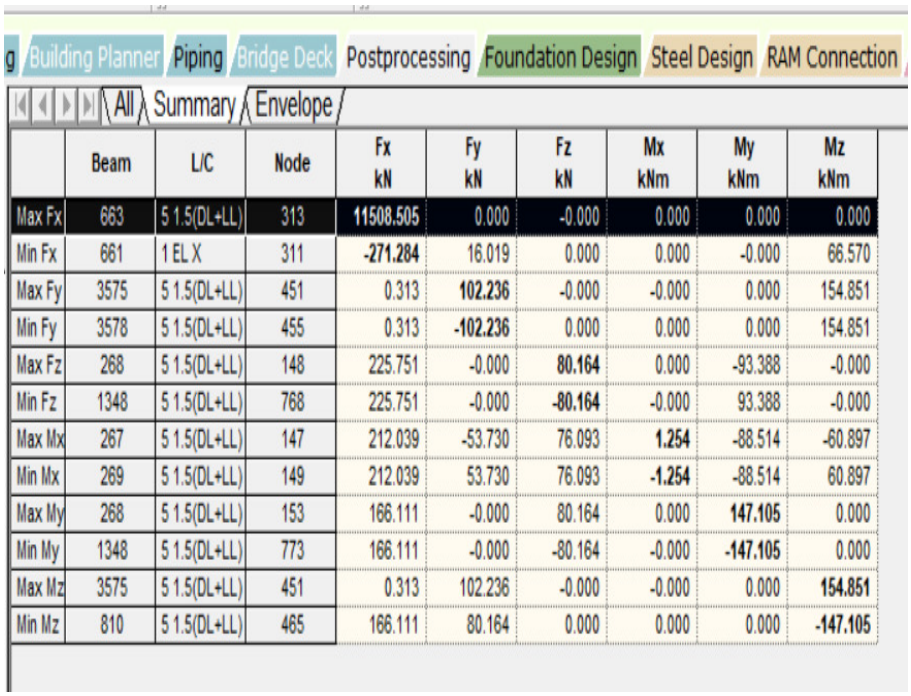
B. Reaction and moment due to WL –

Table 2: Max reaction and moments

NODE	L/C	MAXIMUM REACTION AND MOMENT
311	1.5(DL+LL)	F_X = 30.476 KN
313	1.5(DL+LL)	F_Y = 15983.169 KN
3	1.5(DL+LL)	F_Z = 30.476 KN
3	1.5(DL+LL)	M_X = 32.523 KN-m
622	1.5(DL+LL)	M_Y = 0.071 KN-m
315	1.2(DL+LL+WLX)	M_Z = 53.440 KN-m

C. Beam end forces in EL -

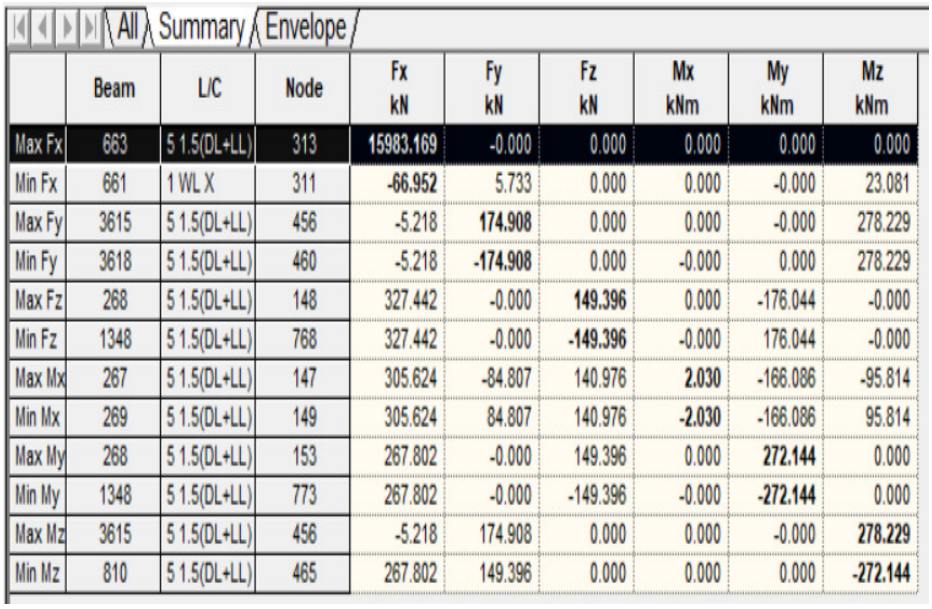
The following picture represents the maximum as well as minimum end forces on beam due to earthquake load in different directions.



	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	663	5 1.5(DL+LL)	313	**11508.505**	0.000	-0.000	0.000	0.000	0.000
Min Fx	661	1 EL X	311	**-271.284**	16.019	0.000	0.000	-0.000	66.570
Max Fy	3575	5 1.5(DL+LL)	451	0.313	**102.236**	-0.000	-0.000	0.000	154.851
Min Fy	3578	5 1.5(DL+LL)	455	0.313	**-102.236**	0.000	0.000	0.000	154.851
Max Fz	268	5 1.5(DL+LL)	148	225.751	-0.000	**80.164**	0.000	-93.388	-0.000
Min Fz	1348	5 1.5(DL+LL)	768	225.751	-0.000	**-80.164**	-0.000	93.388	-0.000
Max Mx	267	5 1.5(DL+LL)	147	212.039	-53.730	76.093	**1.254**	-88.514	-60.897
Min Mx	269	5 1.5(DL+LL)	149	212.039	53.730	76.093	**-1.254**	-88.514	60.897
Max My	268	5 1.5(DL+LL)	153	166.111	-0.000	80.164	0.000	**147.105**	0.000
Min My	1348	5 1.5(DL+LL)	773	166.111	-0.000	-80.164	-0.000	**-147.105**	0.000
Max Mz	3575	5 1.5(DL+LL)	451	0.313	102.236	-0.000	-0.000	0.000	**154.851**
Min Mz	810	5 1.5(DL+LL)	465	166.111	80.164	0.000	0.000	0.000	**-147.105**

Fig 2. Max And min Beam end forces

D. Beam end forces in WL -



	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	663	5 1.5(DL+LL)	313	**15983.169**	-0.000	0.000	0.000	0.000	0.000
Min Fx	661	1 WL X	311	**-66.952**	5.733	0.000	0.000	-0.000	23.081
Max Fy	3615	5 1.5(DL+LL)	456	-5.218	**174.908**	0.000	0.000	-0.000	278.229
Min Fy	3618	5 1.5(DL+LL)	460	-5.218	**-174.908**	0.000	-0.000	0.000	278.229
Max Fz	268	5 1.5(DL+LL)	148	327.442	-0.000	**149.396**	0.000	-176.044	-0.000
Min Fz	1348	5 1.5(DL+LL)	768	327.442	-0.000	**-149.396**	-0.000	176.044	-0.000
Max Mx	267	5 1.5(DL+LL)	147	305.624	-84.807	140.976	**2.030**	-166.086	-95.814
Min Mx	269	5 1.5(DL+LL)	149	305.624	84.807	140.976	**-2.030**	-166.086	95.814
Max My	268	5 1.5(DL+LL)	153	267.802	-0.000	149.396	0.000	**272.144**	0.000
Min My	1348	5 1.5(DL+LL)	773	267.802	-0.000	-149.396	-0.000	**-272.144**	0.000
Max Mz	3615	5 1.5(DL+LL)	456	-5.218	174.908	0.000	0.000	-0.000	**278.229**
Min Mz	810	5 1.5(DL+LL)	465	267.802	149.396	0.000	0.000	0.000	**-272.144**

Fig 3. Max And min Beam end forces

E. Different figures of building structure -

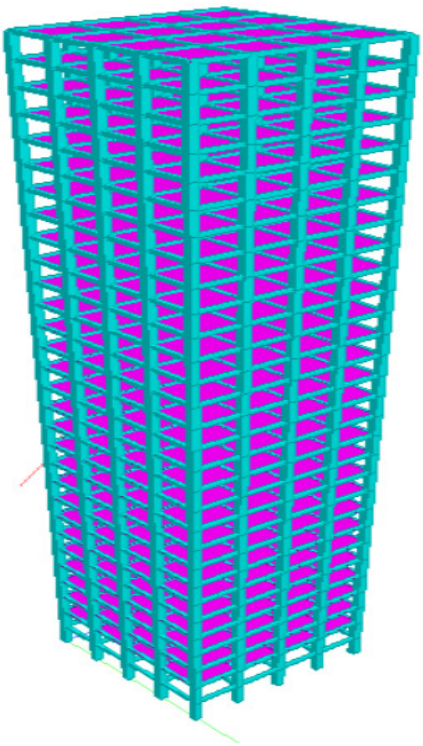


Fig 4. 3-D rendered view of the model

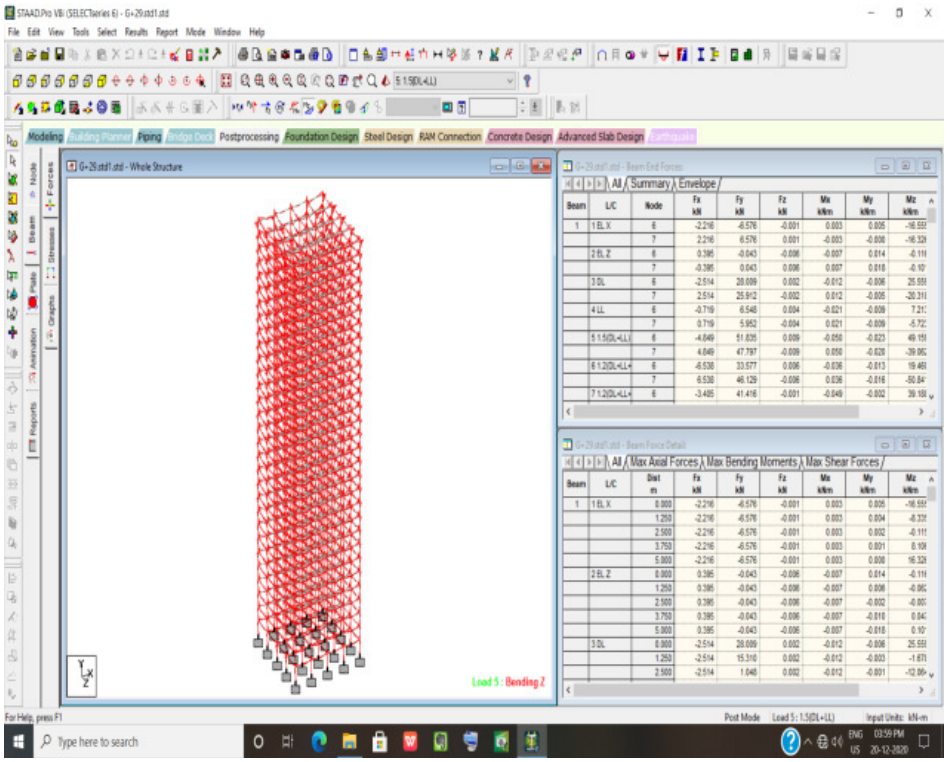


Fig 5. Bending moment diagram

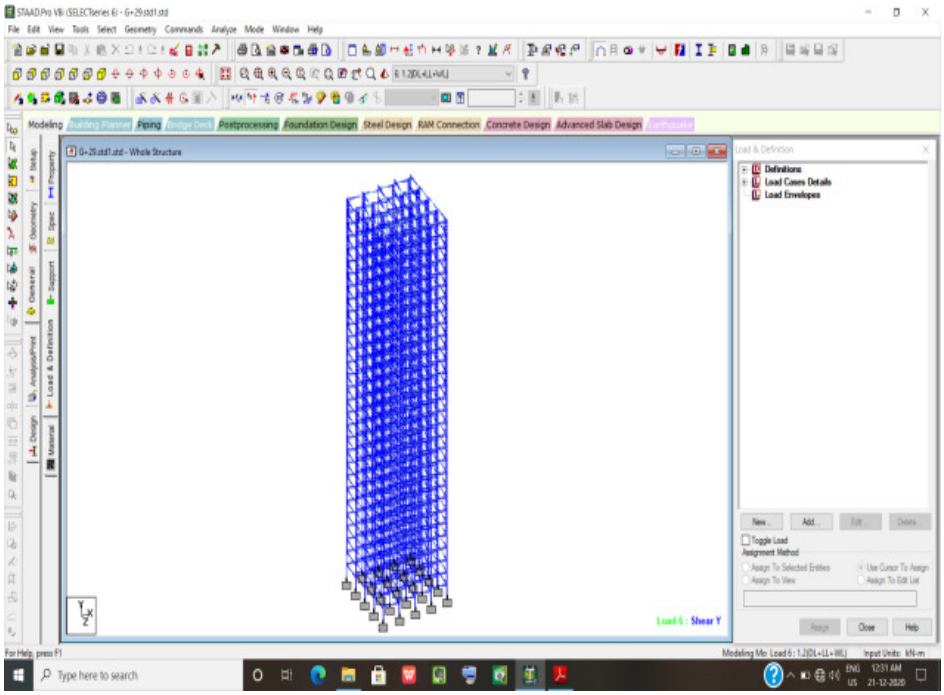


Fig 6. Shear force diagram

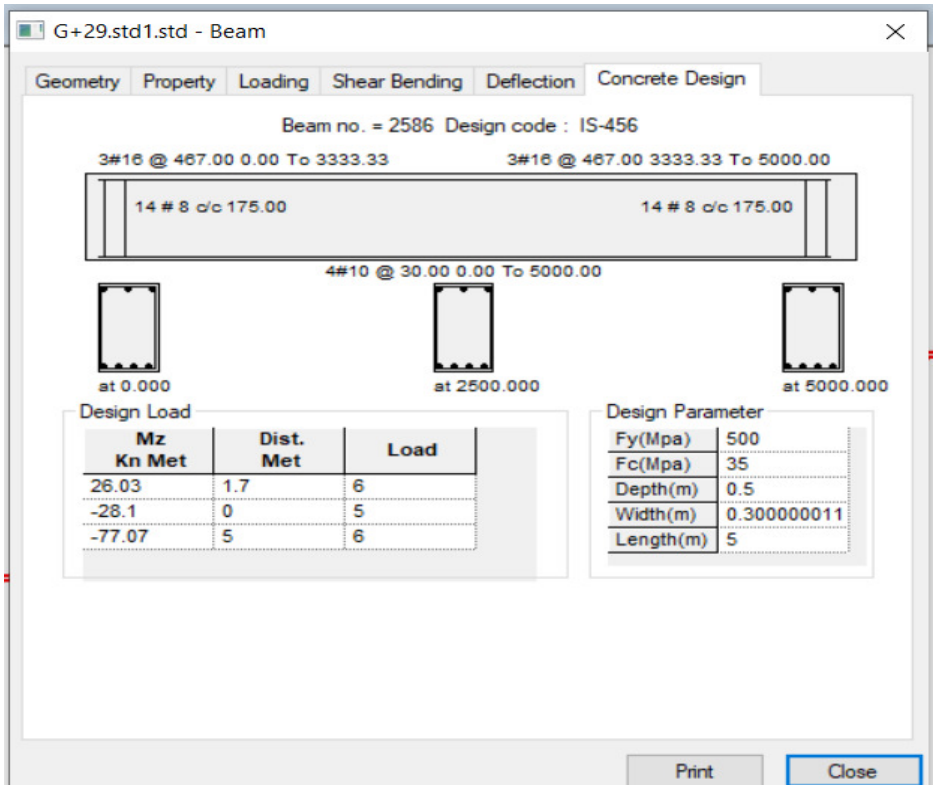


Fig 7. Concrete design of beam 2586

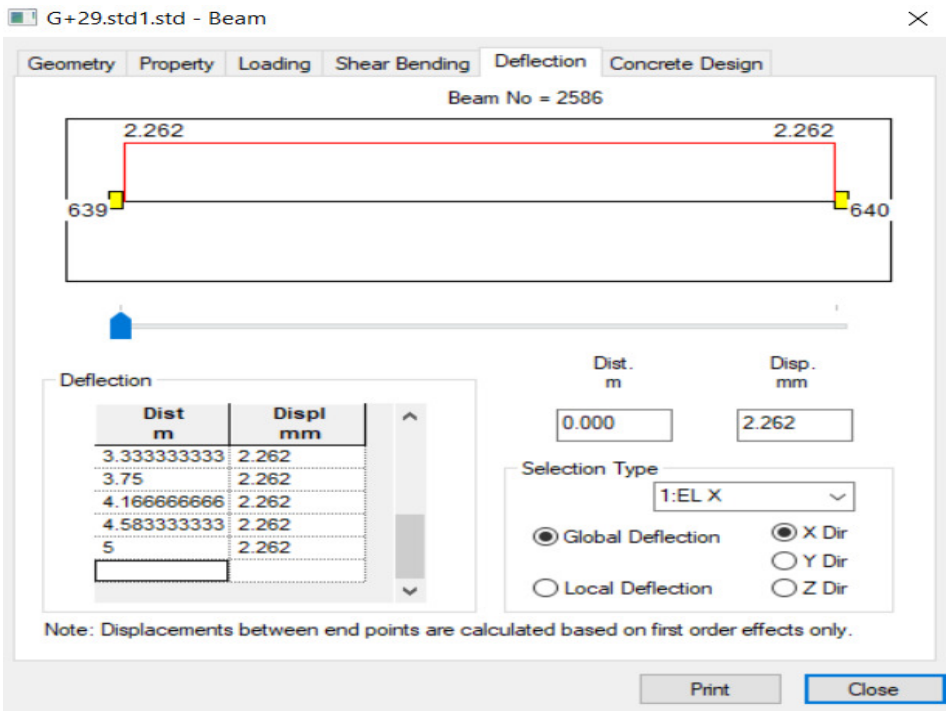


Fig 8. Deflection of beam 2586

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                    SUMMARY OF PROVIDED REINF. AREA
-------------------------------------------------------------------------------
SECTION       0.0 mm      1250.0 mm      2500.0 mm      3750.0 mm      5000.0 mm
-------------------------------------------------------------------------------
 TOP        3-16í          2-16í          3-16í          3-16í          3-16í
REINF.    1 layer(s)     1 layer(s)     1 layer(s)     1 layer(s)     1 layer(s)

BOTTOM      4-10í          4-10í          4-10í          4-10í          4-10í
REINF.    1 layer(s)     1 layer(s)     1 layer(s)     1 layer(s)     1 layer(s)

SHEAR    2 legged  8í  2 legged  8í  2 legged  8í  2 legged  8í  2 legged  8í
REINF.  @ 175 mm c/c  @ 175 mm c/c  @ 175 mm c/c  @ 175 mm c/c  @ 175 mm c/c
-------------------------------------------------------------------------------


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

SHEAR DESIGN RESULTS AT   842.0 mm AWAY FROM START SUPPORT
  VY =    29.80 MX =    -0.05 LD=    5
  Provide 2 Legged  8í  @ 175 mm c/c

SHEAR DESIGN RESULTS AT   842.0 mm AWAY FROM END SUPPORT
  VY =   -45.23 MX =    -0.03 LD=    6
  Provide 2 Legged  8í  @ 175 mm c/c

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Fig 9. Provided reinforcement are of beam 2586

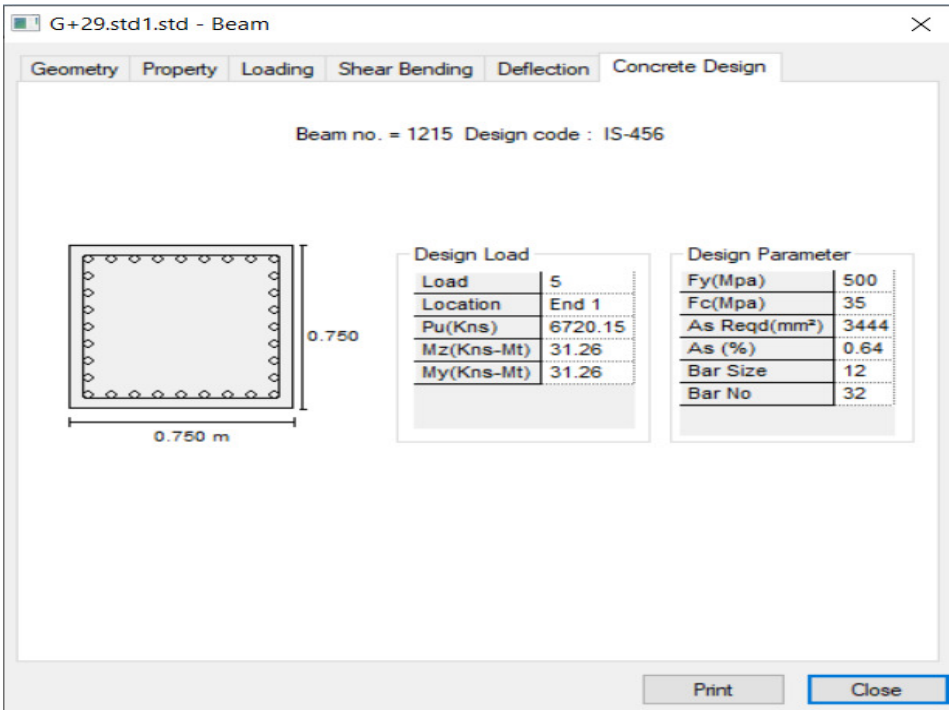

Fig 10. Concrete design of column 1215

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         C O L U M N   N O.   1215  D E S I G N   R E S U L T S

      M35                   Fe500 (Main)              Fe500 (Sec.)

LENGTH:  3000.0 mm   CROSS SECTION:  750.0 mm X  750.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:    5 END JOINT:   635  SHORT COLUMN


REQD. STEEL AREA   :     3444.02 Sq.mm.
REQD. CONCRETE AREA:   430502.78 Sq.mm.
MAIN REINFORCEMENT : Provide  32 - 12 dia. (0.64%,   3619.11 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
----------------------------------------------------------
Puz :  10096.64   Muz1 :    843.54   Muy1 :    843.54

INTERACTION RATIO: 0.17 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:     5
END JOINT:   635 Puz :  10159.54   Muz :    858.65   Muy :    858.65   IR: 0.16
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 STAAD SPACE                                                -- PAGE NO. 1587

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Fig 11. Design result of column 121

5. CONCLUSION

a) By using staad Pro software time was consumed less.

b) Each and every details of all the members are obtained.

c) The wind load combination is more than earthquake load combination in bending moment and shear force.

d) Area of Steel in column is slightly greater in wind load combination as compared to the earthquake load combination.

e) Deflection value of all the members are less than 20 mm , hence the structure is safe.

f) Some rearrangement is required for the reinforcement for practical consideration.

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