Seismic Analysis of G+12 Multistory Building Varying Zone and Soil Type

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Abstract

The building are high rise structures domestically used for residential purpose, this research work is concerned with the analysis for building structure for the purpose of safety. The building is subjected to different seismic zones and variation in soil type. The present paper considered four cases. (Soft soil with zone V, Medium soil with zone V, soft soil with zone II and medium soil with zone II). Analysis were performed to analyze and observe the behavior, performance and response of G+12 story building. Parameters selected and tested are deflection, stresses, bending moment and shear force. Results were traced in tabular format for all parameters value and observed against selected zone like V or II with varying soil type. Conclusion were made to describe the behavior and comparison of result values to set the standard thinking and policy for design engineers and researchers. It is also concluded that the software can be used frequently with positive faith to model, analyze and design buildings which reduces design cost and increases reliability of design with time saving.

Keywords: *High rise building design, seismic load, deflection, stresses, bending moment, shear force, Staad Pro.*

General

It is well known that high-rise buildings act as very important roles in modern cities. First of all, tall buildings can be effectively used to meet the requirements of modern society and solve the problem of limitation of construction site resources. On the other hand, they are the signals of economic properties and civilization. Nowadays high-rise buildings rise higher and higher, with more and more complex and individual plan and elevation, such as multi-tower buildings.

The multi-tower building mentioned in the paper is refer to two or more towers connected with one large podium or conjunction parts at different levels. It is well known that the podium and conjunction parts shall be designed very carefully to meet the internal force and the deformation between towers. Figure below shows the typical style of twin-tower buildings.

From the point of structural properties, multi-tower high-rise buildings have the following characteristics,

- the height exceeding the limitation of present codes;
- extremely irregular shape, including in plan and elevation;
- the distribution of mass and lateral stiffness are sharply changed along the height;
- mega-member with huge space and large span,;
- flexible weak connection between towers;
- New construction materials, methods and details.

Multi-tower high-rise buildings appear in recent decades but the researches on this field are not sufficient now. The nonlinear time-history analysis and structural model tests are seldom presented in document. Some perfect software, such as ADINA, SAP, SUPER-SAP, ANSYS, TBSA, SAP84, TAT and SATWE etc. are widely used by designers and researches in this field. Figure below shows the traditional calculation models of multi-tower buildings.

Factors affecting earthquake design of structure

1) Natural frequency of the building
2) Damping factor of the structure
3) Type of foundation of the structure
4) Importance of the building
5) Ductility of the structure

Quite a few methods are available for the earthquake analysis of buildings; two of them are presented here:

a. Equivalent Static Lateral Force Method (pseudo static method).
b. Dynamic analysis.
(1) Response spectrum method.
(2) Time history method.

Objective

- To develop, design and analyze model of the High rise structure in FEA software
- To study seismic load applied to the structure.
- Comparison of results of earthquake load applied on the structure by FEA software in

Zone II and Zone V for soft and medium soil cases.

- Comparison of results of earthquake load applied on the structure by FEA software in soft and hard soil type.
- To compare deflections and Shear force –

Bending moment obtained by FEA software.

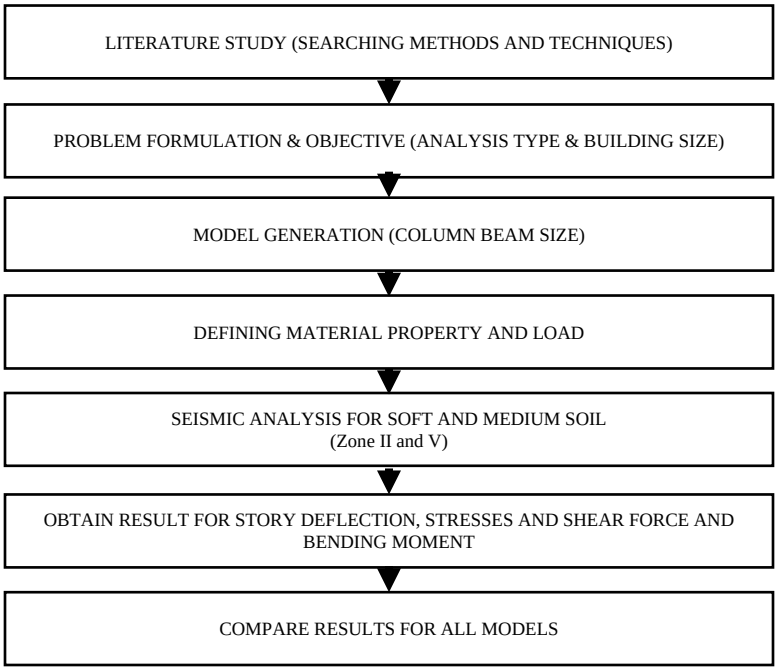
Problem Formulation

A Model of G+12 Multi-story is developed, analyzed and design using STAAD-Pro software. Building plan size is 15m × 21m. The building is situated in earthquake zone II and V. Seismic zone coefficient is taken as 0.1 and 0.36 respectively as per IS code. Following specifications are given to the structure:

Column 0.45 m × 0.3 m

Beam 0.45 m × 0.3 m
Live load 2kN/m2
Dead Load
Member load 6 KN
Floor Load 4 KN
Concrete as per IS456
Yield Strength of Steel 415000 KN/m^2
Maximum Steel Ratio 3%
These values are provided as an input to the STAAD-Pro software for drawing, analysis and designing purposes.

Methodology



Data Collection and Analysis

A hypothetical building is assumed for seismic analysis that consists of a G+12 R.C.C. public cum-Office building. The plan of the building is irregular in nature as it has all columns at equal spacing. The building is located in Seismic Zone II and Zone V for research purpose and is founded on medium type soil.

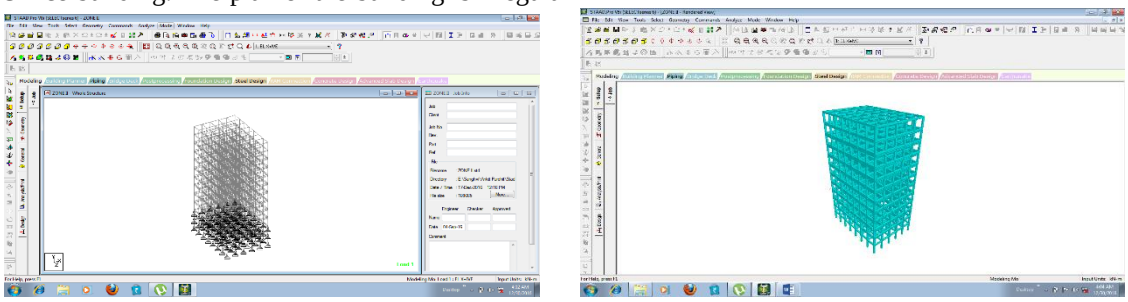


Fig: Building Model and 3D Model

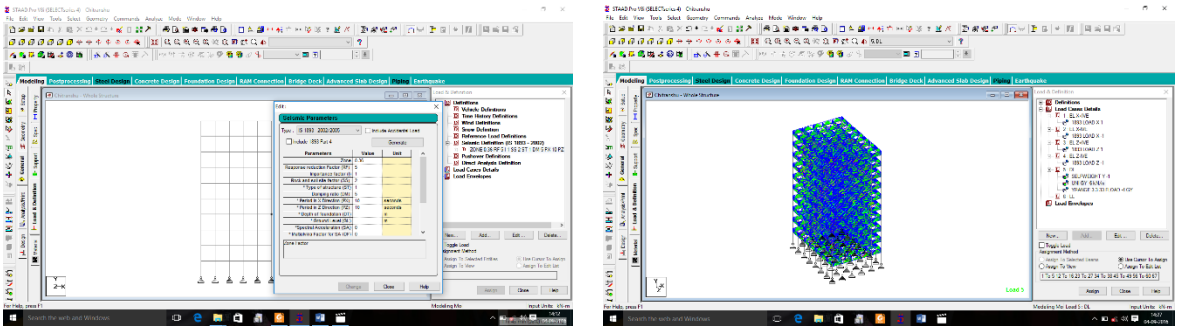


Figure:Applying Load Combinations

Soft Soil Zone V Analysis

Deflection Soft Soil Zone V Analysis

Table 1: Deflection Table Zone V Soft Soil

ZONE V S SOIL						
			Horizontal	Vertical	Horizontal	Resultant
	Node	L/C	X mm	Y mm	Z mm	mm
Max X	1561	7 1.5(DL+LL+EL X+IVE)	0.639	-7.882	-0.007	7.908
Min X	510	8 1.5(DL+LL+EL Z+IVE)	-0.106	-7.644	0.718	7.679
Max Y	1	7 1.5(DL+LL+EL X+IVE)	0	0	0	0
Min Y	1558	7 1.5(DL+LL+EL X+IVE)	0.576	-9.811	0.009	9.828
Max Z	483	8 1.5(DL+LL+EL Z+IVE)	0.015	-7.344	0.883	7.397
Min Z	525	7 1.5(DL+LL+EL X+IVE)	0.537	-7.362	-0.151	7.383
Max rX	483	8 1.5(DL+LL+EL Z+IVE)	0.015	-7.344	0.883	7.397
Min rX	526	7 1.5(DL+LL+EL X+IVE)	0.506	-7.363	-0.151	7.382
Max rY	485	8 1.5(DL+LL+EL Z+IVE)	-0.05	-6.993	0.875	7.047
Min rY	482	8 1.5(DL+LL+EL Z+IVE)	0.05	-6.993	0.875	7.047
Max rZ	504	8 1.5(DL+LL+EL Z+IVE)	-0.106	-7.645	0.735	7.681
Min rZ	499	7 1.5(DL+LL+EL X+IVE)	0.635	-7.625	0.009	7.651

Soft Soil Zone V Stress

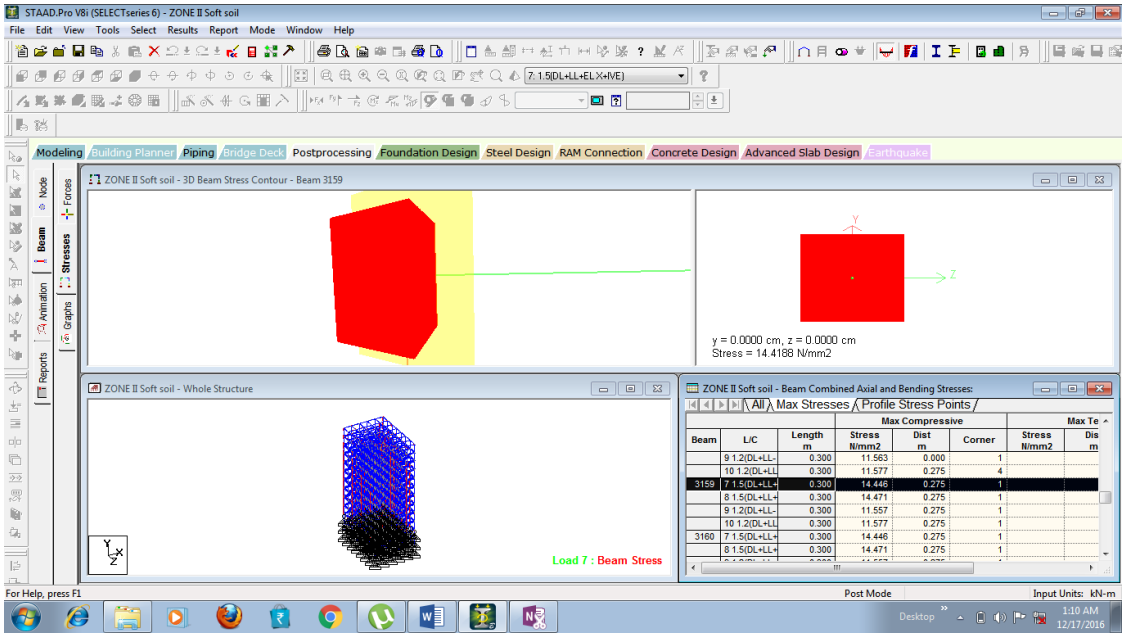


Fig 11: Soft Soil Zone V Stress 14.4188 N/mm^2 at beam number 3159

Soft Soil Zone V SF/BM

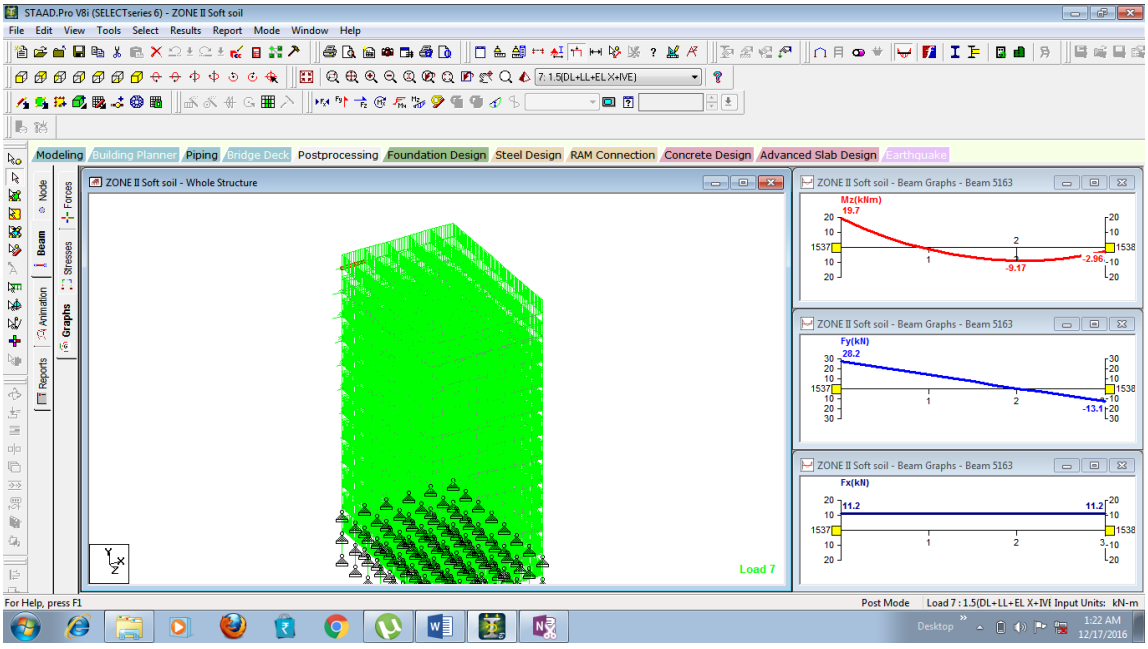


Figure 12: Soft Soil Zone V SF/BM

Soft Soil Zone VShear Force Bending Moment

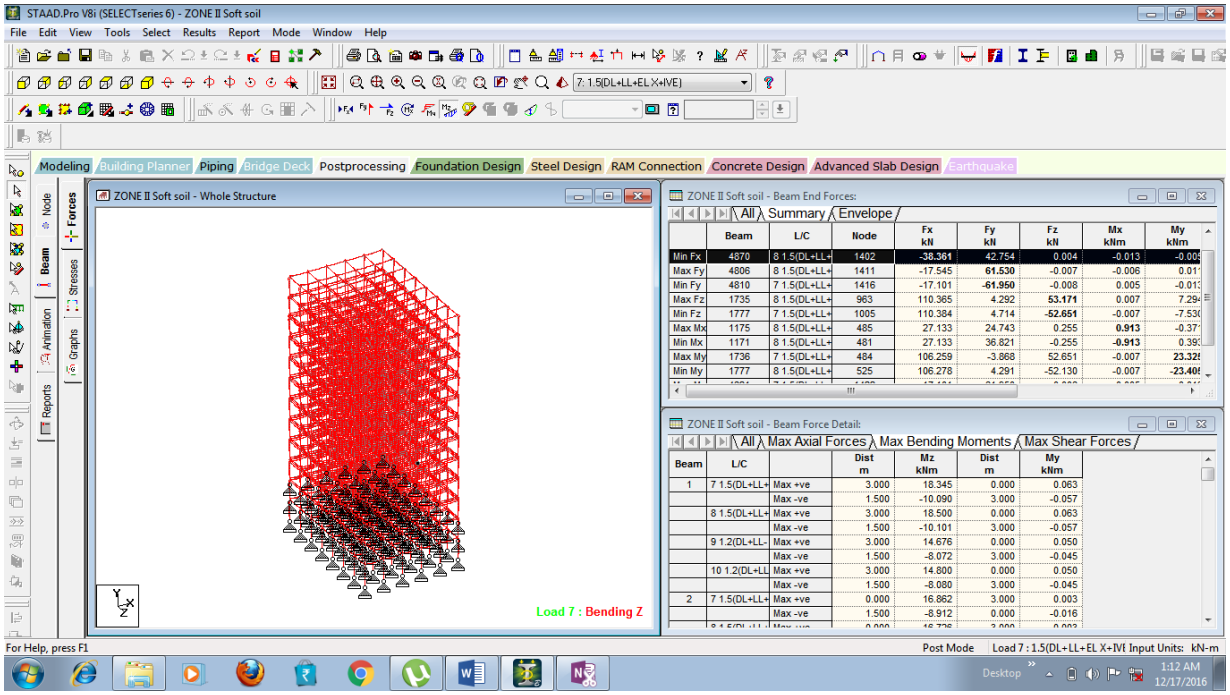


Figure 13: Soft Soil Zone VShear Force Bending Moment Result View

Table 2: Soft Soil Zone V SF/BM Result Table

	Beam	L/C	Node	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
Max Fx	3159	7 1.5(DL+LL+EL X+IVE)	1096	946.536	0.249	-0.484	0.000	0.072	-0.113
Min Fx	4870	8 1.5(DL+LL+EL Z+IVE)	1402	-38.361	42.754	0.004	-0.013	-0.005	23.605
Max Fy	4806	8 1.5(DL+LL+EL Z+IVE)	1411	-17.545	61.530	-0.007	-0.006	0.011	53.192
Min Fy	4810	7 1.5(DL+LL+EL X+IVE)	1416	-17.101	-61.95	-0.008	0.005	-0.013	53.853
Max Fz	1735	8 1.5(DL+LL+EL Z+IVE)	963	110.365	4.292	53.171	0.007	7.294	2.464
Min Fz	1777	7 1.5(DL+LL+EL X+IVE)	1005	110.384	4.714	-52.651	-0.007	-7.530	2.114
Max Mx	1175	8 1.5(DL+LL+EL Z+IVE)	485	27.133	24.743	0.255	0.913	-0.371	5.173
Min Mx	1171	8 1.5(DL+LL+EL Z+IVE)	481	27.133	36.821	-0.255	-0.913	0.393	23.289
Max My	1736	7 1.5(DL+LL+EL X+IVE)	484	106.259	-3.868	52.651	-0.007	23.325	-1.653
Min My	1777	8 1.5(DL+LL+EL Z+IVE)	525	106.278	4.291	-52.130	-0.007	-23.405	1.177
Max Mz	4821	7 1.5(DL+LL+EL X+IVE)	1422	-17.101	-61.950	0.008	-0.005	0.013	53.853
Min Mz	1756	7 1.5(DL+LL+EL X+IVE)	504	111.971	36.956	-7.060	-0.003	-1.098	-32.283

Similarly Analysis were performed for Medium Soil Zone V, Soft Soil Zone II and Soft Soil Zone V Cases.

6.1 Results

Table 9: Result Table for Both Soil and Zone Cases

Parameters	Soft Soil With V Zone	Medium Soil With V Zone	Soft Soil With II Zone	Medium Soil With II Zone

Deflection (mm)	9.85	9.83	9.01	8.81
Stress (N/mm^2)	14.457	14.44	12.60	12.56
Shear Force (kN)	63.214	62.901	61.53	61.149
Bending Moment (kNm)	55.841	55.35	53.928	53.792

Table 10: Difference Value Table for Both Soil and Zone Cases

Parameters	Soft Soil Zone V vsZone II	Medium Soil Zone V vsZone II	Soft Soilvs Medium SoilZone II	Soft Soilvs Medium SoilZone V
Deflection (mm)	0.84	1.02	0.2	0.02
Stress (N/mm^2)	1.857	1.88	0.04	0.017
Shear Force (kN)	1.684	1.752	0.381	0.313
Bending Moment (kNm)	1.913	1.558	0.136	0.491

Conclusion

The Deflection, Shear Force Bending Moment, Beam End Forces, Displacement, Beam Stresses Sectional Force and Bending Moment are noticed maximum in Zone V for all above cases. The graphs and table values for all parameters are greater for Zone V analysis than Zone II analysis.

Soil analysis in medium and soft soil are examined in both Zone V and Zone II. It is found in results for both cases that the displacement in soft soil is greater than medium soil case. Shear force values are also greater in soft soil. Bending moment is noticed lesser in soft soil than medium soil for all cases.

The STAAD Pro is found as a effective tool for Seismic analysis of Multi-storey buildings in any of the Seismic zone. The highest sections of column and higher Beams are subjected to maximum stresses and deflection, so various high side beams can be analyzed and can be designed using FEM software's like STAAD Pro.

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