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Comparison of Seismic Analysis and Static Analysis of Residential Building Using Staad.Pro

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Abstract- *Earthquake resistant design of structures has grown into a multi-disciplinary field of engineering wherein many exciting developments are possible in near future. If the structures are not well designed and analysed for adequate strength and ductility, it may lead to its complete collapse. Therefore, the basic requirement is the seismic analysis of structures prior to their construction. The study of the response of a structure subjected to motions due to the seismic waves is the seismic analysis. In this paper, a residential building with ground floor as partial parking located in seismic zone III has been considered for static analysis and seismic analysis by using STAAD.PRO software. Various load combinations as per IS 1893-2016 have been considered to obtain the worst condition.*

Keywords *– STAAD.PRO, Seismic analysis, Static analysis*

I. Introduction

Vibratory motions are caused at the base of the structure by seismic waves from earthquakes and structure responds actively to these motions. Usually, the base of a structure is fixed which leads to inertia forces causing certain distributions that occur in moving based system. The horizontal and vertical structural elements resist lateral forces produced by seismic waves. Hence seismic analysis is done to understand the resistance of structures to dynamic motions and consists determination of bending moments, shear forces and deflections. However, in zones where the probability of occurrence of the earthquake is very low, static analysis of structure is sufficient to cater to safe design needs. Static analysis is used for the design of ordinary moment resisting frame but the design of special moment resisting frames requires complete seismic analysis of the structure. STAAD.PRO is a leading software for performing the analysis and design of structures. It can be used to generate graphical models, to create the geometry, assign properties and materials. It consists of analysis engines such as linear elastic and P-Delta analysis, finite element analysis, dynamic response. It provides us with displacement diagrams, bending moment diagrams, shear force diagrams, beam, plate, and solid stress contours, etc.

Objectives

1)To enumerate comparison between various parameters in seismic and static analysis.
2) Studying the output of seismic and static analysis on various structural components of building.
3) Checking the necessity of seismic analysis over static analysis in seismic zone 3.

II. Methodology

- Drafting of the plan:
- Preparing of model of G+4 residential building in ‘Staad.Pro’
- The static analysis and seismic analysis of the building is carried out in ‘Staad.Pro’ and the results obtained are compared.
- The analysis is being done in zone 3.
- Earthquake analysis is done by considering (DL +25%LL).

Structural Data

The structure consisting of 4 floors excluding parking and the building will be used for residential purpose, stilt floor shall be left for partial parking purpose and residing purpose. Main beams rest centrally on columns to avoid local eccentricity. Grade of concrete is M20 and Grade of steel is Fe415. Seismic loads are considered acting in the horizontal direction and not allowed in the vertical direction.

Liveload**:-**As per IS 875 part-2 (2or3 kN/m^2) Wall thickness:- 230mm(Outer), 115mm(Inner)
Thickness of slab:-135mm Floors:- 5(Including Parking)
Type of Soil:- Medium Soil Interior Column sizes:- 230 x 400 mm
Allowable bearing pressure:- 20 ton/m^2 Outer Column sizes:- 230 x 500 mm
Beam size:- 230 x 300mm, 230 x 400mm (Depending on span of beam).
Each storey height:-3.15m
Floor finishing:- 1 kN/m^2
Roof finishing:- 3 kN/m^2 (2 kN/m^2 for water proofing and 1 kN/$m^2$for floor finish).
Earthquake load:- As per IS: 1893(part 1).
Live load on roof:- 3 kN/m^2(since terrace is accessible).

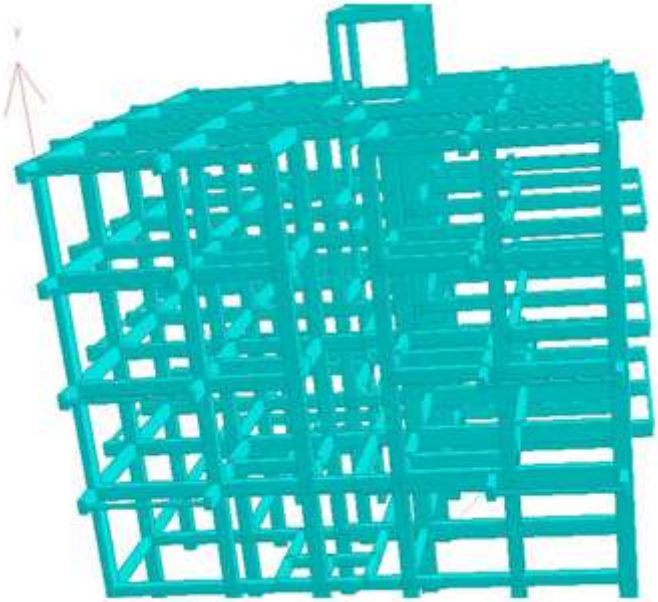

Fig. STAAD.PRO model of the structure

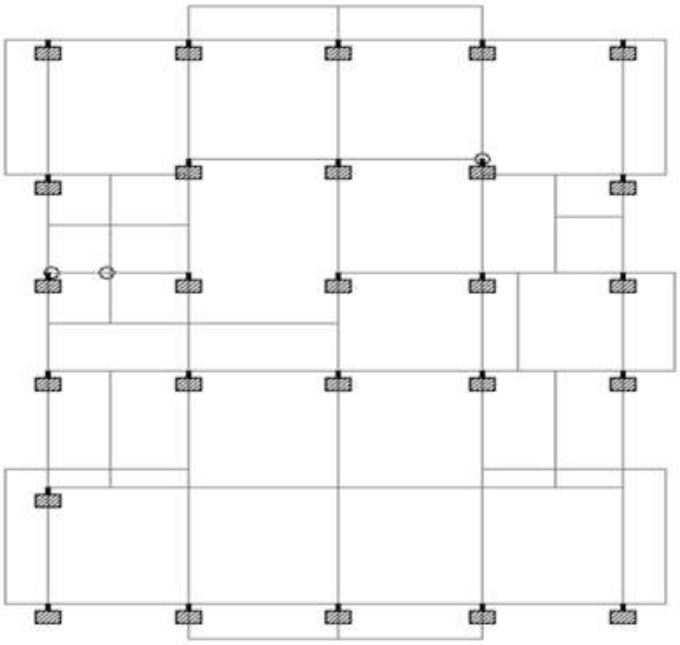

Fig. Plan of the structure

Load CombinationS

1	DL+LL	10	1.5(DL+LL)
2	DL+EQX	11	1.5(DL+EQX)
3	DL-EQX	12	1.5(DL-EQX)
4	DL+EQZ	13	1.5(DL+EQZ)
5	DL-EQZ	14	1.5(DL-EQZ)
6	0.9DL+1.5EQX	15	1.2(DL+LL+EQX)
7	0.9DL-1.5EQX	16	1.2(DL+LL-EQX)
8	0.9DL+1.5EQZ	17	1.2(DL+LL+EQZ)
9	0.9DL-1.5EQZ	18	1.2(DL+LL-EQZ)

III. Observation And Results

1) BEAM (NUMBER-14):-

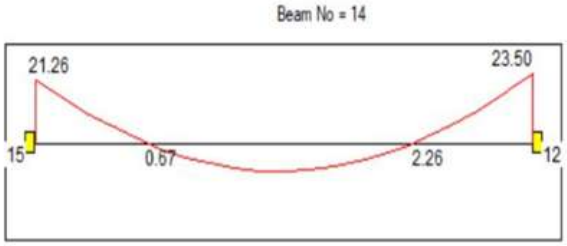

Fig.1(a) Bending moment (static)

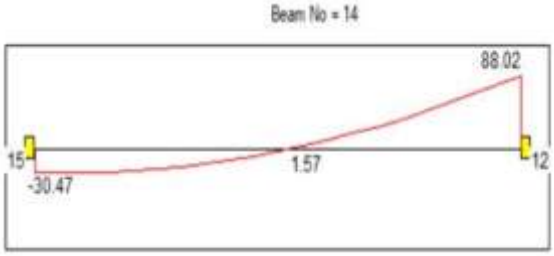

Fig.1(b) Bending moment (seismic)

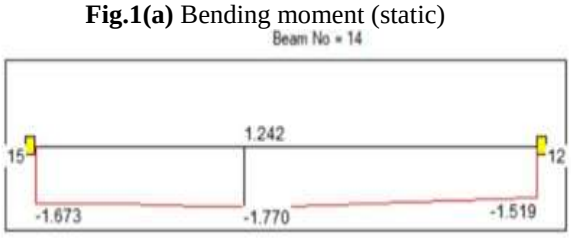

Fig.2(a) Deflection (static**)**

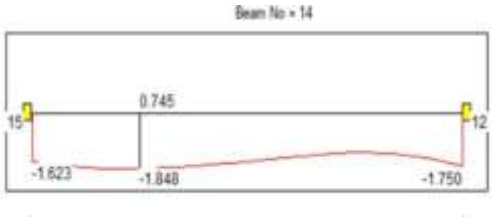

Fig.2(b) Deflection (seismic)

Static analysis 1.5 (DL +LL)			Seismic analysis 1.5(DL+EQZ)		
Fy(kN)	Mz(kNm)	Deflection (mm)	Fy(kN)	Mz(kNm)	Deflection(mm)
-41.551	23.503	-1.770	-80.561	88.021	-1.848

Table No. 1 Output

2) BEAM (NUMBER-616):-

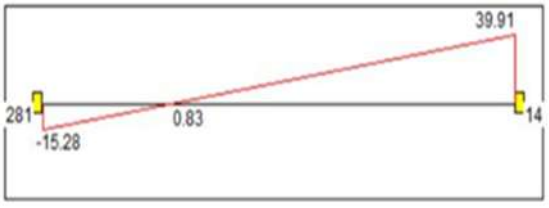

Fig.3(a) Bending moment (static)

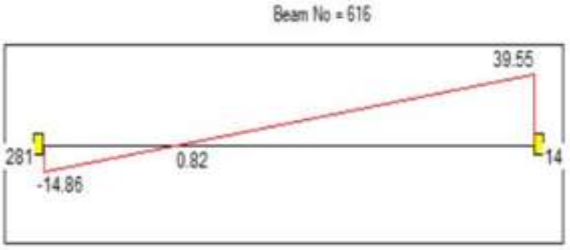

Fig.3(b) Bending moment (seismic)

Fig.4(a) Deflection (static**)**

Fig.4(b) Deflection (seismic)

Static analysis 1.5 (DL +LL)			Seismic analysis 1.5(DL+EQZ)		
Fy(kN)	Mz(kNm)	Deflection (mm)	Fy(kN)	Mz(kNm)	Deflection(mm)
-18.395	39.909	-1.905	-18.140	39.554	-2.308

Table No. 2 Output

3) NODES :-

Static analysis 1.5 (DL +LL)			Seismic analysis 1.5(DL+EQZ)		
Node number	Fy(kN)	Mz(kNm)	Node number	Fy(kN)	Mz(kNm)
384	779.972	1.251	384	863.669	2.325
386	973.048	0.865	386	1049.456	3.314

Table No. 3 Output

IV. Conclusion

For Beam:

- The research paper enables to analyse the G+4 structure in Zone III under seismic as well as static loads wherein the displacements observed are nearly same.
- The moment obtained in z-direction is very high in case of seismic analysis as compared to that in static analysis.
- From our following results, we can conclude that with the effect of seismic forces the moment on the load carrying member gets increased.

For Column:

- The research paper enables to analyse the G+4 structure in Zone III under seismic as well as static loads wherein the displacements observed are nearly same.
- The change in moment in Z direction is nearly same but the change in moment in y-direction is very high in case of seismic analysis. Because of the higher moment, we have to provide higher amount of reinforcement.

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Future Scope

- The effect of wind load can be considered in the analysis.
- The height of the structure can be increased to study its effects on moments as well as displacements.
- Variation of steel to be provided in structure can be studied according to different seismic zones to understand the change caused by zones.