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Comparative Study of Time History Analysis and Response Spectrum Analysis of Steel Frame Building using Staad Pro

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Abstract:

In today's generation time has more value than money and we have a great extent of construction techniques too that are demanding on the duration of construction. Steel Structural buildings are considered as a revolution in the new construction era due to its quick erection method. To have a prudent and effective structure design the most ideal route is to choose the kind of construction relying upon the suitable conditions and functional requirements. "The Comparative study on design of Steel frame Structures" will help us to choose the kind of construction which ideally suits the conditions and type of structure. The present work contains the experimental investigation on reducing the size of the member to make structure economical and efficient by locating shear wall at varying places in irregular shape building. The results that are obtained from the time history analysis and response spectrum analysis includes the max displacements, max moments and shears, mode shapes, time periods and frequencies, time history plots, base reactions for response spectrum case, and finally concrete design are represented for software's models. Dynamic analysis is carried out using STAAD Pro software. The Loads on structure were considered as per IS standards. The dynamic analysis may be Response spectrum method or time history analysis method.

Keywords: ***Response Spectrum method; Time history method; El_Centro_earthquake; displacement; STAAD Pro software.***

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1. INTRODUCTION:

The height of a building is subjective and can be described neither in terms of height nor number of storeys in absolute terms. But from the perspective of a structural engineer, the high-rise building can be characterized as one that is influenced by lateral forces due to wind, earthquakes or both**.**A dual design philosophy has been adopted for the design of building in earthquake prone regions due to nature of earthquake. The buildings which do not fulfill the requirements of seismic design, may suffer extensive damage or collapse if shaken by a severe ground motion. The seismic evaluation reflects the seismic capacity of earthquake vulnerable buildings for the future use. Therefore, it is necessary to study variation in seismic behavior of multistoried steel building in terms of various responses such as displacement and base shear. In this study the seismic behavior of steel building and also, analysis of structure by using time history method is been carried out in this paper. The story displacement result has been obtained. The pertaining structure of 20 stories residential building has been modeled. The story mass is kept same in the different floors. The building has been analyzed by using the time history method spectrum based on IS codes; the results obtained are compared to determine the structural performance.

1.1 Objective of the study

• To study behavior of steel building (G+19) with and without shear walls at different locations like edges and corners of building.
• To study the behavior of G+19 storied steel frame building situated in earthquake zone V using equivalent

lateral force analysis, modal analysis, time history analysis and response spectrum analysis.
• To measure the shear force and bending moment of these structures at numerous levels, relative to ground displacements in horizontal direction in both the STAAD.PRO
• The study on Dynamic analysis discloses an effort to see the elemental natural frequency of various building's victimization Matrix methodology based mostly software packages, STAAD.

1.2 Methodology

Time history is basically a method of seismic analysis for the simulation of an earthquake motion. It is an ultimate tool to study the dynamic response of a structure. This paper gives time history analysis by using timeacceleration data as input function and then performance of the structure is evaluated with various mode shapesand time-acceleration results.

2. MODELING OF THE STRUCTURE

One of the objectives of this model designing is to ensure that the model represent the characteristics of high-rise buildings. Buildings with different number of stories with 20(G+19) storeys having same floor plan of 25 m-by-25 m dimensions were considered for this study. The floor plans were divided into five by five bays in such a way that center to center distance between two grids is 5 meters by 5 meters respectively as shown in Figure 1. The floor height of the building was assumed as 3 meters for all floors and plinth height is 5 meters above from foundation base as shown in Figure 2.

2.1 DESCRIPTION OF BUILDING

- **Type of structure:** High rise Steel frame structure with shearwall.
- **Occupancy:** Office building
- **Number of stories:** 20
- **Foundation depth :** 5 m
- **Intermediate storeyheight :** 3m
- **Type of soil :** Soft Soil
- **Zone :** V (Yamuna Nagar)
- **Type of Steel-** ISHB

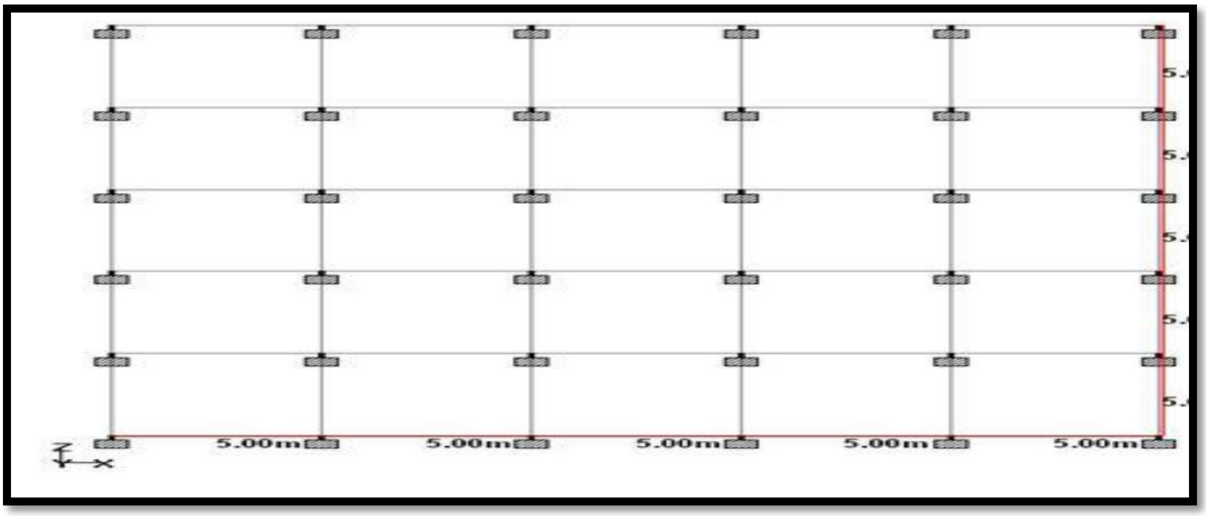

Fig. 1: Typical Floor Plan for all Buildings in STAAD Pro

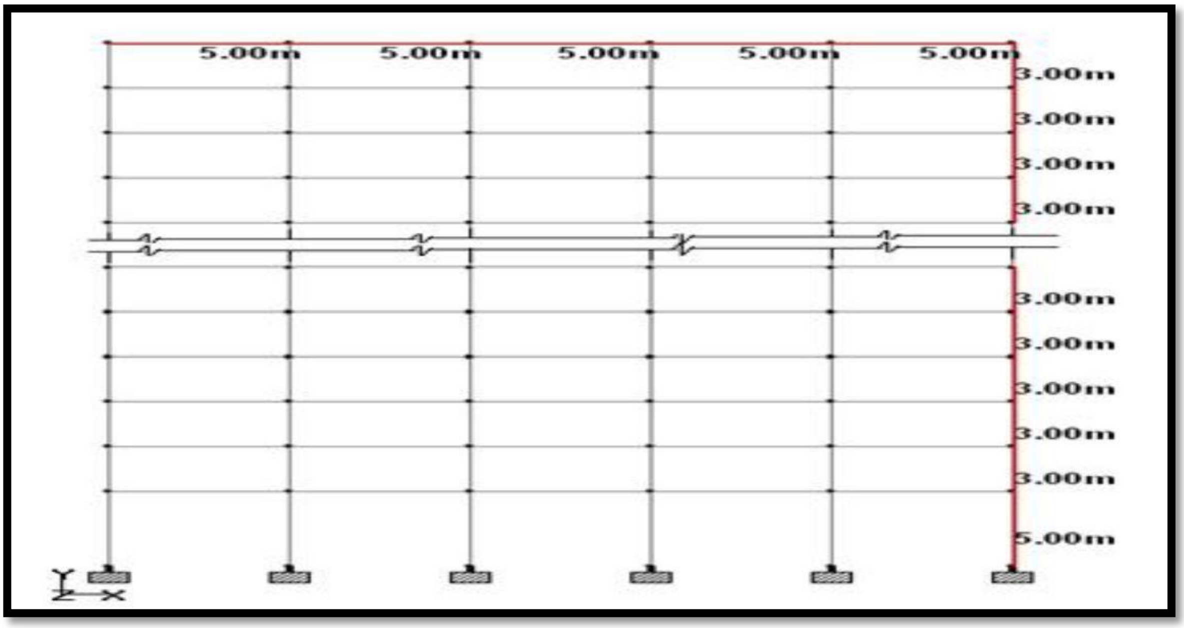

Fig. 2: Elevation of the building model

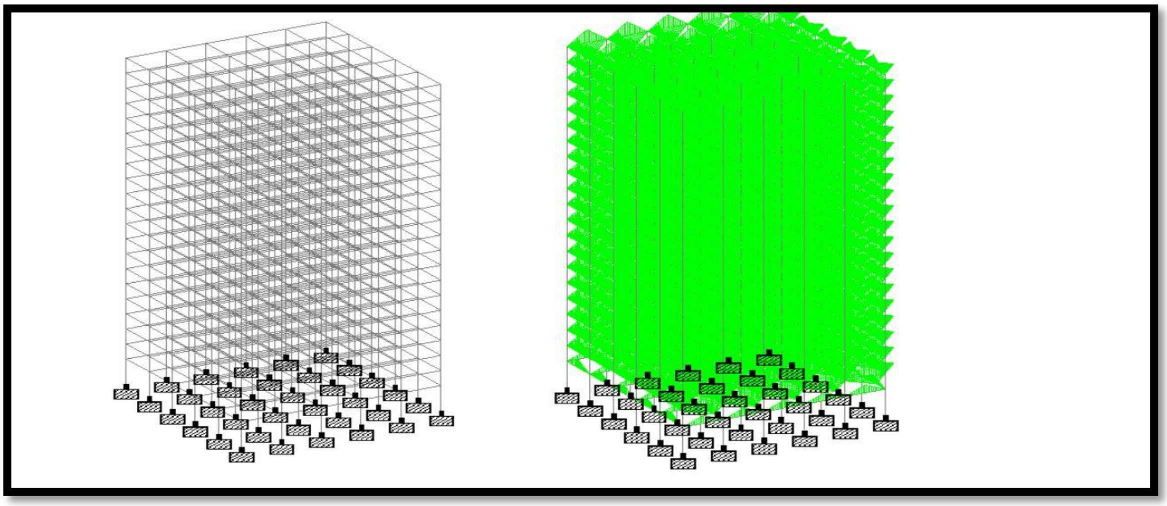

Fig. 3: 3D model in Staad-Pro

3. Structure loading and Analysis

All the loads are calculated and generated in accordance with Indian standard codes IS 875 part-I for dead load calculations, Part II for live load calculations, Part III for Wind load calculations, IS 1893 for earthquake load and load combinations these are followed strictly for generation of loads.

The following are the loads and assigned for the structure

Sl no	Load Type	Assignment	Intensity
1	**Dead load**	Self-weight of the element	1 kN/m^2
2		Wall load	10 kN/m^2
3		Floor Finish	1.5 kN/m^2
4	**Live load**	Live Load on Slabs	2 kN/m^2

Table 1 -Loadings

Sl.No	Seismic Properties	Data
1	Zone Factor	.36
2	Response Reduction Factor	5
3	Importance Factor	1
4	Soil type	Medium
5	Structure Type	Steel
6	Damping Ration	5 %

Table 2- Data of the earthquake properties which are assigned to the structure

S.no	Wind Load Parameters	Data
1	Wind Speed	50 m/s
2	Terrain Category	2
3	Importance Factor	1
4	Risk Coefficient	1
5	Topography Factor	1

Table 3- Wind Load Parameters

4. RESULTS AND DISCUSSIONS:

Following table shows displacement values for different floors at different time periods.

Floor No	Time Periods (Seconds)	Displacement in X-Direction(mm)
Ground Floor	7.02	1.57
1	7.02	3.54
2	7.03	5.98
3	7.03	8.7
4	7.04	11.6
5	7.05	14.6
6	7.06	17.7
7	7.07	20.8
8	7.08	23.9
9	7.1	27
10	7.12	30.1
11	7.14	33.2
12	7.17	36.2
13	7.18	39.1
14	7.21	41.7
15	7.21	44.1
16	7.21	47.8
17	7.21	46.1
18	7.21	49.3
19	7.21	50.6
20	7.22	51.7

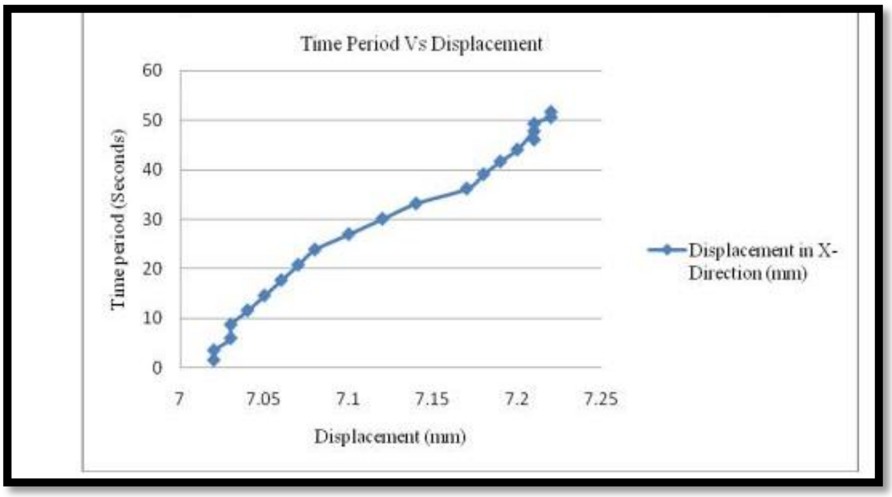

Fig.4 Comparison of Base shear for Box type shear wall without openings and with openings.

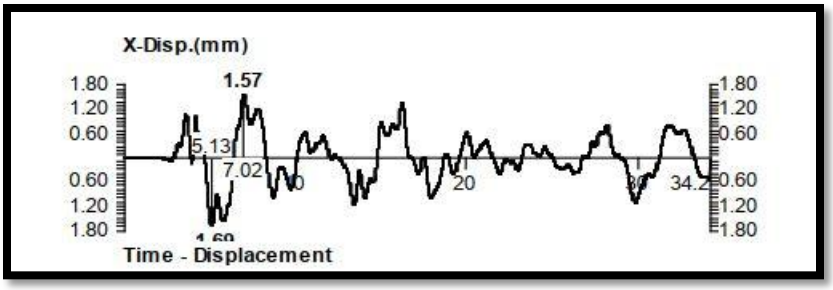

Fig. 5: Displacement Vs Time at 20th Floor

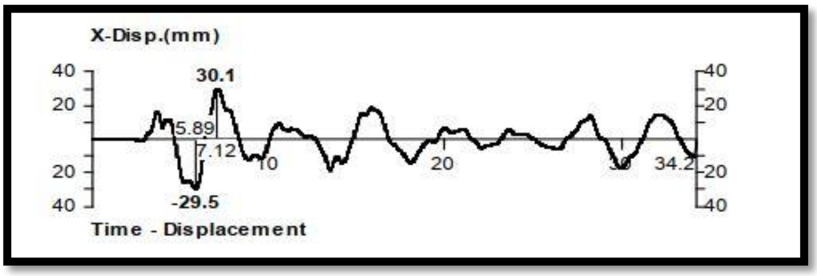

Fig. 6: Displacement Vs Time at 10th Floor

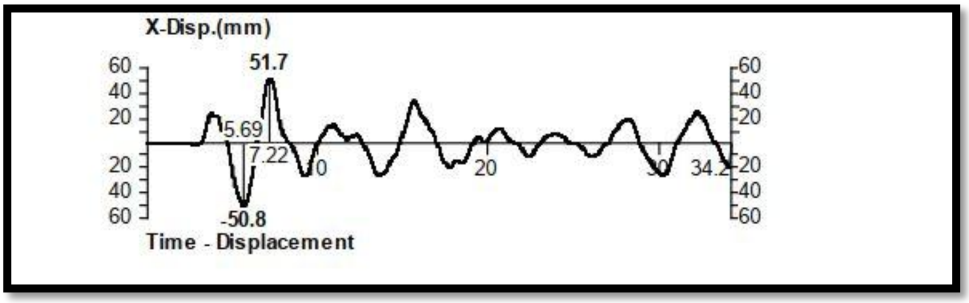

Fig. 7: Displacement Vs Time at Ground Floor

It is observed that the time period Vs displacement graphs obtained were similar to that of Time Vsacceleration graph obtained from earthquake data. As the time period increases displacement of eachfloor also increases. As the height of structure increases time period increases which is in accordancewith IS: 1893(Part 1): 2002.

5. CONCLUSION:

There is a significant decrease in the bottom column shear and moment in the three models with the incorporation ofshear wall this is because of the increased stiffness at the bottom of models which are having shear wall, this can bedescribed by assuming the building as a cantilever projection, where the moments are high at fixed end and less at thefree end. From the model analysis, it is concluded that the models with higher mass oscillation has less time period and viceversa. The shear wall model has higher time period compared to bare frame models.The user interface and steps to follow differs a lot in both the software's, in staad.pro the interface and steps to befollowed are archaic.

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