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Dynamic Analysis of Multi-Storeyed Frame-Shear Wall Building Considering SSI

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ABSTRACT
The structural system of a high-rise building often has a more pronounced effect than a low rise building on the total building cost and the architecture aspect of building. Shear walls are lateral load resisting structural systems which provide stability to structures from lateral loads like wind and seismic Loads. The design of multi storey building is to have good lateral load resisting System along with gravity load system for safety of occupant and for better performance of structure even in most adverse condition. The main scope of this project is to apply class room knowledge in the real world by designing a multi-storied residential building. Shear walls are more efficient in resisting lateral loads in multi storied buildings. Steel and reinforced concrete shear walls are kept in major positions of multi storied buildings which are made in consideration of seismic forces and wind forces. To solve this purpose shear walls are a very powerful structural elements, if used judiciously can reduce deflections and stresses to a very great extent. Our project contains a brief description of building with shear wall and without shear wall thoroughly discussed structural analysis of a building to explain the application of shear wall. The design analysis of the multi storied building in our project is done through STAAD-PRO, most popular structural engineering software. It is featured with some ultimate power tool, analysis and design facilities which make it more users friendly.
Keywords: Shear wall, Building Drift, Response spectrum method, Time period, OMRF, Base shear.

I. INTRODUCTION

Soil-structure interaction (SSI) has been recognized as an important parameter that may significantly affect the motion of base, relative building response and motion of surrounding soil. Generally building soil interaction consists of two parts kinematic interaction and dynamic interaction. The former result of wave nature is excitation and is manifested through the scattering of incident waves from foundation system and through filtering effect of the foundation that may be stiffer than the soil. Therefore it may not follow the higher frequency deformations of soil. This interaction depends on angle of incidence, frequency, type of incident waves, shape of foundation and depth of foundation. It develops due to presence of stiff foundation elements on or in soil cause foundation motion to deviate from free-field motions. The later is due to inertia forces of building and of the foundation which act on soil due to contact area. And it depends on the mass and height of the building and the mass and depth of foundation, on the relative stiffness of soil compared with the building and on the shape of foundation. It develops in structure due to its own vibrations which gives rise to base shear and base moment, which in turn cause displacements of the foundation relative to free field. At low level of ground shaking, kinematic effect is more dominant causing increase of period. Observations from recent earthquakes have shown that the response of the foundation and soil can greatly influence the overall structural response.

II. SCOPE OF THE STUDY

The lateral behavior of the multistory building designed according to the IS-456 and IS-1893 part-I is evaluated using dynamic analysis of framed structures using Response Spectrum Method. The inadequacies of multi-storied frame shear wall building are discussed comparing the lateral behavior, building drift, axial force, and seismic base shear. Two important parameters zone factor and Soil-structure interaction (SSI), which influence the lateral behavior of building is also considered in this study. Software **STAAD-ProV8i** is used for this purpose. In this study number of stories, zone factor and soil condition are varying parameters.

III. SHEAR WALL

Vertical elements of the horizontal force resisting system are known as Shear walls. It is typically wood frame walls covered with a structural sheathing material like plywood. When the sheathing is properly fastened to the stud wall framing, the shear wall can resist forces directed along the length of the wall. If shear walls are designed and constructed properly, it will have the good strength and stiffness to resist the horizontal forces.

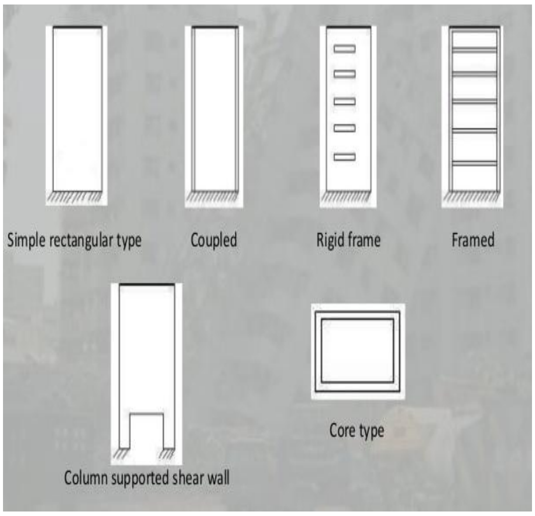


Figure-1 Types of shear wall

IV. METHODS OF ANALYSIS

1. Equivalent Static Analysis

All design against earthquake effects must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is often sufficient. This is permitted in most codes of practice for regular, low- to medium-rise buildings and begins with An estimate of peak earthquake load calculated as a function of the parameters given in the code. Equivalent static analysis can therefore work well for low to medium-rise buildings without significant coupled lateral–torsion modes, in which only the first mode in each direction is of Significance. Tall buildings (over, say, 75 m), where second and higher modes can be important, or buildings with tensional effects, are much less suitable for the method, and require more complex methods to be used in these circumstances.

2. Time History Method

Time-history analysis is a step-by-step analysis of the dynamical response of a structure to a specified loading that may vary with time. The analysis may be linear or non linear. Time history analysis is used to determine the dynamic response of a structure to arbitrary loading.

3. Response Spectrum Method

The word spectrum in seismic engineering conveys the idea that the response of buildings having a broad range of periods is summarized in a single graph. For a given earthquake motion and a percentage of critical damping, a typical response spectrum gives a plot of earthquake-related responses such as acceleration, velocity, and deflection for a complete range, or spectrum, of building periods

V. ANALYSIS AND DESIGN

STAAD-Pro V8i is a comprehensive and integrated finite element Analysis and design offering, including a state-of-the-art user interface, visualization tools, and international design codes. It is capable of analyzing any structure exposed to static loading, a dynamic response, wind, earthquake, and moving loads.

1. Considerations for analysis and design

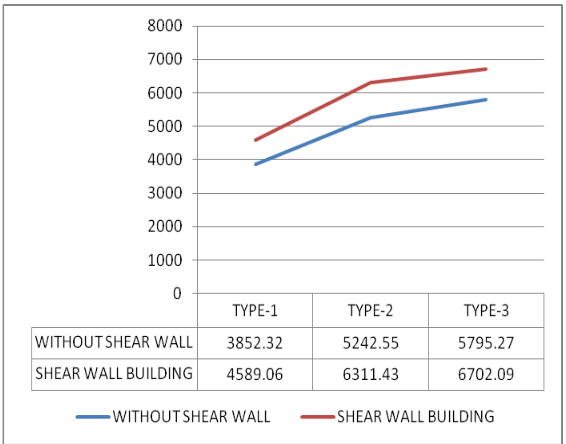
- Model of buildings are prepared in STAAD Pro with given loading conditions. To compare the behavior of the building with shear wall and without shear wall during lateral condition, stiffness of column is kept same. Columns are assumed to have the same size at the particular storey level.
- **B**eam of same dimensions are provided.
- Column size is reduced after every three stories as per requirement of gravity loads.
- Thickness of slab is provided according to the deflection requirement.
- Dynamic analysis is carried out by placing two building in all four zones and with three soil conditions. (For storey drift).
- Response reduction factor '3', and importance factor '1' is assumed.

2. Preliminary Data for 12-story building

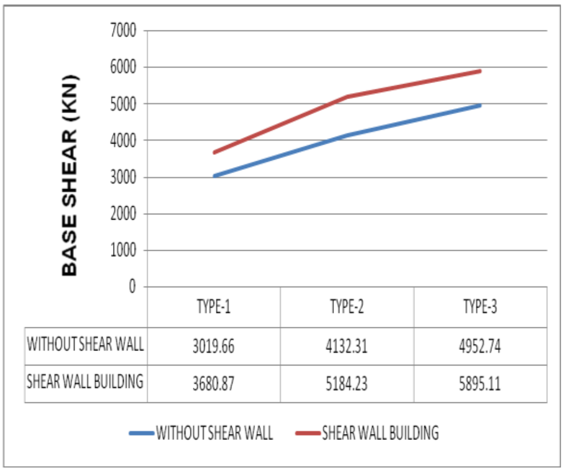
1	**Type of the Building**	**Residential Building**
2	**Number of Story**	**G+11**
3	**Plan dimensions**	**40 m x 24 m c/c**
2	**Length in X-direction**	**40 m**
3	**Length in Y-direction**	**24 m**
4	**Floor to floor height**	**3.5 m**
5	**No. of Stories**	**12**
6	**Total height of Building**	**42 m**
7	**Slab Thickness**	**120 mm**
8	**Shear wall Thickness**	**200 mm**
9	**Grid Beam**	**230mm x 870 mm**
10	**Size of the Column**	**1-3 story-950 mm x 950 mm**
		3-6 story- 850 mm x 850 mm

		6-9 story-750 mmx750 mm	
		9-12 story-650 mmx650 mm	
11	Grade of concrete	M25	
12	Grade of Steel	Fe415	
13	Zone-II	Soil Type 1- Roc k or hard soil	
		Soil Type 2- Medium soil	
		Soil Type 3 -Soft soil	
14	Loading	Terrace	Remaining Floors
	Dead load (FF)	1KN/m^2	1 KN/m^2
	Live load	1.5KN/m^2	3KN/m^2
	Wall load	12KN/m	12KN/m

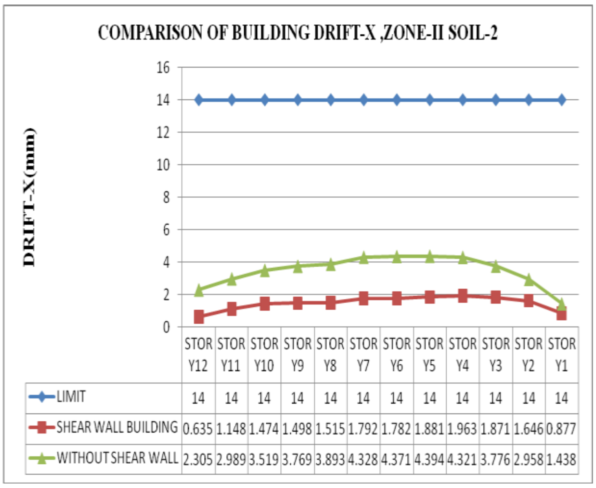
VI. COMPARISON OF ANALYSIS RESULTS



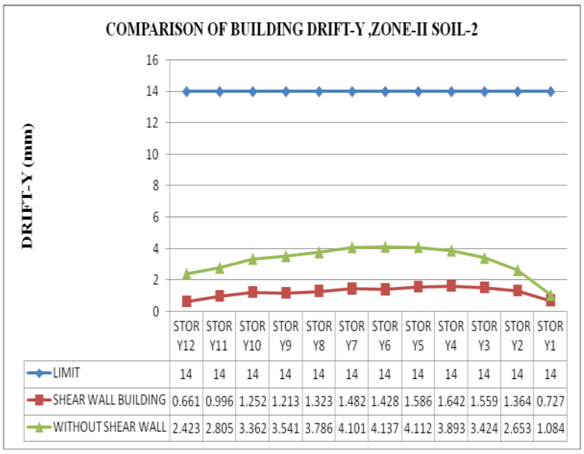
Graph 1 Seismic base shear in Y-direction for different soils in zone II



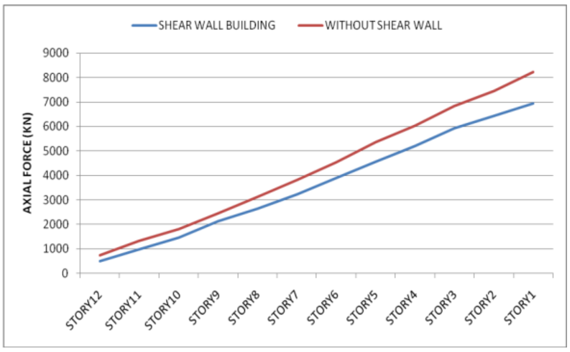
Graph 2 Seismic base shear in Y-direction for different soils in zone II



Graph 3 Comparison of building drift-X, Zone-II Soil-2



Graph 4 Comparison of building drift-Y, Zone-II Soil-2



Graph 5 Axial force in column C1

VII. CONCLUSION

Lateral response of multi storied building is studied by dynamic analysis. Dynamic characteristics of the same building are compared with shear wall building. Change in axial force, shear force, bending moment, seismic base shear and building drift due to change in zone factor and soil conditions are studied.

1. Quantity of Concrete and steel required in shear wall building is more as compared to without shear wall building, which makes, it uneconomical.
2. Base shear of building without shear wall is less than the base shear in shear wall building for all types of soil and all earthquake zones. \
3. Building drift for all storey of without shear wall building is about 34 % more than that of shear wall building
4. Axial force of building without shear wall is more than as compaired to shear wall building for column C1 and C4.
5. Graphs clearly shows that Axial force of shear wall building is more than as compaired to building whiout shear wall for column C2 and C3.
6. Graphs clearly shows that due to symetry Axial force of shear wall building and without shear wall building for column C1 and C4 are approximately equal.

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