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Seismic Analysis of Multistoried Building with and without Shear Wall using ETABS

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Abstract - *Shear walls are generally used in high earth quake prone areas, as they are highly efficient in taking the lateral loads. Not only the earthquake loads but also the wind loads which are quite high in some zones can be well resisted by these shear walls efficiently and effectively. Since two decades the principles of Structural design has not changed, now limit state method is turning into conventional it is no more accounted as modern design principle. Beyond the elastic design there is also a modern and futuristic method which involves the design beyond the material inelastic range and is known as 'Performance based design for a complex multi-storied building with and without shear wall for the seismic loads during earthquakes and the design above is verified for this same structure using extended three dimensional analysis of buildings (ETABS) software. The results are compared. And also to analyse storey drift , lateral displacement , shear ,storey stiffness model period and frequency on different floor with and without shear wall*

Key Words: Shear wall, seismic loads, wind loads, response spectrum, linear static analysis, storey drift, storey displacement, base shear, overturning moment.

1. INTRODUCTION

I. Shear wall **-** It is a vertical element of a seismic force resisting system that is designed to resist in-plane lateral forces, typically wind and seismic loads.

II. Wind load – The force on a structure arising from the impact of wind on it.

III. Seismic load – It is the lateral load or force or the agitation generated by the earthquake on the building. It usually happens at the contact surface either with ground or with adjacent structures.

1.1 SHEAR WALL BUILDING

Shear walls should be located on each level of the structure. It should be added to the building interior when the exterior walls cannot provide sufficient strength and stiffness or when the allowable span-width ratio for the floor or roof diaphragm is exceeded. For subfloors with conventional diagonal casing, the span-width ratio 3:1.

Shear walls are most efficient when they align vertically and are supported on foundation walls or footings. When shear walls do not align, other parts of the building will need additional strengthening. Consider the common case of an interior wall supported by a subfloor over a crawlspace and there is no continuous footing beneath the wall. For this wall to be used as shear wall, the subfloor and its connections will have to be strengthened near the wall.

Shear walls carry the adequate lateral strength to resist incoming horizontal earthquake forces. When shear walls are well-built, they easily transfer the horizontal force to the next elements of load path below the shear walls. The next elements in the load path may be considered as another shear walls, floors, foundation walls, slabs or footings.

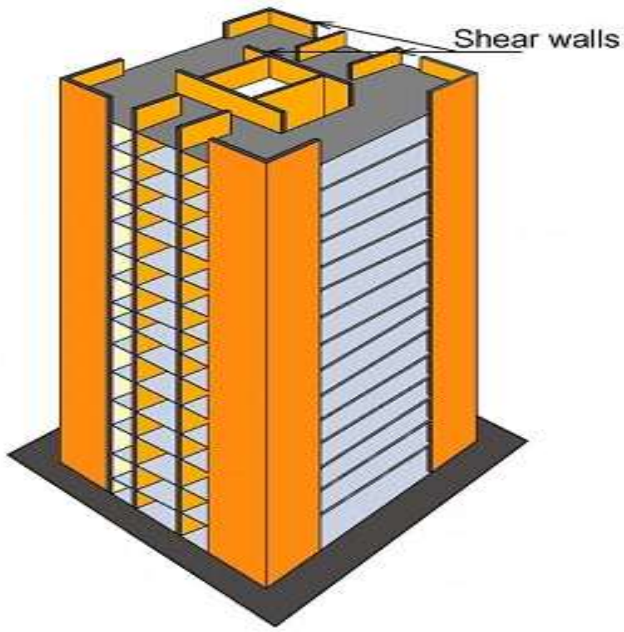

Fig -1: pictorial representation of shear wall

2. METHODOLOGY

It is a plot of the peak or steady-state response of a series of oscillators of varying natural frequency, that are forced into motion by the same base vibration or shock. The resulting plot can then be used to pick off the response of any linear system, given its natural frequency of oscillation. One such use is in assessing the peak response of buildings to earthquakes. The science of strong ground motion may use some values from the ground spectrum for correlation with seismic damage.

Response spectra can also be used in assessing the response of linear systems with multiple modes of oscillation, although they are only accurate for low levels of damping. Modal analysis is performed to identify the modes, and the response in that mode can be picked from the response spectrum. These peak responses are then combined to estimate a total response. A typical combination method is the square root of the sum of the squares (SRSS) if the modal frequencies are not close. The result is typically different from that which would be calculated directly from an input, since phase information is lost in the process of generating the response spectrum.

3. PROBLEM IDENTIFICATION

1. The earthquake forces mainly affects the high-raised multi-storeyed buildings.
2. Multi-storeyed buildings without shear walls shows large storey drifts, lateral stiffness, base shear.
3. Each storey in the building receives different frequencies of vibrations and affects each storey in different levels.
4. Base shear at the base of the columns occurred will be very high.

4. OBJECTIVES

1. To analyse the shear forces, bending moment, stress-strain and deformation or deflection for a multi-storied complex building.
2. To analyse storey drift , lateral displacement , storey stiffness and frequency on different floor with and without shear wall.

5. MODEL DESCRIPTION

Building considered here is a post metric boys hostel of G+2 floors.

Plot area = 501.752 m²

Concrete grade: Columns, Beams & slabs = M20

Reinforcement Steel: Fe415

Live load = 2 KN/m² for all floors

Floor finish = 1 KN/m².

Seismic zone = II

Zone factor = 0.1

Importance factor = 1

Response reduction factor =3

Soil type = Medium

Total height of building = 9m

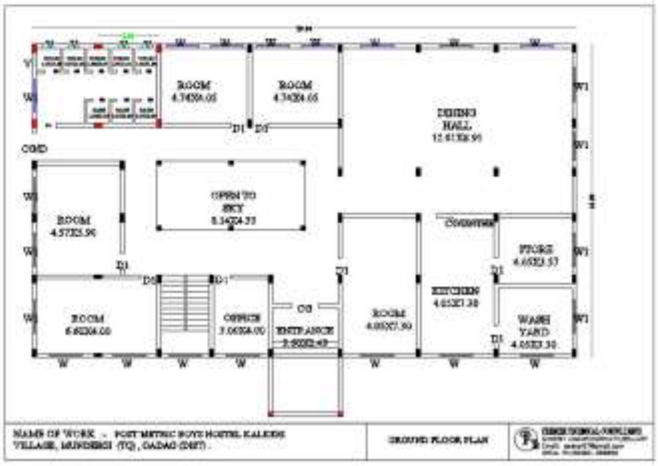

Fig -2: ground floor plan

Model 1-Without shear wall

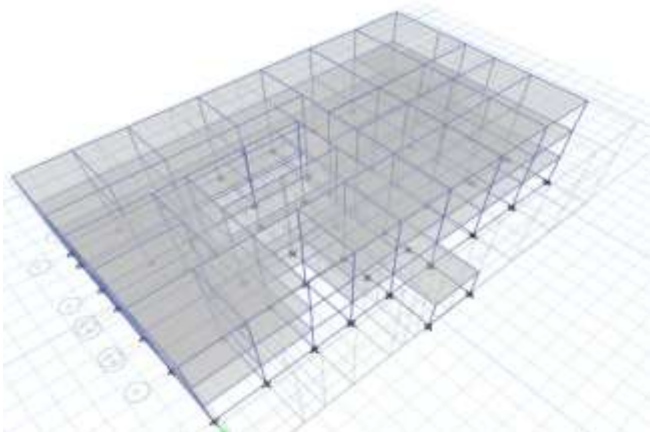

Fig -3: 3D model

Fig -4: SFD & BMD of a beam

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Model 2-With shear wall

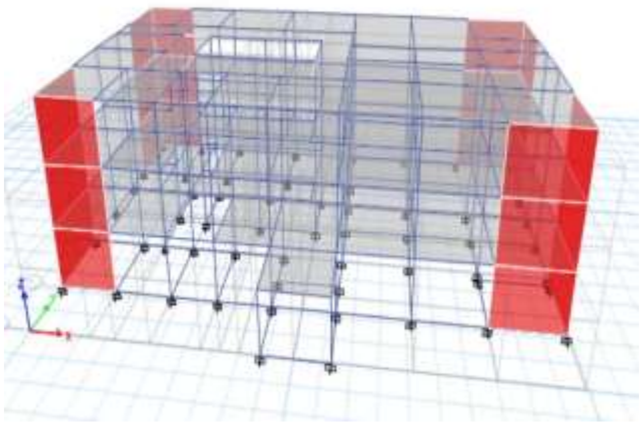

Fig -5: 3D model with shear wall

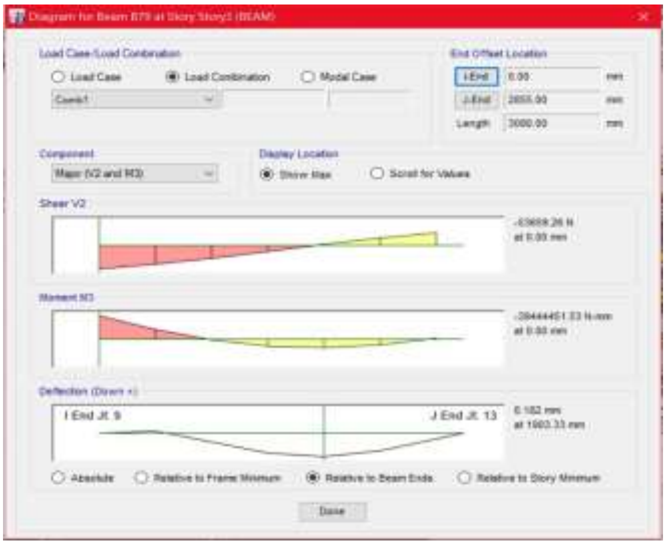

Fig -6: SFD & BMD of a beam

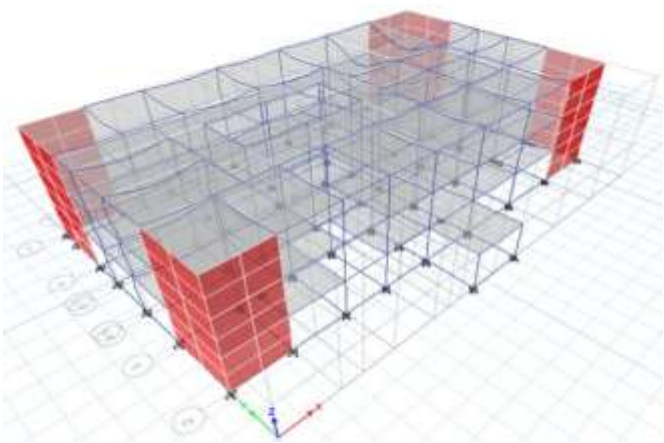

Fig -5: deformed 3D model with shear wall

6. RESULTS & COMPARISION

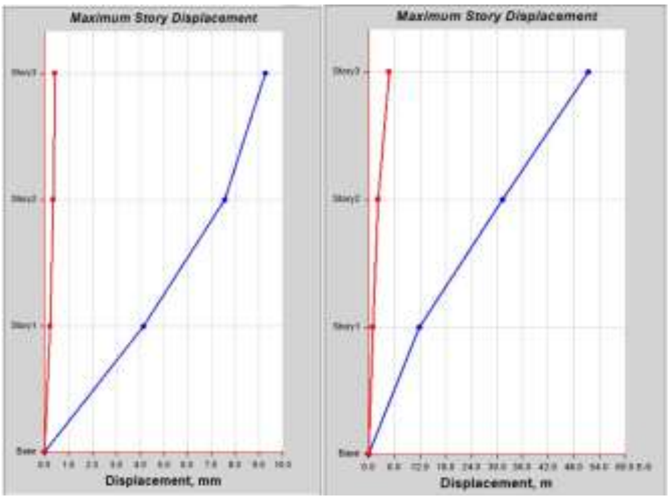

Chart -1: maximum storey displacements comparison for building without shear wall with shear wall

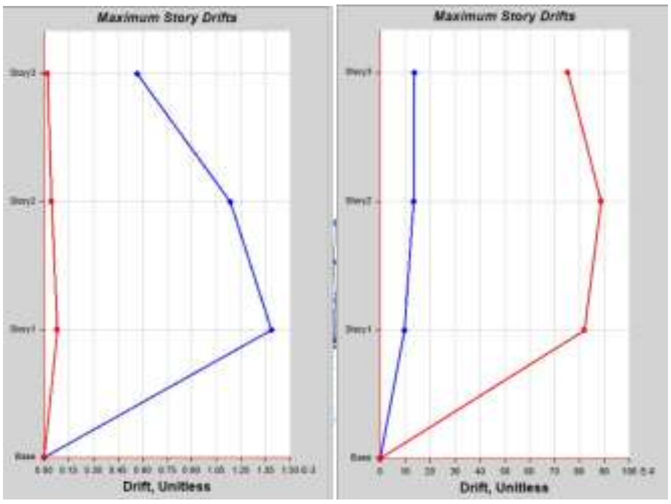

Chart -2: maximum storey drifts comparison for building without shear wall with shear wall

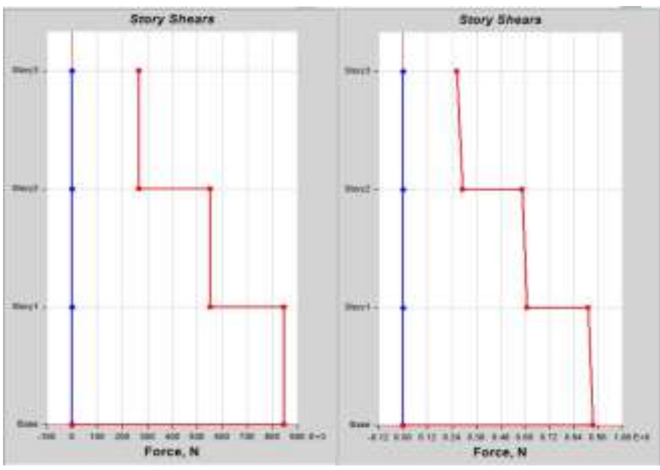

Chart -3: maximum storey shears comparison for building without shear wall with shear wall

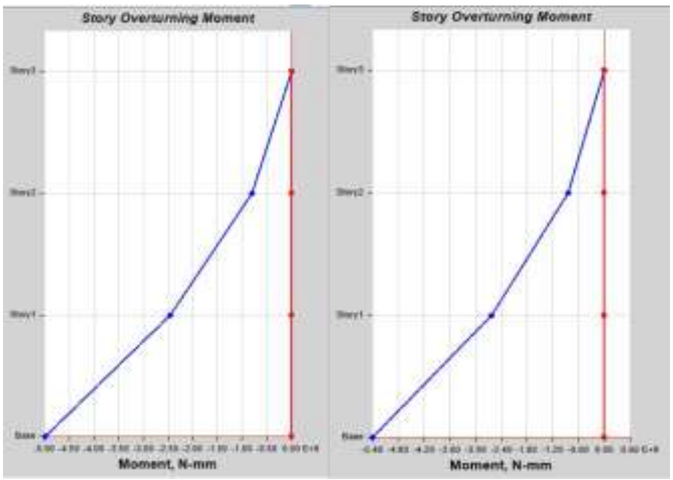

Chart -4: maximum over turning moments comparison for building without shear wall with shear wall

7. DISCUSSION & CONCLUSION

The present study of analysis makes an effort to understand the effect of shear wall on the structure situated in the zone susceptible to earthquake.

The following are the conclusions obtained from the analysis carried out:

1. Shear walls considerably enhance the rigidity and strength of the frame structure therefore, neglecting them in analysis & design of structure will lead to failure due to stiffness irregularity.
2. Symmetry in position of shear wall in plan is a key factor to obtain desirable performance of shear wall structure.
3. Increment in number of storeys make the building frame more vulnerable and therefore shear wall becomes a necessity in high rise buildings to save damage due to earthquake.
4.Increasing number of storeys result in increasing lateral movement causing more storey drift and therefore we have found that high rise buildings with no shear wall are vulnerable to collapse under seismic loads and dangerous to both life and property.
5. Base shear for structure with shear wall at corners is greater than the other structure. Hence it is feasible to provide to shear wall at corners in higher earthquake prone areas.
6. Storey displacement for structure with shear wall at corners is less as compared to that of structure without shear wall. Hence it is feasible to provide shear wall.

There are multi-dimensional advantages of shear walls such as:

1. The high level of rigidness in their own plane easily can limit the adverse deflection effectively;

2. Act as fire compartment walls, ability to resist lateral wind effect at super-structure and earth motion effect in the sub-structure.

However, for low and medium rise buildings (less than 10-storeys), the construction of shear walls are more time consuming and less accurate in dimensions than steelwork. Generally, RC walls acquire satisfactory strength and stiffness to resist the lateral loading system. Shear walls comprise minor ductility and may not meet the energy required under severe earthquake.

8. SCOPE OF FUTURE WORK

Generally, RC walls acquire satisfactory strength and stiffness to resist the lateral loading system. Shear walls comprise minor ductility and may not meet the energy required under severe earthquake. Care should be taken in the design of ductile shear walls which are used to resist earthquake loads. Steel shear walls are also used sometimes, by connecting them to framework by welding or high strength bolts. Masonry shear walls are also used, with solid walls and grouted cavity masonry to carry shears and moments, with reinforcements encased.

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