Analysis of RCC Building with Shear Walls at Various Locations and In Different Seismic Zones

Sylviya B, P. Eswaramoorthi

Abstract: ***Shear walls are the structural systems which counteracts the effect of lateral loads such as wind and earthquake loads acting on a structure. They are usually provided as an encasement for the elevator cores, stairwells etc., thereby resisting the horizontal and vertical forces effectively. In the present study, analysis of RCC building has been carried out by changing the locations of shear walls in the building. Also, the effect of variations in seismic zones as per IS codes has been presented. The seismic analysis performed is linear dynamic response spectrum analysis using the well known analysis and design software ETABS16.2.0. Seismic performance of the building has been investigated based on parameters such as storey drift, base shear and storey displacements.***

Keywords: ***ETABS, Asymmetric building, Shear walls, Response spectrum, seismic zones.***

I. INTRODUCTION

Earthquakes are the vibrations caused under the earth's surface which leads to loss of life and damage of structures. The main purpose of structural systems used in the building is to transfer the gravity loads effectively, which includes dead load, live load and snow load. In addition to gravity loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake, capable of developing high stresses, produce sway or leads to vibration. Sufficient strength against vertical loads together with adequate stiffness can resist lateral forces effectively. In case of a high rise building, possibility of sway is more in comparison with a low rise buildings. Structural forms such as shear walls, tube structures, dampers aids in reducing the damage to the building. Provision of shear walls in a building resists a combination of shear, moment and axial load due to lateral load and gravity load.

II. SHEAR WALLS

Shear walls are vertically oriented members in addition to slabs, beams and columns, capable of resisting the lateral loads. They start at the foundation and run throughout the height of the building. The thickness of the shear walls vary from 150mm to 400mm depending on the height of the building. RCC shear wall has high in plane stiffness, at the same time resist massive horizontal masses and support gravity masses in the direction of orientation of the walls, thereby serving advantageous in many Structural Engineering applications and reducing the risk of damage in structure. Shear walls additionally give lateral stiffness to prevent the roof or floor on top of from excessive side-sway.

Shear walls are of varied cross sections such as rectangular shaped, irregular cores like channel, T, L, barbell shape, box etc. are being used. Usually they form the core for elevator or used as reinforced walls with openings in it. Positioning of shear wall in a building influences the behaviour of the building. For effective and economic performance of building it is essential to position shear walls in a proper location so that they are symmetrical and torsional effect on the building is avoided. In this study, a reinforced concrete structure with shear walls at various locations is analysed and the optimum position of the shear walls has been studied.

A. Types of Seismic Analysis

- Equivalent Static analysis
- Response spectrum analysis
- Non linear static analysis
- Time History Analysis

B. Response Spectrum Analysis

To perform a seismic analysis of a structure, the actual time history at the particular location should be known which is not possible at all times. In addition, the seismic analysis cannot be carried out based on the on the peak value of the ground acceleration as the response of the structure depend upon the frequency content of ground motion and its own dynamic properties. to overcome the above limitations, response spectrum method serves to be an advantageous tool in the seismic analysis of structures. . The method involves the calculation of only the maximum values of the displacements and member forces in each mode of vibration using smooth design spectra that are the average of several earthquake motions. It is useful for those structures in which modes affects the response of the structure. Modal response is being determined by the spectral analysis of single -degree-of-freedom (SDOF) system, which is then combined to compute the total response of the structure. The main limitation of response spectra method of analysis is that it is applicable for linear systems.

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III.LITERATURE REVIEW

Ashish S. Agrawal (2012) Effect of position of shear wall with totally different shapes for crucial parameters like structure drift, axial load and displacement has been investigated in this paper. Presence of shear wall far away from the centre of gravity resulted in increase in most of the member forces. It has been concluded that increase in eccentricity, the building shows non-uniform movement of right and left edges of roof owing to torsion and induce excessive moment and forces in member.R.S.Mishra (2015) In this paper, positional configuration of shear wall subjected to seismic loads has been studied. It has been observed that intermediate position of shear walls is best suited with respect to core aqnd periphery positions of shear walls in a building. The shear wall make the structure safe by enhancing stiffness, ductility and reducing lateral and vertical drift of the storey at joints, which is due to direct reduction of displacement of member along the propagation of seismic force. Mahdi hosseini(2014) has studied on seismic performance of a shear wall in buildings .Buildings with sufficient amount of walls that were not specially detailed for seismic performance which had enough well-distributed reinforcement were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries as they are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient; both in terms of construction cost properly designed and detailed buildings with Shear walls have shown very good performance in past earthquakes.

A. Model Specifications

No. of storey : G+4
Height of each storey : 3.0m
Floor area : 375m2
Thickness of R.C.C slab: 150mm
Thickness of shear wall : 200mm
Size of Beam : 300 x 450mm
Size of column : 450X450mm

B. Material Property

Reinforced concrete of grade M25 and Fe 415 steel has been adopted for the study.

Modulus of elasticity of steel: 2 x 105 Mpa

C. Building Model

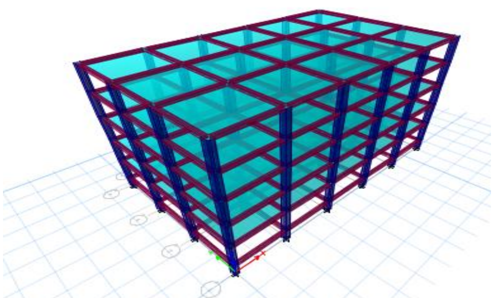

Fig. 1 Building without shear wall

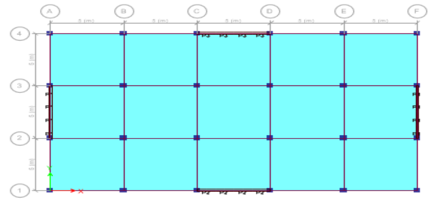

Fig. 2. MODEL I - Building with shear wall at periphery

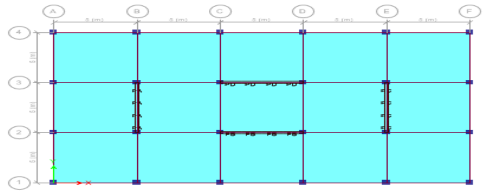

Fig. 3. MODEL II - Building with shear wall at intermediate walls

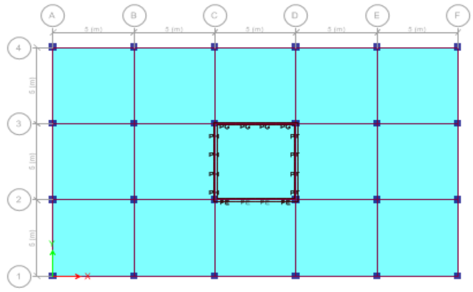

Fig. 4. MODEL III Building with shear wall at core

Table 1 Building Identity

MODEL	IDENTITY
Building without shear wall	NO SW
Building with shear wall at periphery	MODEL I
Building with shear wall at intermediate walls	MODEL II
Building with shear wall at core	MODEL III
Model I in seismic zone II (Z=0.10)	SW Z II
Model I in seismic zone III(Z=0.16)	SW Z III
Model I in seismic zone IV(Z=0.24)	SW Z IV
Model I in seismic zone V(Z=0.36)	SW Z V

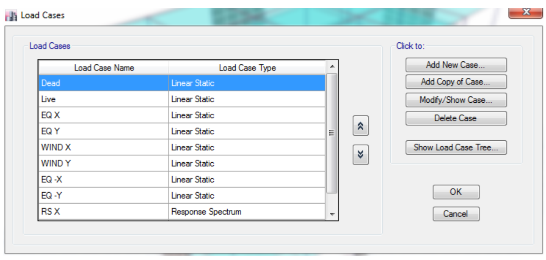

Fig. 5 Load case details

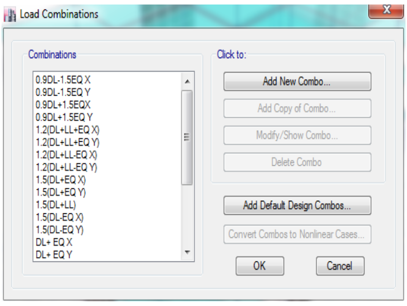

Fig. 6 Load combination

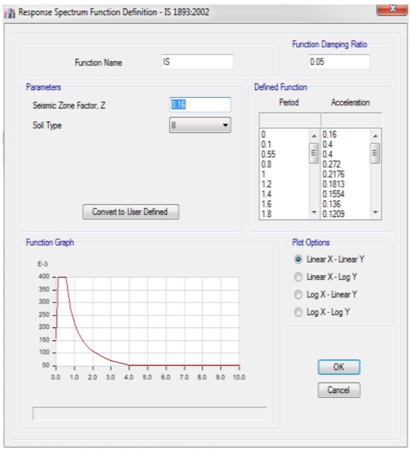

Fig. 7 Response spectrum function

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Parameters	No SW		MODEL I		MODEL II		MODEL III	
	RS X	RS Y	RS X	RS Y	RS X	RS Y	RS X	RS Y
Storey Displacement(mm)	12.43	12.28	4.473	4.443	4.405	4.426	3.626	2.982
Storey drift	0.00062	0.00058	0.000338	0.00032	0.000338	0.00034	0.00027	0.00022
Storey shear(kN)	1138.6	1099.46	1201.59	1201.09	1201.61	1202.07	1197.07	1357.18

TABLE 2. Analysis Of Building Without & With Shear Walls At Various Locations

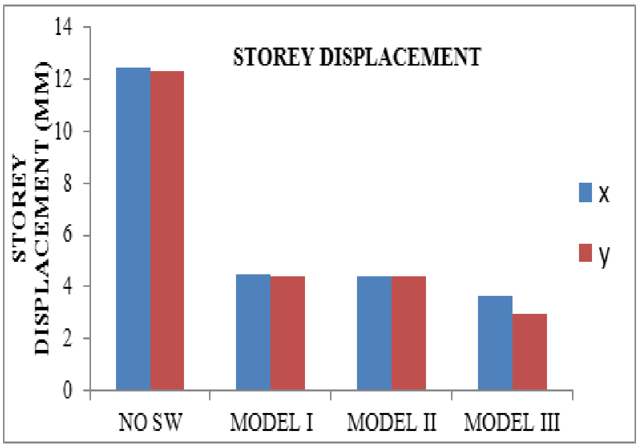

Fig. 8. Maximum storey displacement

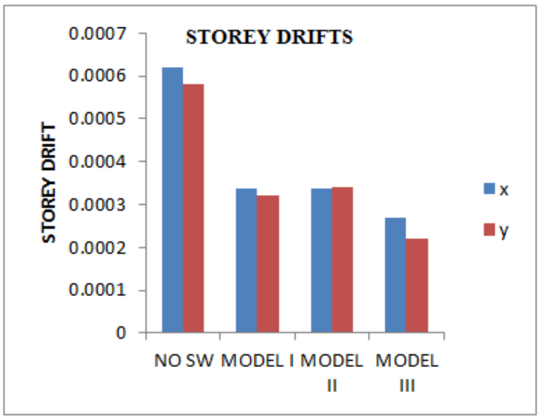

Fig. 9. Maximum storey drift

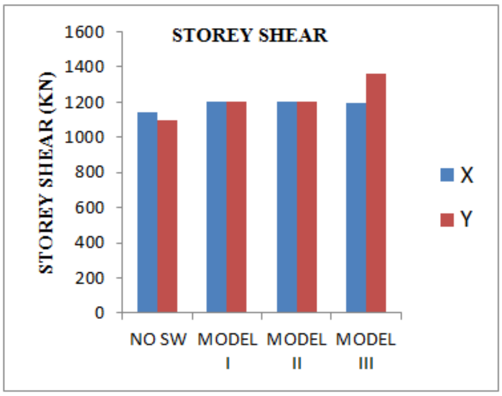

Fig. 10. Maximum storey shear

Parameters	SW Z II		SW Z III		SW Z IV		SW Z V	
	RS X	RS Y	RS X	RS Y	RS X	RS Y	RS X	RS Y
Storey Displacement(mm)	4.401	4.414	4.413	4.443	4.424	4.457	4.475	4.483
Storey drift	0.000238	0.000242	0.000308	0.00032	0.000339	0.000343	0.000388	0.000392
Storey shear(kN)	1095.72	1101.42	1201.59	1279.09	1379.80	1402.904	1411.58	1489.079

TABLE 3. Analysis Of Model I Shear Wall Building In Different Seismic Zones

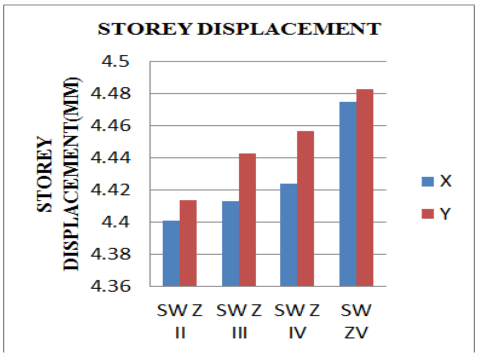

Fig. 11. Maximum storey displacement

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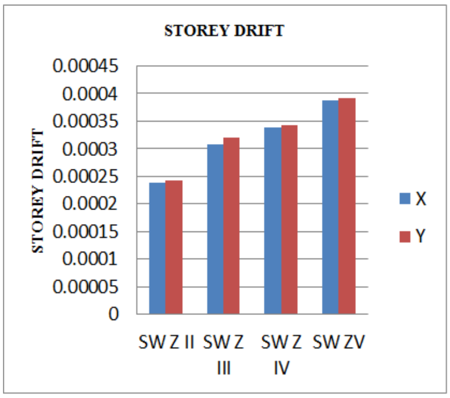

Fig. 12. Maximum storey drift

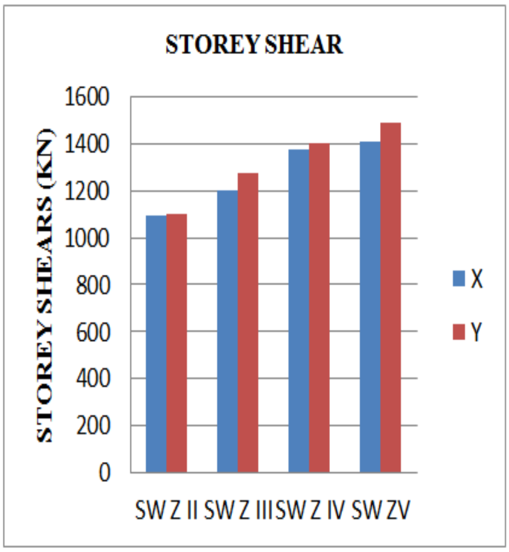

Fig.13. Maximum storey shear

IV. CONCLUSIONS

It is observed that the structural walls should be provided throughout the height of buildings for best earthquake performance.

Placing the structural walls towards the centre of the building allows flexibility for buildings to undergo torsion as the first mode of oscillation, which is not desirable.

It is studied that structural walls are most effective when placed at the periphery of the building.

Zone factor of a particular location plays a major role in the behaviour of a building.

Risk of damage for buildings of higher seismic zone is more and so, adopting special moment resisting frames are highly necessary.

The storey drifts and displacements are found to be more in Seismic Zone V building compared to other zones.

It is observed that the values of storey shears are found to be increasing in higher seismic zones.

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