ISSN(Online) : 2319-8753
ISSN (Print) : 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

Seismic Analysis of Building with and Without Shear Wall

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ABSTRACT:Shear wall systems are one of the most commonly used lateral load resisting systems in buildings. Shear walls are one of the most efficient lateral force resisting elements in buildings. In the seismic design of buildings, reinforced concrete structural walls, or shear walls, act as major earthquake resisting members. Shear walls have very high in plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads, making them quite advantageous in many structural engineering applications. They are mainly flexural members and usually provided in buildings to avoid the total collapse of the buildings under seismic forces.The properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. The scope of present work is to study the effect of seismic loading on placement of shear wall in building at different alternative location.Effectiveness of shear wall has been studied with the help of five different models. Model one is bare frame structural system and other four models have different arrangements of shear wall.Response spectrum and time history method are used for analysis in SAP2000 software and structure was assumed to be situated in zone II. From analysis some parameter are determine like base shear, storey drift and displacement of a structure.

KEYWORDS:Bare frame, Response spectrum, Shear wall, Time history analysis.

I. INTRODUCTION

Now-a-days in multi-storey buildings, the RC frame structures are constructed initially due to ease of construction and rapid work in progress.Generally shear wall can be defined as structural vertical member that is able to resist combination of shear, moment and axial load induced by lateral load and gravity load transfer to the wall from other structural member. In modern tall buildings, shear walls are commonly used as a vertical structural element for resisting the lateral loads that may be induced by the effect of wind and earthquakes which cause the failure of structure [1]. Shear wall are one of the excellent means of providing earthquake resistance to multistoried reinforced concrete building. The structure is still damaged due to some or the other reason during earthquakes. Behaviour of structure during earthquake motion depends on distribution of weight, stiffness and strength in both horizontal and planes of building. To reduce the effect of earthquake reinforced concrete shear walls are used in the building. These can be used for improving seismic response of buildings. Structural design of buildings for seismic loading is primarily concerned with structural safety during major Earthquakes, in tall buildings, it is very important to ensure adequate lateral stiffness to resist lateral load. The provision of shear wall in building to achieve rigidity has been found effective and economical. When buildings are tall, beam, column sizes are quite heavy and steel required is large. So there is lot of congestion at these joint and it is difficult to place and vibrate concrete at these place and displacement is quite heavy. Shear walls are usually used in tall building to avoid collapse of buildings. When shear wall are situated in advantageous positions in the building, they can form an efficient lateral force resisting system [2].

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II. RELATED WORK

P. S. Kumbhare, A. C. Saoji [3] work on the effect of seismic loading on placement of shear wall in medium rise building at different alternative location. The residential medium rise building is analysed for earthquake force by considering two type of structural system *i.e.* Frame system and Dual system. Effectiveness of shear wall has been studied with the help of four different models. Model one is bare frame structural system and other four models are dual type structural system. Analysis is carried out by using standard package ETAB. The comparison of these models for different parameters like Displacement, Storey Drift and Story Shear has been presented by replacing column with shear wall. Based on the analysis results they found that from result observed that the displacement of Model II, Model V reduced up to 20-30 % as compared with bare frame model. where as in model III and IV maximum displacement also reduced up to 30-50 % as compared with bare frame. From result observed that drift is increased as height of building increased and reduced at top floor. From above results it is clear that shear wall frame interaction systems are very effective in resisting lateral forces induced by earthquake. Placing shear wall away from center of gravity resulted in increase in the most of the members forces. It follows that shear walls should be coinciding with the centroid of the building.

Shahzad Jamil Sardar , Umesh. N. Karadi [4] work on effect of change in shear wall location on storey drift of multistorey building subjected to lateral loads. The twenty five storey building is analysed for earthquake force by equivalent static analysis and response spectrum analysis by ETAB software.Effectiveness of shear wall has been studied with the help of five different models. Model one is bare frame, model twois shear wall placed at centre of building, model three is shear wall placed at center four shear wall placed at outer edge parallel to Y direction, model four is shear wall placed at center four shear wall placed at outer edge parallel to X direction and model five is shear wall placed at centre and four shear wall placed at outer edge parallel to X and Y direction. From result they observed that in equivalent static analysis it has been found that model-5 shows lesser displacement and lesser inter-storey drift as compared to other models in longitudinal direction. In response spectrum analysis model-5 shows lesser displacement and lesser inter-storey drift as compared to other models in longitudinal direction. The presence of shear wall can affect the seismic behaviour of frame structure to large extent, and the shear wall increases the strength and stiffness of the structure.It has been found that the model-5 shows better location of shear wall since lateral displacement and inter-storey drift are less as compared to other models.

Himalee Rahangdale , S.R.Satone [5]work on design and analysis of multi-storey building with effect of shear wall. The G+5 storey building is analysed for lateral loading and seismic loading by STAAD-Pro software. They studied with the help of four different models. Model one is bare frame, and other three models have shear wall at different location in building. From result they observed that different location of shear wall effect on axial load on the column. In absence of shear wall axial load and moments are maximum on column. Shear walls are one of the most effective building elements in resisting lateral forces during earthquake. By constructing shear walls damages due to effect of lateral forces due to earthquake and high winds can be minimized.Shear walls construction will provide larger stiffness to the buildings there by reducing the damage to structure and its contents.

III. SYSTEM DEVELOPMENT

Different arrangements of model

In this paper different location of shear wall is take for different model as follows:

a. Shear wall at center
b. Shear wall at core and parallel side
c. Shear wall at corner
d. Shear wall at periphery

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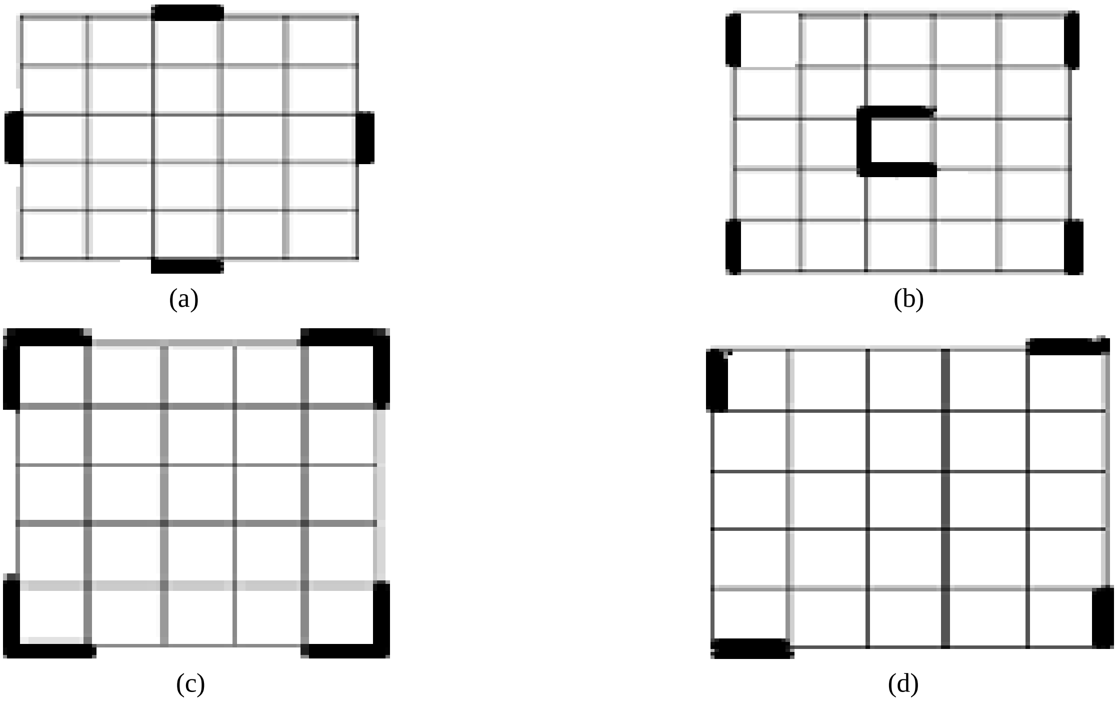

Fig.1 shows different location of shear wall in model

Problem description

I : Building Configuration Data

Each storey height	3 m
Thickness of external wall	0.23 m
Thickness of internal wall	0.15 m
Thickness of slab	0.15 m
Thickness of parapet wall	0.15 m
Height of parapet wall	1 m
Floor finish	1 kN/m^2
Live load	3 kN/m^2
Grade of concrete (f_{ck})	M 25
Grade of steel (f_y)	Fe 500
Size of beam	0.3m x 0.4 m
Size of column	0.4m x 0.6 m
Thickness of shear wall	0.23m

G+7 Building with soft storey is modelled in SAP2000 FEM based software for frame situated in zone II. RC frame with and without different arrangement of shear wall are adopted in the analysis of this study. The geometry of the building is as shown in fig. 2 and the building configuration data is shown in table I.

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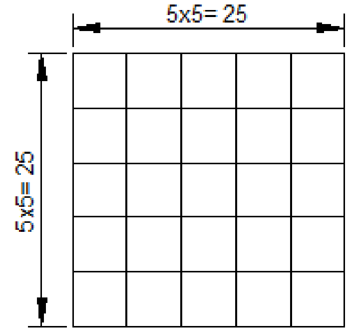

Fig.2. Plan of G+7Building

IV. PERFORM ANALYSIS

Response spectrum method: The objective of response spectrum analysis is to obtain the likely maximum response of the systems. The response spectrum is a plot of the maximum response (maximum displacement, velocity, acceleration or any other quantity of interest) to a specified load function for all possible single degree-of-freedom systems. The abscissa of the spectrum is the natural period (or frequency) of the system and the ordinate is the maximum response. It is also a function of damping. The design response a spectrum given in IS 1893:2002 [7] for a 5% damped system.

Time history analysis: In order to examine the exact linear behaviour of building structures, linear time history analysis has to be carried out. In this method, the structure is subjected to real ground motion records. This makes this analysis method quite different from all of the other approximate analysis methods as the inertial forces are directly determined from these ground motions and the responses of the building either in deformations or in forces are calculated as a function of time, considering the dynamic properties of the building structure. The earthquake record used to analyse the building is Imperical Valley(El Centro 1979).

V. RESULTS

Base shear

The base shear of a building with and without shear wall is calculated by time history analysis method. In the time history analysis of a building with and without shear wall Imperical valley (El Centro 1979) earthquake record is used. The numerical value of the building with and without shear wall is shown in table II.

II. Base shear for with and without infill wall

Model	Base shear (kN)
Bare frame	14770
Center shear wall	18400
Core with parallel side shear wall	18560
Corner shear wall	18920
Periphery shear wall	18610

The Fig.3 shows that comparison of base shear for bare frame and for different location of shear wall. From the analysis it observed that due to provision of shear wall base shear of building increases. Among all the different locations of shear wall, the building having corner shear wall shows higher base shear.

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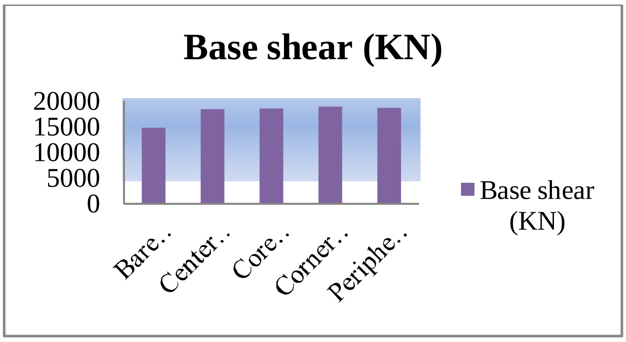

Fig.3 Base shear for with and without shear wall

Max.storey drift

Storey drift is the displacement of one storey to the other storey level above or below [7]. The max. storey drift of building with and without shear wall is calculated by response spectrum analysis method. For the analysis of building with and without shear wall zone-II is considered in response spectrum analysis. The numerical value which is got from analysis is shown in table III.

III. Max. storey drift with and without shear wall

Model	Max.Storey drift (M)
Bare frame	3.47 E-4
Center shear wall	2.53 E-4
Core with parallel side shear wall	2.73 E-4
Corner shear wall	4.33 E-5
Periphery shear wall	9.8 E-5

The Fig.4 shows that comparison of max. storey drift for bare frame and for different location of shear wall. It observed that provision of shear wall reduce the storey drift. Among all the different location of shear wall corner shear wall shows less storey drift.

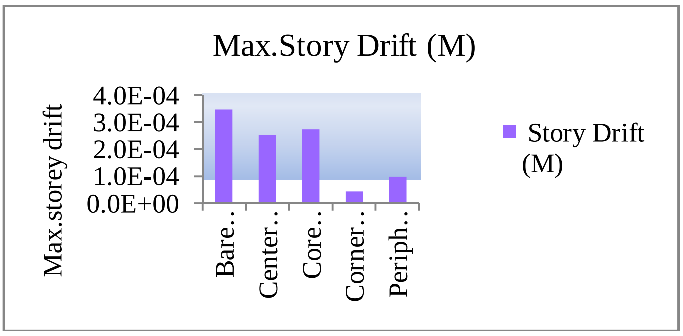

Fig. 4. Maximum storey drift for building with and without shear wall

Displacement

The displacement of building with and without shear wall is calculated by response spectrum analysis method. For the analysis of building with and without shear wall zone-II is considered in response spectrum analysis. The numerical value which is got from analysis is shown in table IV

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IV. Max. displacement drift with and without shear wall

Model	Displacement (M)
Bare frame	5.368 E-3
Center shear wall	4.339E-3
Core with parallel side shear wall	4.136 E-3
Corner shear wall	7.450 E-4
Periphery shear wall	4.377E-3

The Fig.5 shows that comparison of max. displacement for bare frame and for different location of shear wall. It observed that provision of shear wall reduce the displacement of a building. Among all the different location of shear wall corner shear wall shows less displacement.

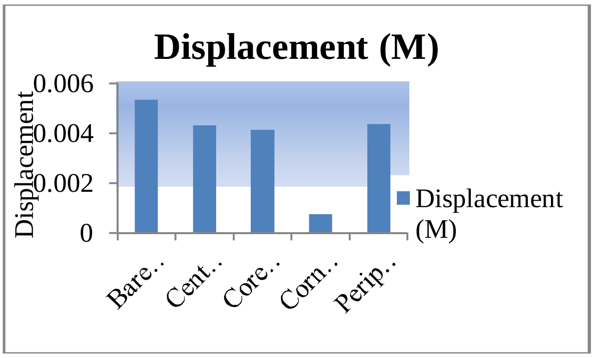

FIG. 5. Maximum displacement for building with and without shear wall

VI. CONCLUSION

In this study, Response spectrum and time history analysis were performed for G+7 RC frame structure with shear wall frame at their different location. Some of main conclusion as follows:

- RC frame with shear wall is having higher value of base shear than bare frame.
- The presence of shear wall can affect the seismic behaviour of frame structure to large extent, and the shear wall increases the strength of stiffness of structure.
- The max. storey drift of shear wall reduces 0.0074% to 0.0303% as compared to bare frame.
- The displacement of shear wall for center shear wall,Core with parallel side shear wall, Corner shear wall and Periphery shear wall is 0.1029%, 0.1232%, 0.4623% and 0.0991% respectively less compared to bare frame.
- From the all different location of shear wall, shear wall at corner in building gives better result. It shows grater base shear, less storey drift and displacement as compared to other shear wall location.

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