

# Analysis of Shear wall at Different Location for Asymmetric High Rise Building

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**Abstract**— In case of high rise structure high lateral forces develops due to earthquake and wind loads. Shear walls have very high in plane stiffness and strength, they resist large horizontal loads and support gravity loads, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. In this research article main focus is comparative study of seismic analysis of shear wall at different location for asymmetric multi-storey buildings. A RCC building of G+12 storey subjected to earthquake loading in zone-III. An earthquake load is calculated by Response spectrum method using IS 1893 (Part-I):2002. These analyses were performed using ETAB 2016.

**IndexTerms**— Response Spectrum, Asymmetric structures, Seismic Analysis, ETAB.

## 1. INTRODUCTION

Earthquake is a sudden violent shaking of the ground, typically causing great destruction, as a result of movements within the earth's crust or volcanic action. Earthquake causes two types of losses known as primary and secondary losses. A primary loss is a irrecoverable loss, which results in the loss of human life in earthquake. All other losses incurred due to earthquake that can be recouped are termed as secondary losses. Building having simple regular geometry suffer much less damage than the irregular configuration. Most recent data of earthquake show that the asymmetrical distribution of mass, stiffness and strengths may cause serious damage in structural system. This research is concerned with the study of seismic analysis of asymmetrical building. Etabs 2016 software is used. In the present study, the response spectrum analysis of asymmetrical RC building is carried out with shear walls provided at different positions of the building.

### 1.1 RESEARCH AND IMPORTANCE

Tall building structures are subjected to lateral loads due to wind and earthquakes. Therefore lateral stiffness is a major consideration in the design of various components in tall buildings. Shear wall defined as structural elements in addition to slabs, beams and column. These walls generally start at foundation level and are continuous throughout the building height. These are provided to multi-storey or tall buildings or buildings in areas of high wind velocity or seismic activity. The purpose of a shear wall is to resist the lateral loads that are imposed on the structure due to wind, earthquake or sometimes due to hydrostatic or lateral earth pressure. Such loads tend to act along the direction of movement of wind or vibrations of the earthquake and they act laterally to the building along one of the two directions. Tall buildings and towers are attracting development from last two decades. In the present situation of metropolitan urban areas tall structures are assuming an imperative part as there is lack of area. Step by step trek in the area rates are confronting interest for the tall structures. Shear walls in high seismic regions require special detailing. However in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries like Chile, New Zealand and USA. Shear walls 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 and effectiveness in minimizing earthquake damage in structural and non structural elements. A structural engineer has to decide a system, which would effectively resist these lateral loads and still meet the economic constraints. Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads.

Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Shear walls should be provided along preferably both length and width. Shear walls in buildings must be symmetrically located in plan to reduce ill-effects of twist in buildings.

### 1.2 OBJECTIVES

The objectives of research are stated below:

- (1) Providing dual system, which consist of shear wall and special moment resisting frame.
- (2) To analyze asymmetric structure by placing the shear wall at centre, at core and parallel side, at corner and periphery.
- (3) Seismic analysis of asymmetric in plan of G+12 buildings by IS1893 (Part-I):2002 by response spectrum method.
- (4) To identify effective location of shear wall by comparing the results.
- (5) Comparison of parameters is storey displacement, storey drift and storey shear.

## 2. METHODOLOGY

Following are the widely used methods of seismic analysis of structures but in present study only response spectrum method is carried out for analysis of structures.

- Equivalent Static method
- Response Spectrum method
- Time history method
- Pushover method

### Equivalent Static Method

Seismic analysis of most of the structures remains applied on the premise of lateral force assumed to be equivalent to the particular loading. The bottom shear that is that the total horizontal force on the structure is calculated on the premise of structure mass and elementary amount of vibration and corresponding mode shape. This method requires less effort because, except for the fundamental period, the periods and shapes of higher natural modes of vibration are not required. The bottom shear is distributed on the peak of structures in terms of lateral force in line with code formula. This technique is conservative for low to medium height buildings with regular configuration.

### Response Spectrum Method

This technique is applicable for those structures wherever modes apart from the elemental one affect significantly the response of the structure.

During this technique the response of Multi-Degree-of Freedom (MDOF) system is expressed because the superposition of modal response, every modal response being determined from the spectral analysis of single -degree-of-freedom (SDOF) system, that is then combined to compute total response. Modal analysis ends up in the response history of the structure to a such ground motion; however, the strategy is sometimes utilized in conjunction with a response spectrum. A response spectrum is simply a plot of the height or steady-state response (displacement, rate or acceleration) of a series of oscillators of varied natural frequency, that square measure forced into motion by an equivalent base vibration or shock. The resulting plot will then be went to decide off the response of any linear system, given its natural frequency of oscillation. One such use is in assessing the height response of buildings to earthquakes. Following are the modal combination rules:

- Absolute sum (ABSSUM) method.
- Square root of sum of squares (SRSS) method.
- Complete quadratic combination (CQC) method.

In our present study we have used the SRSS method to combine the modes. The peak value of the total response is estimated by first squaring the peak response of each mode, then summing up the squared peak responses and finally finding the square root of the summed, squared peak responses.

### Time History Method

The analysis involves the development of a complex mathematical model of the building considering the non-linear behavior of material and structure at both local and global levels. The model is then subjected to time histories of earthquake ground acceleration that may be either historical records or synthetic design spectrum compatible records. Non linear dynamic analysis involves enormous computational time and also difficulties in modeling the structure and its components for the non linear behaviour to a reasonable extent. There are also difficulties in interpreting the results of response.

### Pushover method

Pushover analysis is explained as the response of the structure to a non-linear static approximation of the seismic loading. The static approximation of the seismic loading consists of applying a vertical distribution of lateral loads to a model and monotonically increasing those loads until the peak response or collapse of the structure.

## 3. PROBLEM FORMULATION

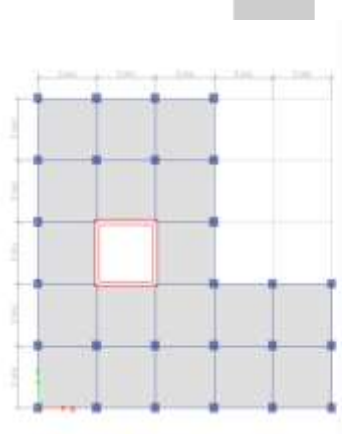
In this study asymmetrical in plan of reinforced concrete residential building with special moment resisting RC frame and shear walls resisting systems were selected as shown in fig. Structure is analyzed using Etab 2016 software. Square-Type and L-Type shape of G+12 buildings frame with five bays in horizontal and five bays in lateral direction is analyzed by Response Spectrum Method. The dimensions of plan of a buildings are shown in table below.

**Table 1:** Building Details

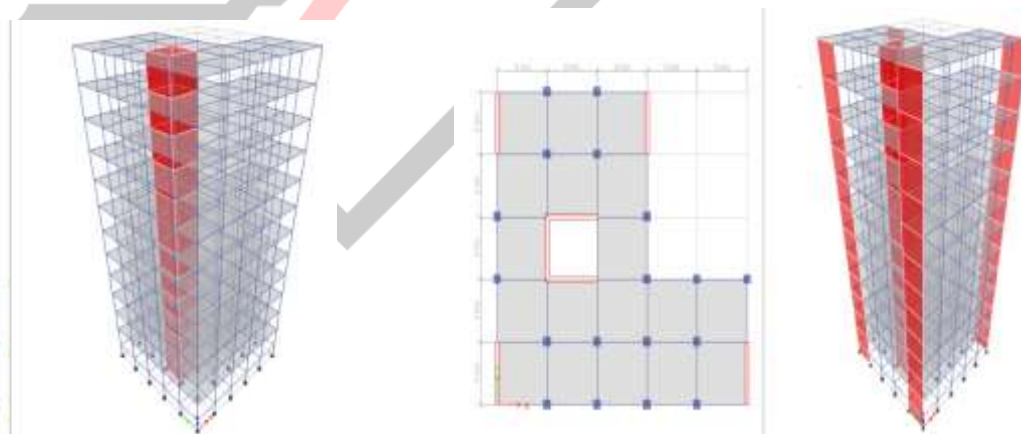
Parameters	Values
Material used	M30 & FE415
Plan dimension	15mX15m
Ht. of each storey	3m
Ht. of bottom storey	2m
Density of concrete	25KN/m <sup>3</sup>
Density of masonry	20KN/m <sup>3</sup>
Code of Practice adopted	IS456:2000 , IS1893:2002,
Seismic zone for IS 1893 : 2002	III
Importance Factor	1
Response Reduction Factor	IS 1893(R)=5 ,
Foundation soil	Hard
Slab thickness	150mm
Wall thickness	230mm
Shear wall thickness	230mm
Floor Finish	1KN/m <sup>2</sup>
Live load	3 KN/m <sup>2</sup>
Live load on roof	1.5 KN/m <sup>2</sup>
Earthquake load	As per IS 1893-2002
Size of beam	300mmx600mm
Column size	450mmx450mm

### 3.1 Plan of structures

Following are the figures of typical floor plan and 3D view of asymmetric building



**Fig -1:** Shear wall at centre



**Fig -2:** Shear wall at core and parallel side

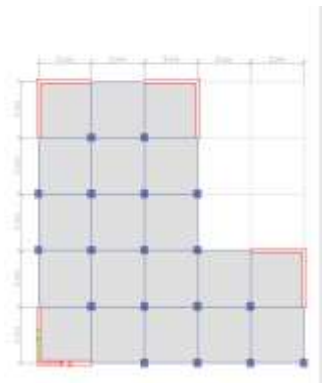


Fig -3: Shear wall at corner

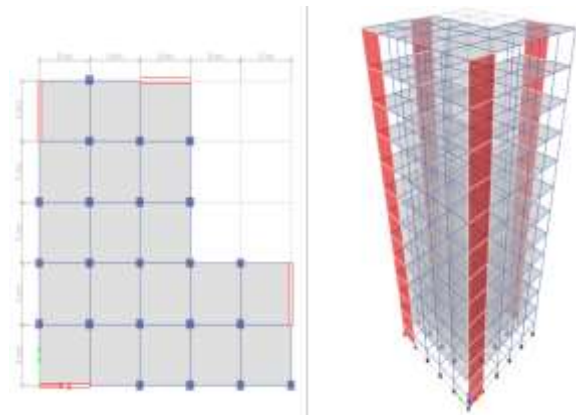


Fig -4: Shear wall at periphery

4. RESULTS

The analysis of different models was performed by response spectrum method for asymmetric structures. The max. storey displacement, max. storey drift, max. storey shear were calculated and graph was plotted for structures.

4.1 Results for max storey displacement of asymmetric building.

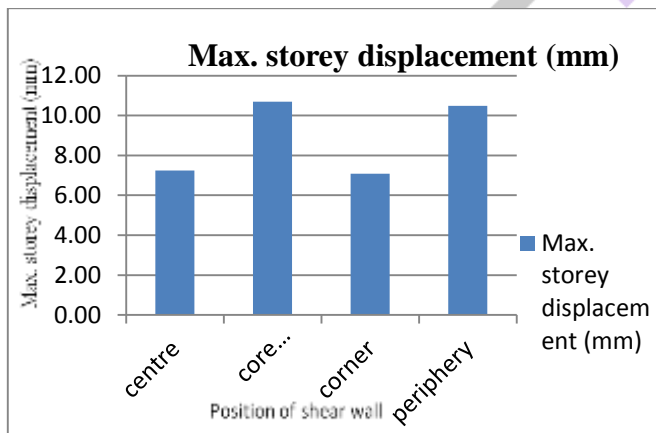


Chart-1: Max. storey displacement along X-direction

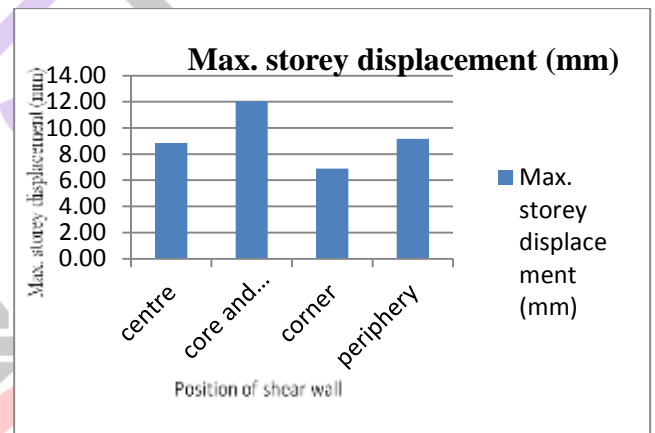


Chart-2: Max. storey displacement along Y-direction

The percentage decrease of storey displacement for shear wall provided at corner is 2.21% and 22.06% compared to shear wall provided at centre, 33.74% and 42.73% compared to shear wall provided at core and parallel side and 32.41% and 24.86% compared to shear wall provided at periphery along x-direction and y-direction.

4.2 Results for max storey drift of asymmetric building.

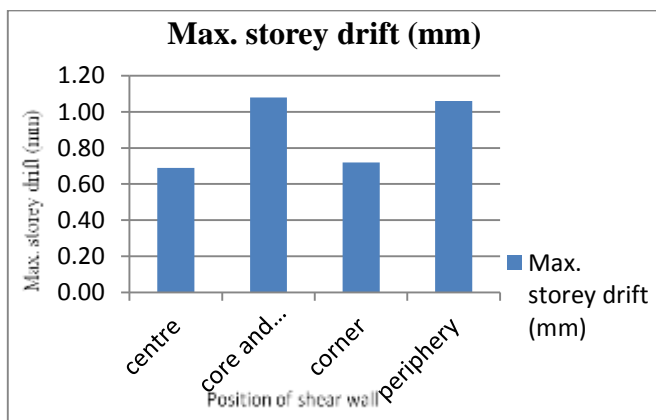


Chart-3: Max. storey drift along X-direction

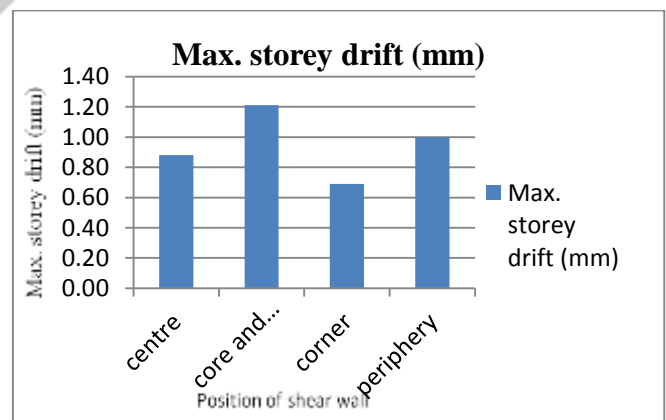


Chart-4: Max. storey drift along Y-direction

The percentage decrease of storey drift for shear wall provided at centre is 36.11% compared to shear wall provided at core and parallel side, 4.17% compared to shear wall provided at corner and 34.91% compared to shear wall provided at periphery along X-direction. The percentage decrease of storey drift for shear wall provided at corner is 21.59% compared to shear wall provided at centre, 42.98% compared to shear wall provided at core and parallel side and 31% compared to shear wall provided at periphery along Y-direction.

#### 4.3 Results for max storey shear of asymmetric building.

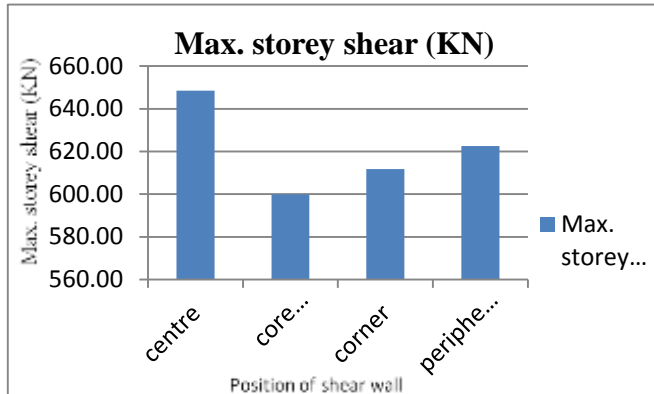


Chart-5: Max. storey shear along X-direction

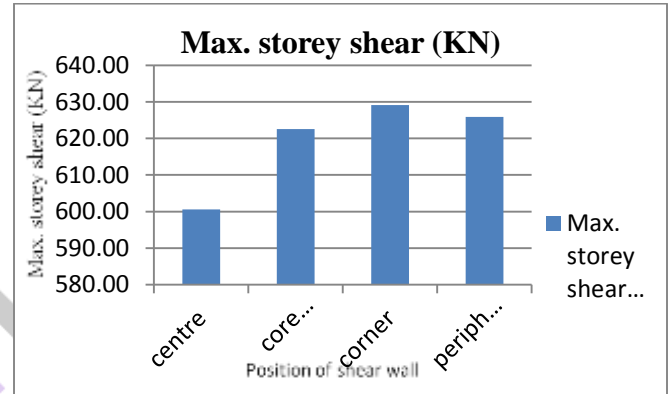


Chart-6: Max. storey shear along Y-direction

The percentage decrease of storey shear for shear wall provided at core and parallel side is 7.50% compared to shear wall provided at centre, 1.94% compared to shear wall provided at corner and 3.65% compared to shear wall provided at periphery along x-direction. The percentage decrease of storey shear for shear wall provided at centre is 3.53% compared to shear wall provided at core and parallel side, 4.54% compared to shear wall provided at corner and 4.04% compared to shear wall provided at periphery along y-direction.

## 5. CONCLUSION

Shear wall is very effective in resisting horizontal forces in multi-storey structure. If the shear wall located properly, then it will reduce storey displacement, storey drift etc.

Based on the analysis results of different models following conclusions have been drawn:

- 1) Maximum storey displacement is lowest when shear wall is placed in corner position and greater when the shear wall is placed at centre, at periphery and also at core and parallel side along both direction.
- 2) Maximum storey drift is lowest when shear wall is placed in centre position along x-direction and at corner position in y-direction.
- 3) It has been observed that maximum storey shear is lowest when shear wall is placed in core and parallel side along x-direction and at centre position along y-direction.
- 4) Shear wall at corner will give the best results to overcome the destruction occurring during an earthquake in asymmetric structure.

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