Seismic Analysis of Shear Wall At Different Location For Symmetric And Asymmetric Multi-Storey RCC Building

Patil A. G.[1], Prof. Hamane A. A.[2]
[1]Dept of Civil Engineering
[2]Asst.Professor, Dept of Civil Engineering
[1, 2] M.S. Bidve Engineering College, Latur, Maharashtra, India

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 symmetric and 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***.**

Keywords- Symmetric and Asymmetric structures, Response Spectrum Method, Storey displacement, Storey shear, Storey drift.

I. 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 symmetrical and asymmetrical building. Etab 2016 software is used. In the present study, the response spectrum analysis of symmetrical and 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 OBJECTIVE OF WORK:

The objectives of research are stated below:

1) Providing dual system, which consist of shear wall and special moment resisting frame.
2) To analyze a symmetric and asymmetric structure by placing the shear wall at centre, at core and parallel side, at corner and at periphery.
3) Seismic analysis of symmetric and 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 of symmetric structures with asymmetric structures.
5) Comparison of parameters are storey displacement, storey drift and storey shear.

II. METHODOLOGY OF WORK

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 wont 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.

III. PROBLEM FORMULATION

In this study symmetrical and 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 No. 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^3
Density of masonry	20KN/m^3
Code of Practice adopted	IS456:2000 , IS1893:2002
Seismic zone for IS 1893 : 2002	III
Importance Factor	1
Response Reduction Factor	For IS 1893(R)=5
Foundation soil	Hard
Slab thickness	150mm
Wall thickness	230mm
Shear wall thickness	230mm
Floor Finish	1KN/m^2
Live load	3 KN/m^2
Live load on roof	1.5 KN/m^2
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 symmetric and asymmetric buildings.

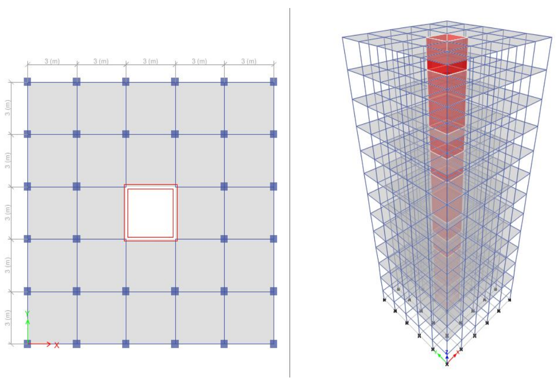

Fig -1: Shear wall at centre

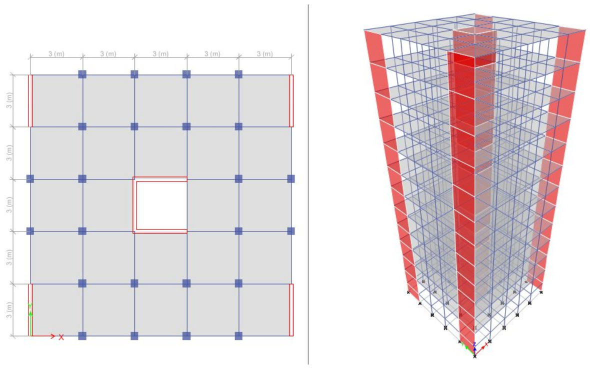

Fig -2: Shear wall at core and parallel side

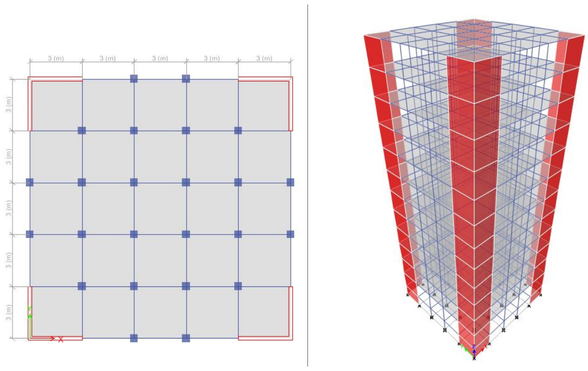

Fig -3: Shear wall at corner

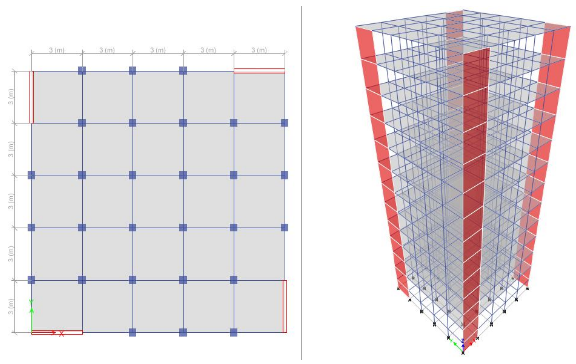

Fig -4: Shear wall at periphery

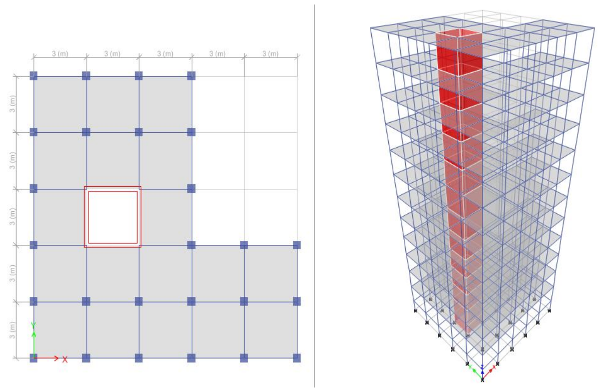

Fig -5: Shear wall at centre

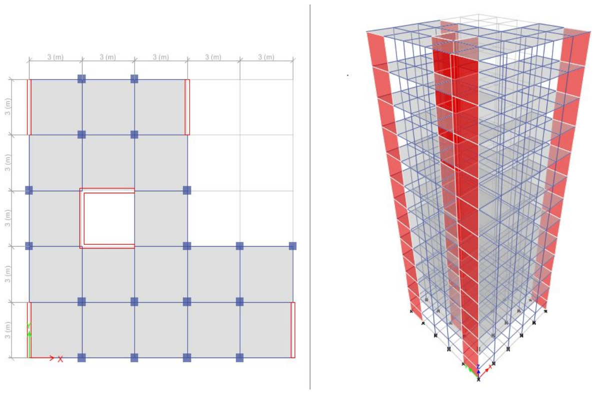

Fig -6: Shear wall at core and parallel side

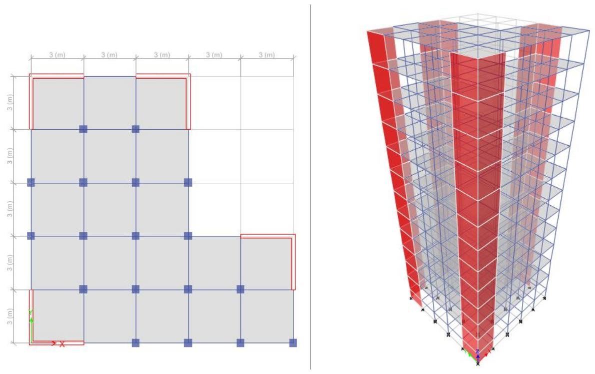

Fig -7: Shear wall at corner

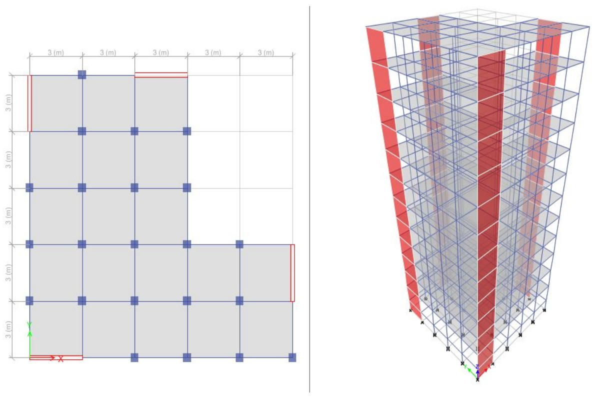

Fig -8: Shear wall at periphery

IV. RESULTS AND DISCUSSIONS

The analysis of different models was performed by Response Spectrum method for symmetric and asymmetric structure. The max. storey displacement, max. storey drift, max. storey shear were calculated and graph was plotted for both structures. (sy- symmetric, asy-asymmetric)

4.1 Results for max. storey displacement of symmetric and asymmetric building

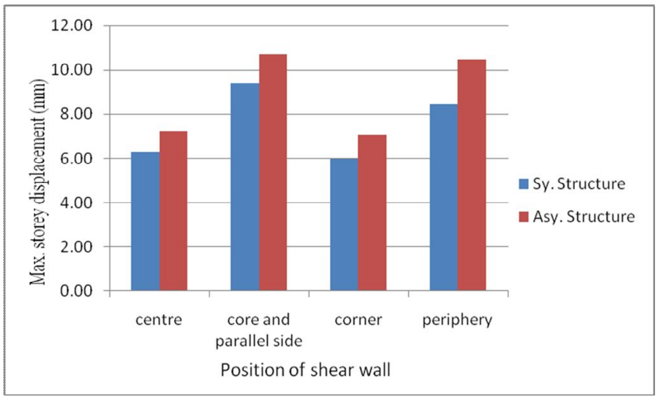

Chart-1: Max. storey displacement along X-direction

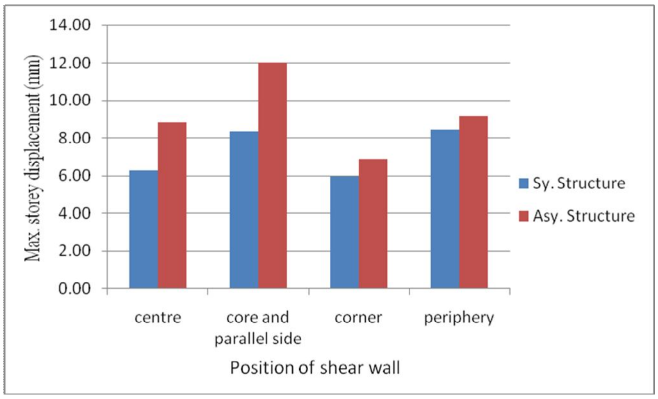

Chart-2: Max. storey displacement along Y-direction

The percentage of storey displacement increased by 14.90%, 13.59%,18.76% ,24.14% along x-direction and 40.10%, 43.73%, 15.41%, 8.52% along y-direction times in asymmetric structure compared with symmetric structure when shear wall placed at centre , at core and parallel side, at corner and at periphery.

4.2 Results for max. storey drift of symmetric and asymmetric building

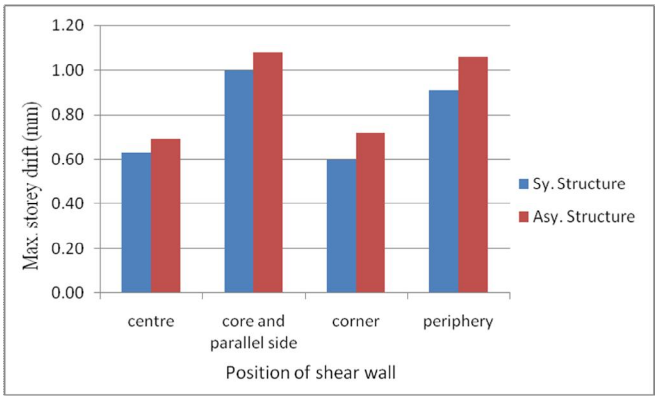

Chart-3: Max. storey drift along X- direction

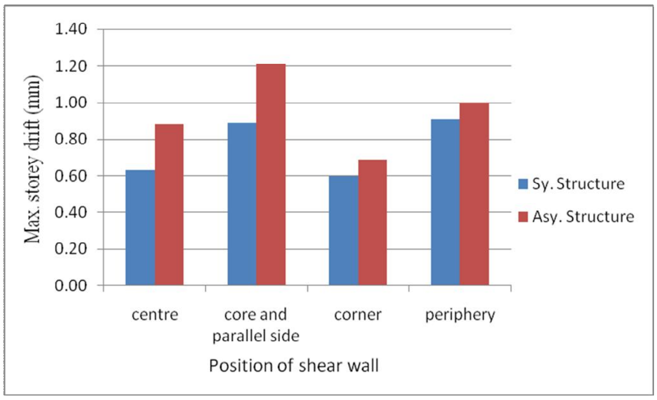

Chart-4: Max. storey drift along Y- direction

The percentage of storey drift increased by 9.52%, 8%, 20%, 16.48% along x-direction and 39.68%, 35.96%, 15%, 9.89% along y-direction times in asymmetric structure compared with symmetric structure when shear wall placed at centre, at core and parallel side, at corner and at periphery.

4.3 Results for max. storey shear of symmetric and asymmetric building

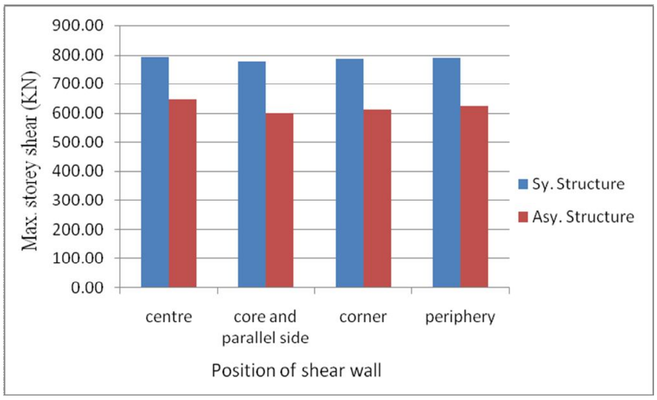

Chart-5: Max. storey shear along X-direction

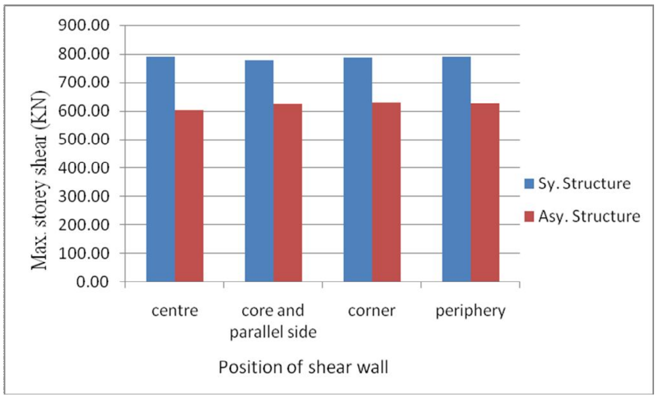

Chart-6: Max. storey shear along Y-direction

The percentage of storey shear increased by 22.12%, 29.74%, 28.72%, 27.07% along x-direction and 31.86%, 25%, 25.16%, 26.40% along y-direction times in symmetric structure compared with asymmetric structure when shear wall placed at centre , at core and parallel side, at corner and at periphery.

V. 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 and storey drift etc. Based on the analysis results of different models following conclusions have been drawn:

1) Maximum storey displacement is considerably increases in asymmetric structure as compare to symmetric structure in x-direction and y-direction.
2) The displacement increases as the height of the structure increases.
3) Maximum storey drift is considerably increases in asymmetric structure as compare to symmetric structure along both direction.
4) Maximum storey shear is increases in symmetric structure as compare to asymmetric structure along both direction.
5) Values of storey shear along both direction are nearly similar in case of symmetric structure.
6) The observation of results will gives that shear wall at corner is effective and greater in resisting the seismic forces than the shear wall at centre, at core and parallel side and at periphery in symmetric structure as compare to asymmetric structure along both direction.

REFERENCES

[1] Anjali Kulkarni ,Vaishnavi Dabir [Volume , 06 Issue, 05] In May – 2016 “Study of variations in dynamic stability of tall structure corresponding to shear wall positions: Case Study”
[2] Dr. B. KAMESHWARI, Dr. G. ELANGOVAN, P. SIVABALA, G.VAISAKH In 27 December 2013 “Dynamic response of high rise structures under the influence of discrete staggered shear walls”
[3] Ehsan Salimi Firoozabad, Dr. K. Rama Mohan Rao ,Bahador Bagheri In 2012.“Effect of Shear Wall Configuration on Seismic Performance of Building”
[4] IS 1893 (part1), “Criteria for earthquake resistance design of structures”, BIS, New Delhi, 2002.
[5] Kiran Tidke , Rahul Patil, Dr. G.R.Gandhe [Vol. 5, Issue 10] In October 2016 “Seismic Analysis of Building with and Without Shear Wall”
[6] Mr.K.LovaRaju, Dr.K.V.G.D.Balaji [Vol. 2, Issue 1] In January 2015. “Effective location of shear wall on

performance of building frame subjected to earthquake load”

[7] Mallika.K, Nagesh Kumar.G [Vol. 5, Issue 11] In November 2016. “Analysis of Shear Wall in High Rise Unsymmetrical Building Using Etabs”

[8] Mohammed Hashim Basheer , K. Sandeep Kumar , D. Chandra Mouli , T.Hari Babu [Volume 6 Issue No. 4] In April 2016. “Dynamic Behaviour of a High Rise Reinforced Cement Concrete RCC Structure for Different Orientation of Shear Wall with and without Soil-Structure Interaction”

[9] Najma Nainan [Volume, 04 N0. 05] In May – 2012 “Dynamic response of sesmo resistant building frames”

[10] P. P. Chandurkar , Dr. P. S. Pajgade [Vol. 3, Issue. 3] In May - June 2013 “Seismic Analysis of RCC Building with and Without Shear Wall”

[11] Ravikanth Chittiprolu ,Ramancharla Pradeep Kumar[Vol. 4, Issue Spl-2] In Jan - June 2014 “Significance of Shear Wall in Highrise Irregular Buildings”

[12] Shahzad Jamil Sardar and Umesh. N. Karadi [Vol. 2, Issue 9] In September 2013. “Effect of change in shear wall location on storey drift of multistorey building subjected to lateral loads”

[13] Syed Khasim Mutwalli , Dr. Shaik Kamal Mohammed Azam [Vol. 4, Issue 9(Version 6)] In September 2014 “Dynamic Response of High Rise Structures Under The Influence of Shear Walls”

Author Profile

Patil Ankita G. is pursuing M.E. degree in civil engineering from M S Bidve Engineering college, Latur. (2018)

Prof. Hamane Ajay A. is working as Assistant Professor in M S Bidve Engineering college, Latur. He has got six year of teaching experience