ISSN (e): 2250 – 3005 || Volume, 06 || Issue, 05||May – 2016 ||
International Journal of Computational Engineering Research (IJCER)

Study of variations in dynamic stability of tall structure corresponding to shear wall positions: Case Study

Anjali Kulkarni [1] Vaishnavi Dabir[2]

[1] Assistant Professor, Symbiosis Institute of technology, Symbiosis International University

[2] Assistant Professor, Symbiosis Institute of technology, Symbiosis International University

Abstract

Construction of tall buildings, both residential and commercial are in insistance. In case of tall structure high lateral forces develops due to earthquake load and wind load are crucial. Thus the effects of lateral loads needs consideration for strength and stability of the structures. In tall buildings, lateral loads are critical as it increases drastically after a certain height of the structure. Shear wall systems are one of the most commonly used dynamic load resisting systems in high-rise buildings which help in achieving strength and stability along with economy. In this study, an attempt has been carried out to check the dynamic stability of a tall residential structure by applying variations symmetric arrangement of the shear wall. The Case study of a 26 storied RCC structure situated in Pune region of Maharashtra, India has been carried out. The effect of location of shear wall on dynamic behaviour of building is analysed using ETABS software using response spectrum method for earthquake analysis and IS875 (III) for wind analysis. The proposed position of shear wall gives the effective results as compare to other position.

Keywords: *Dynamic stability, RCC building, Shear wall, Tall structures, Lateral forces, Response spectrum method, wind analysis, IS 875(III)*

I. Introduction

Shear wall systems are one of the most commonly used lateral-load resisting systems in high-rise buildings. Shear walls have very high in-plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads. Shear walls can be used as lateral load resisting systems and also retrofitting of structures also internal shear walls are more efficient than external shear walls (V. Kumar et.al).

Literature Review:

Anshuman S. et al. (2011) determined appropriate location of shear wall in 15 storied RCC building based on its both elastic and elasto-plastic behaviors. There is reduction in top deflection after providing shear wall in any of middle two frames. Also there is reduction in bending moment & shear force. Positioning shear wall at end of "L" section reduces overall bending moment of building. Anuj Chandiwala (2012) determined effect of location of shear wall on static and dynamic load behavior on column. O. Esmaili et al. (2013) analyzed 56 stories RC tall building with shear wall with irregular openings. The RC shear walls not only carried seismic loads but also bear significant percentage of gravity loads. Chandurkar et.al (2011) focused on determining the solution for shear wall location in multi-storey building. Effectiveness of shear wall has been studied with the help of four different models. Model one being bare framed structural system and other three models are dual type structural system. An earthquake load is applied to ten storied building located in zone II, zone III, zone IV and zone V. It is observed that the shear wall in short span at corner is economical as compared with other models. It is observed that changing the position of shear wall affect the attraction of forces, so that wall must be constructed in proper position. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake

Studies till now indicate symmetric positions of shear wall to be efficient for placing and constriction.

In present study, the effect of various symmetric arrangement of shear wall on dynamic stability of building is assessed using E Tab software.

II. Materials and Methods

A G+25 storied RCC building from Pune City, Maharashtra, India is taken for proposed study. The structure is analyzed by response spectrum analysis for assessing stability against earthquake. Comparison of variation of storey displacement, Base shear, Time period, Axial Forces in column, shear forces, and Bending

Moment is studied for each location type. Wind analysis pertaining to IS 875 Part III is performed. The modeling and analysis is carried out by using ETAB software. Load combinations are considered as per IS 875-1987 (Part- V). Earthquake and wind parameters considered are shown in Table 1 and 2. Figure 1 shows plan of floor 1st to 5th, 7th to 11th, 13th to 17th, 19th to 23rd floors and figure 2 shows plan of 6th, 12th 18th floors of the building.

Table 1: Earthquake parameters based on structure location [IS 1893-2002 (Part-I)]

Parameters	**Code Provisions**
Type of structure	RCC
Nature of Building	Residential
Seismic Zone	III
Importance factor	1
Response Reduction factor	4.5 (Ductile shear wall with OMRF)
Soil Type	Hard
Damping for concrete	5%

Table 2: Wind parameters based on structure location [IS 875-19878 (Part-III)]

Parameters	Code Provisions
Wind Speed	44 m/s
Terrain category	4
Structure class	C

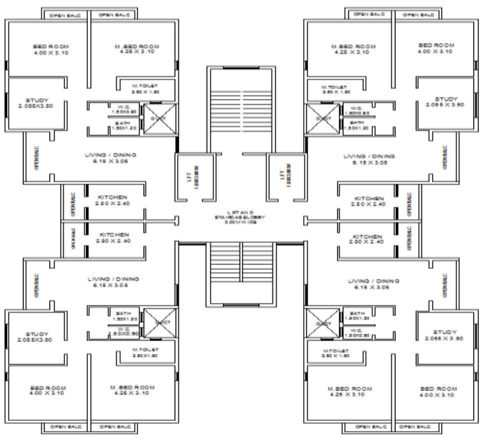

Figure 1: Typical floor plan of residential floors

Figure 2 : floor plan with refuge area

III. Modeling & Analysis:

The building with dual system is analyzed for different positions of shear walls. Proposed locations of shear wall are highlighted in red and as shown in figure 4 to figure 7. Building with various arrangement of shear wall is designated as ‘Model’.

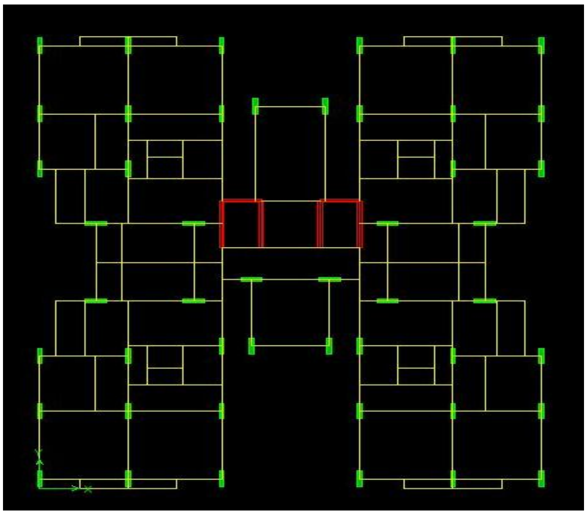

Figure 4. Model 1

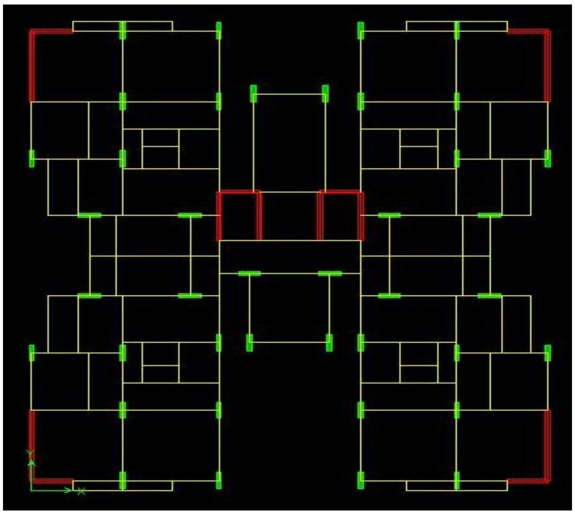

Figure 5. Model 2

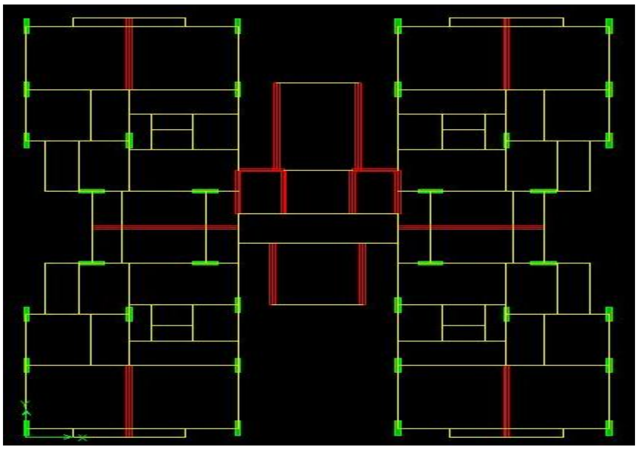

Figure 6. Model 3

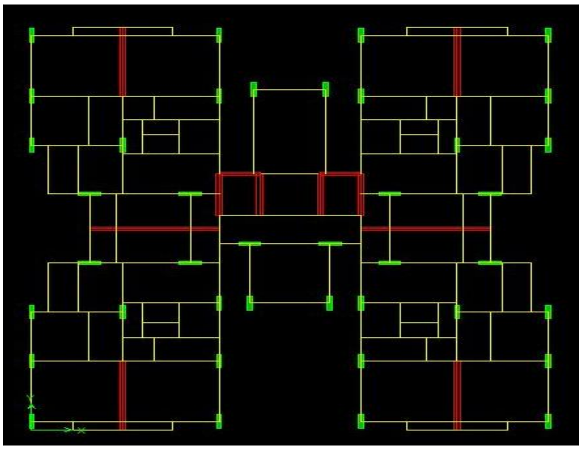

Figure 7. Model 4

IV. Results and Discussion:

1. Study of Storey Displacement

The lateral displacements govern the stability of entire structure with respect to its height at different storey level. The trend obtained is as shown in Figure 8 to Figure 11.

Earthquake forces in X & Y direction:

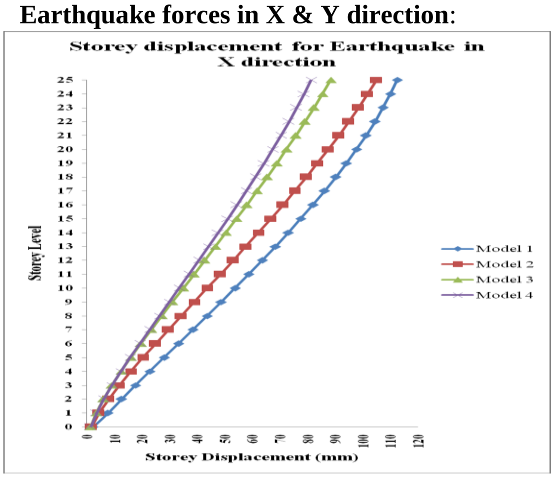

Figure 8: Variation of storey displacement for earthquake in X direction

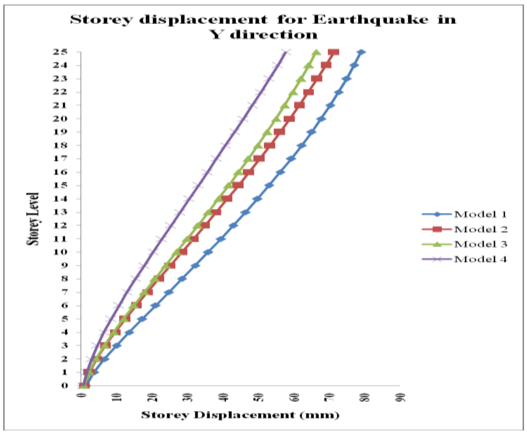

Figure 9: Variation of storey displacement for earthquake in Y direction

Wind forces in X & Y direction:

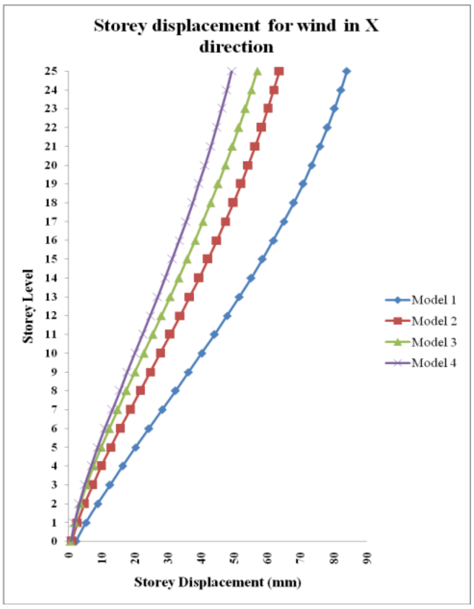

Figure 10: Variation of storey displacement for wind in X direction

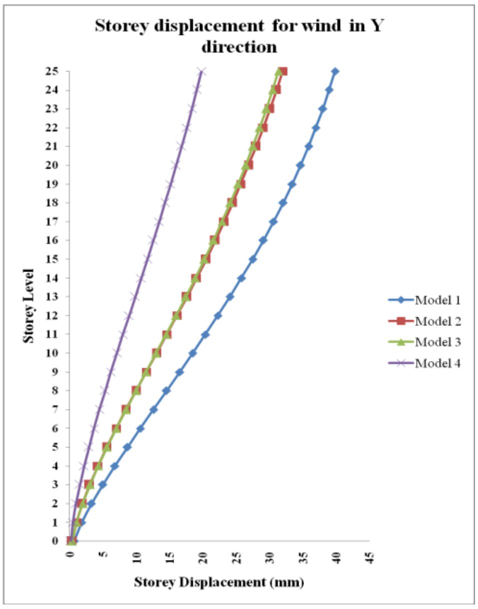

Figure 11: Variation of storey displacement for wind in Y direction

For building with shear wall and frame, the storey displacement is maximum for model 1and it is minimum for model 4. It is 27.67% & 26.86% less for model 4 than model 1for earthquake forces in X and Y direction respectively. In case of storey displacement due to wind forces it is seen that it is maximum for model 1 and minimum for model 4. It is 41.29% & 50.26% less for model 4 than model 1 for wind in X and Y direction respectively. Hence, Model 4 shows best behavior against earthquake and wind forces.

II. Study of Base Shear

Lesser value of base shear indicates higher seismic weight of the structure. The base shear variation for earthquake forces in X and Y direction for all models is as shown in figure below

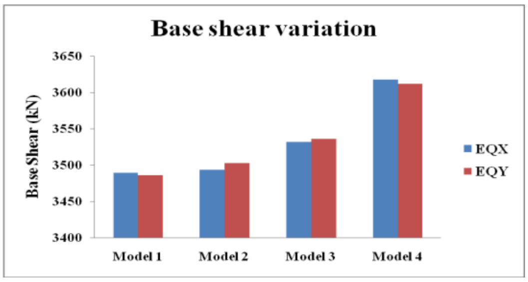

Figure 12: Base shear variations for earthquake forces

The base shear value for model 2, 3, 4 is respectively 0.11%, 1.11%, and 2.44% more than model 1 for earthquake in X direction, and for earthquake in Y direction it is respectively 0.48%, 0.95%, and 2.14% more for model 2, 3, 4 than model 1. Hence Model 1 shows best performance as far as base shear values is of concern.

III. Study of Time Period

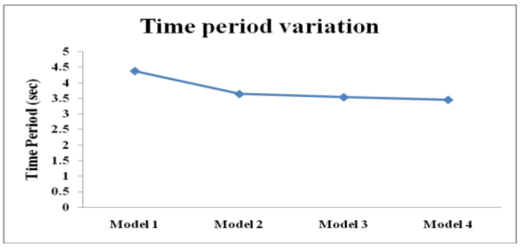

Figure 13: Time period variation

Higher the time period indicates lesser frequency of seismic motion and hence lesser vibration against earthquake. This leads to lesser damage of the structure. The time period is maximum for model 1 than models 2, 3, 4. It is 16.66%, 19.01%, 20.92% less for model 2, 3, 4 respectively than model 1. Model 1 shows better performance in such conditions.

IV. Study of Axial force

The axial force transferred on columns due to various models is studied.The variation of critical axial force on columns for model 1, 2, 3 and 4 is as shown in figures below

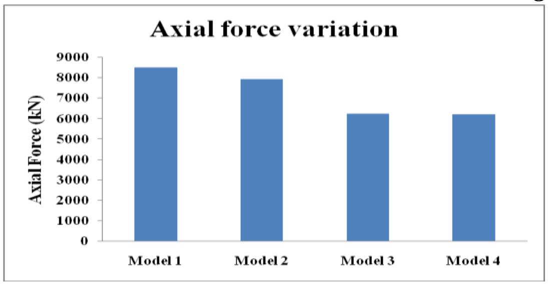

Figure 14: Axial force variation

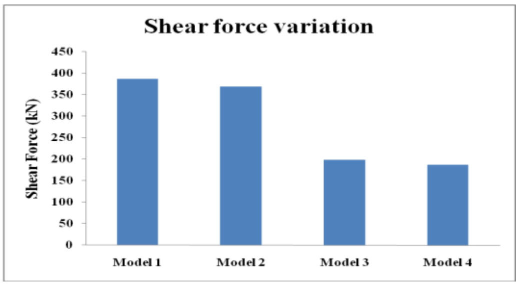

Figure 15: Shear force variation

From Figure 14, it is seen that the critical value for axial force in column is maximum for model 1. It is respectively 6.95%, 26.52%, & 27.17 % less for model 2, 3, & 4.

V. Study of Shear force

Figure15 indicates that the critical value for shear force in column is maximum for model 1. It is 4.68%, 48.49%, & 51.47 % hence, less for model 2, 3, & 4 respectively.

VI. Study of Bending Moment

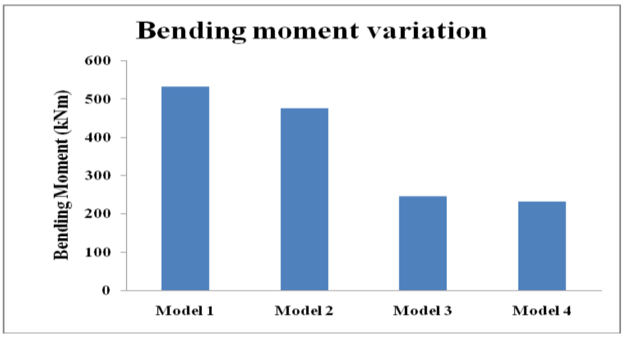

Figure 16: Bending moment variation

Figure 16 shows that the critical value for bending moment in column is maximum for model 1. It is 10.53%, 53.89%, & 56.3 %, hence less for model 2, 3, & 4 respectively.

From the results and discussion , it is seen that for building with frame and shear walls, the model 4 shows minimum values for storey displacement, time period, axial force, shear force, and bending moment as compared to models 1, 2, & 3.

VI. Conclusion

The G+25 storied RC building is analyzed by response spectrum method for both earthquake and wind forces. Even though literature shows that symmetric positions of shear wall are efficient, the results from present study indicate that variations in symmetrical positions shall yield to variation in behavior of the structure. Certain models show better performance in one criteria whereas fair performance in other. Out of all the models, Model4 gives considerable percentage reduction in axial force, shear force, bending moment, storey displacement. The Model has placement of shear wall perpendicular to the direction of wind and earthquake acceleration applied. Therefore the shear wall located at the center of building is more effective as compared to other location of shear walls. The work has given insight on carrying out more studies on symmetric positions of shear wall. Hence, for any multistory structure, the position of shear wall cannot be generalized and needs to be studies carefully.

References:

[1] Anshuman. S, Dipendu Bhunia, Bhavin Ramjiyani,"Solution of shear wall location in multistory building", International journal of civil and structural engineering, 2011

[2] Anuj Chandiwala, "Earthquake Analysis of Building Configuration with Different Position of Shear Wall", International Journal of Emerging Technology and Advanced Engineering ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 2, Issue 12, December 2012, Adhoc Lecturer in Sarvajanik College of Engineering & Technology, Athvalines, Surat, Gujarat, India.

[3] O. Esmaili, S. Epackachi, M. Samadzad and S. R. Mirghaderi, "Study of Structural RC Shear Wall System in a56-Story RC Tall Building", The 14th World Conference on Earthquake Engineering, October,2008,China.

[4] P. Chandurkar, Dr. P. S. Pajgade, " Seismic Analysis of RCC Building with and Without Shear Wall" International Journal of Modern Engineering Research (IJMER)www.ijmer.com Vol. 3, Issue. 3, May June 2013 pp18051810 ISSN: 2249 6645

[5] Venkata Sairam Kumar.N, Surendra Babu.R, Usha Kranti.J, "Shear walls – A review", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 3, Issue 2, February 2014