Evaluation of Shear Wall Behaviour in RC Building using ETAB

Deepak Gupta[1], Senthil Pandian M.[2]

[1]*PG student, School of Mechanical and Building Sciences (SMBS) VIT Chennai, Chennai, Tamil Nadu-600127*

VIT Chennai, Chennai, Tamil Nadu-600127

[2]*School of Mechanical and Building Sciences (SMBS)*

VIT Chennai, Chennai, Tamil Nadu-600127

ABSTRACT

Shear wall are the system are one of the most commonly used lateral load resisting system in high rise building. Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal loads. Incorporation of shear wall has become inevitable in multistory storey building to resist the lateral forces. This paper presents the study of symmetrical and unsymmetrical RC building with/without shear wall at different positions. Response spectrum method with 5% damping has been performed using ETAB software in according with IS 1893:2002. The performance of both symmetrical and unsymmetrical RC building is evaluated in terms of Response spectrum amplitude, storey shear, Storey displacements, Storey acceleration and Storey shear and torsional irregularity.

Keywords: Response spectrum, Shear wall, Storey displacement, Storey acceleration, Storey shear and Torsional irregularity.

1. INTRODUCTION

Shear wall are one of the excellent means for providing earthquake resistance to multistory reinforced concrete building. RC multistory buildings are adequate for resisting both the vertical and horizontal loads. In high earthquake region it is essential to resist earthquake load. Hence, it is necessary to take into account the seismic load for the design of high rise structure. In tall building lateral load due to earthquake is a matter of concern, these lateral forces can produce critical stresses, induce undesirable vibration or cause excessive lateral sway of the structure. Sway or drift is the magnitude of the lateral displacement at the top of the building relative to its base. Torsional irregularity is also a main concern in earthquake analyses of building. Torsional irregularity mentioned in IS 1893:2002 is just description of definition of torsional irregularity as the maximum storey drift, computed with design eccentricity, at one end of the structure transverse to an axis is more than 1.2 times the average of the storey drift at the two ends of the structure. As comparison with FEMA273 for linear analysis of building with rigid diaphragms when the ratio of maximum storey drift (δmax) due to total torsional moment exceeds 1.2, the effect of accidental torsion be amplified by a factor Ax = [δmax/1.2δavg] and 1≤Ax≤3. In present study, the earthquake analyses of symmetrical (G+8) and unsymmetrical (G+9) RC building was done by response spectrum method. The modal combination rule for response spectrum analysis is SRSS. The main parameters considered in this study to compare the seismic performance of both the building with shear wall at different positions. To understand the dynamic analysis of shear wall some factors has been considered from *Romy Mohan C Prabha (2011)*[1]. The criteria of earthquake resistant structure have been considered from *IS1893. Bureau of Indian Standards code, IS1893-2002.*[2] *Chopra A. K*[4] has been considered for the better understanding of dynamic theory and application to earthquake engineering.

2. SCOPE OF THE STUDY

The work is focused on the study of seismic demands of different position of shear walls in RC buildings using response spectrum method for seismic zone II India. The analysis results would be compared for symmetrical and unsymmetrical RC buildings in terms of response spectrum amplitude, storey drift, storey shear and torsional irregularity using IS 1893:2002.

3. DESCRIPTION OF STRUCTURE MODEL:-

In this study symmetrical and unsymmetrical floor plan layout of reinforced concrete residential building with moment resisting RC frame and shear walls resisting systems were selected as shown in fig 1 to 6. The building consists of 8 storey floor and height of 3.0 m each in all floors. Buildings are located in seismic zone II, and soil profile type was assumed to be medium. Response damping ratio for RC frame has taken as 5. All the six models are designed and analyzed as per IS 456, 2000. Further inputs include unit weight of the concrete is 25 x 106 KN/m2, compressive strength of concrete is 20 N/mm2 (M20), yield strength of concrete is 415 KN/m2, elastic modulus of steel is 2 x 108. The loading of building was assumed to be member load 10.82KN/m2 and live load 6.75 KN/m2 and floor finishes is 1 KN/m2. Percentage of imposed load to be considered in seismic weight calculation is 25. The support condition of column is fixed. The columns and beams size for analyses had 0.450 m x 0.50 m and thickness of slab considered is 0.125 m. Finally the examples structure considered in this study are following.

1. *Model A- Moment resisting RC frame for symmetrical building*
2. *Model B- Symmetrical RC building with shear walls arranged at inner core*
3. *Model C- Symmetrical RC building with shear walls arranged in outer periphery*
4. *Model D- Moment resisting RC frame for unsymmetrical building*
5. *Model E- Unsymmetrical RC building with shear walls arranged in outer periphery*
6. *Model F- Unsymmetrical RC building with shear walls arranged at inner core*

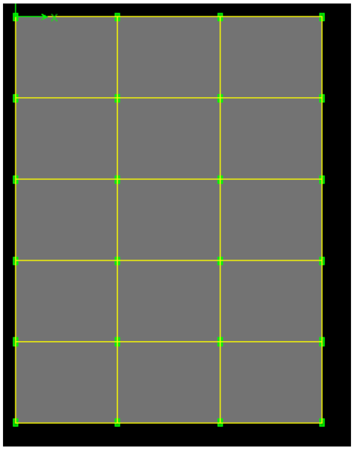

Fig. 1 Model A

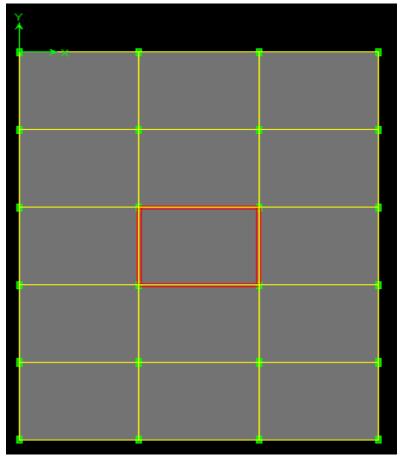

Fig. 2 Model B

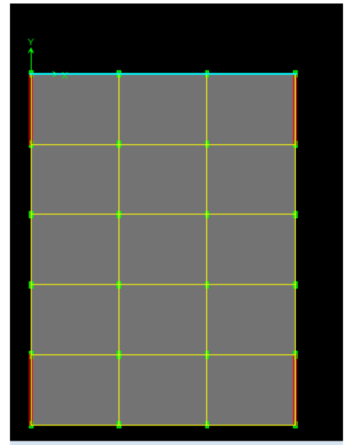

Fig.3 Model C

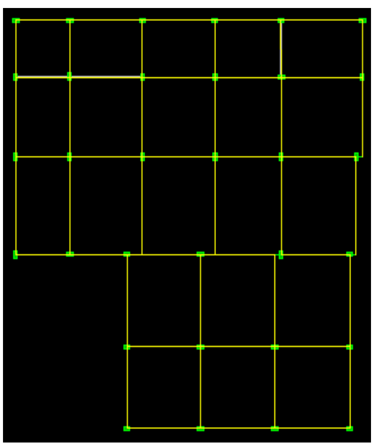

Fig. 4 Model D

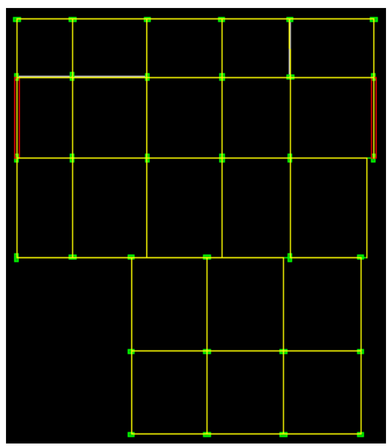

Fig. 5 Model E

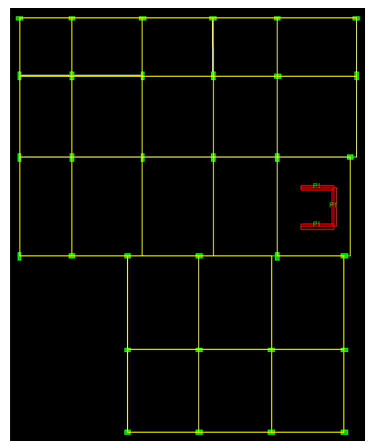

Fig. 6 Model F

4. ANALYSIS AND RESULTS

The linear Response spectrum analysis was performed for all models. Models were designed and checked as per IS456. The comparative results of Response spectrum amplitude, Storey shear, Storey displacement, Storey acceleration, Storey drift and Torsional irregularity as per IS1893:2002.

5. RESPONSE SPECTRUM AMPLITUDE

The modal period K is more in model B as compare to model A and model D. The modal natural period K is somewhat is less in F, E and C. Therefore the Sa/g value is more in modal B as compared to remaining modal as shown in Fig. 7.

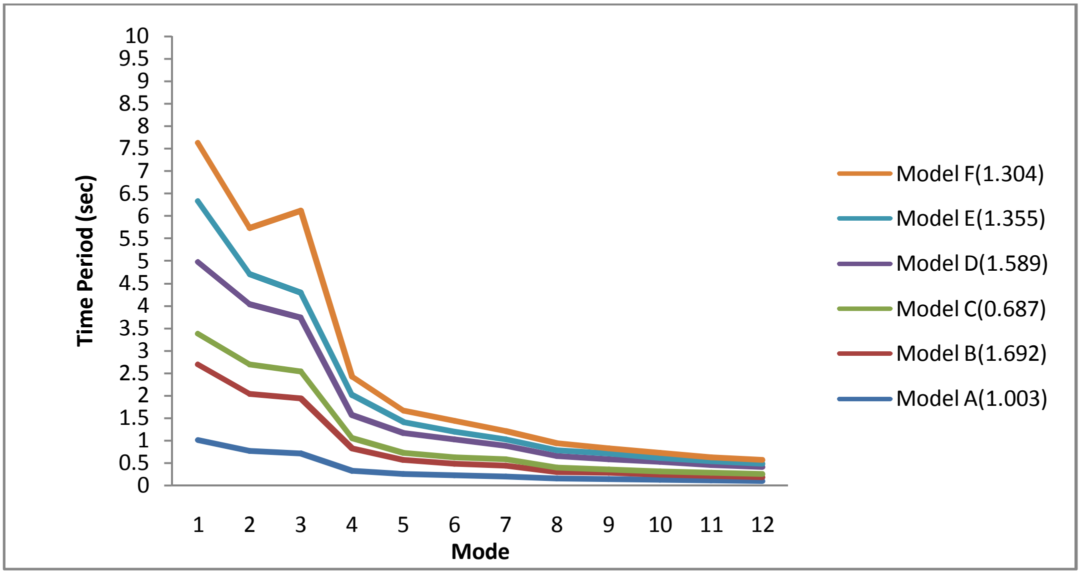

Fig. 7

Base Shear due to Earthquake force (EQX):-

Base shear is calculated by using IS 1893:2002 method for all the model shown in Fig. 8 illustrate the comparison of base shear using lateral load Equivalent method. The lower base shear is getting in model A and the higher base shear is getting in model E

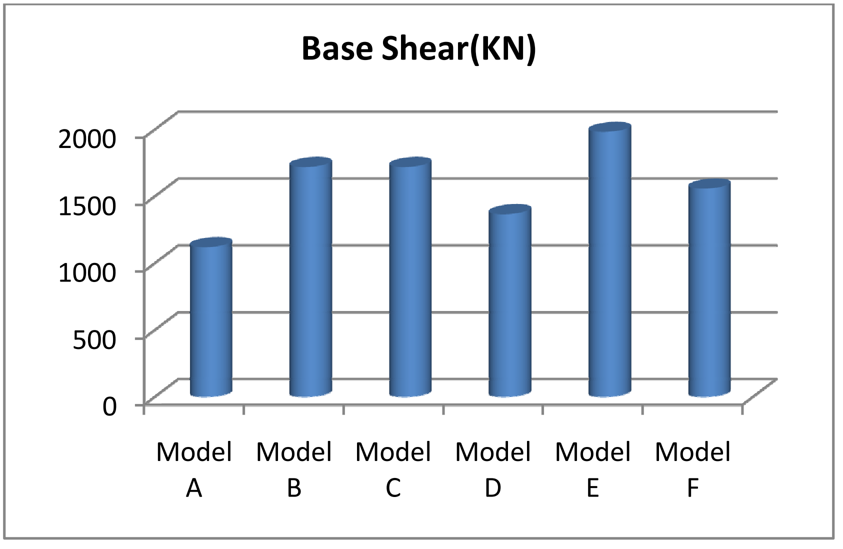

Fig. 8

Displacement due to force (EQX):-

When shear walls are shifted to outer periphery in symmetrical building, than displacement is getting high in model C as compare to other model.

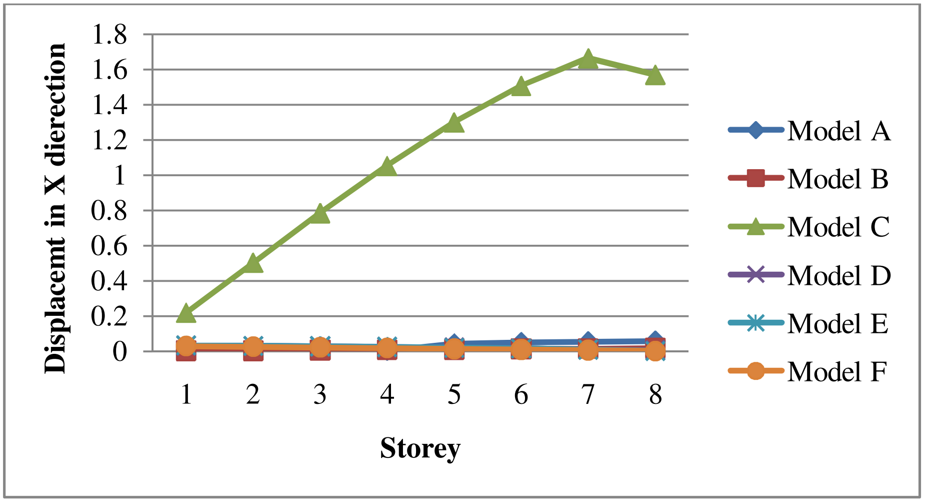

Fig. 9

Response Spectrum Acceleration for all the models:-

The response spectrum acceleration depends upon the time period and percentage of damping therefore acceleration is varies according to the time period of modes.

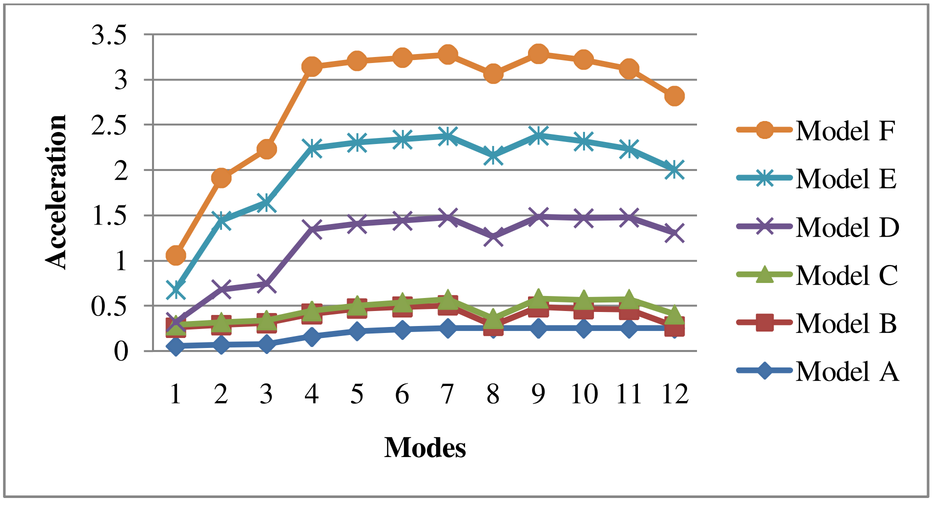

Fig. 10

Storey Drift due to Earthquake force (EQX):-

As per clause no. 7.11.1 of IS 1893:(part 1) 2002, the storey drift in any storey due to specified design lateral force with partial load factor of 1.0, shall not exceed 0.004 times the storey height . From the analysis the storey drift is shown for symmetrical RC building in Figure 9 and for unsymmetrical RC building in Figure 10. In symmetrical building when shear walls are shifted to inner core, the storey drift is getting less as shown in figure 9. And for unsymmetrical building storey drift is getting less when shear walls are shifted in the position of lift

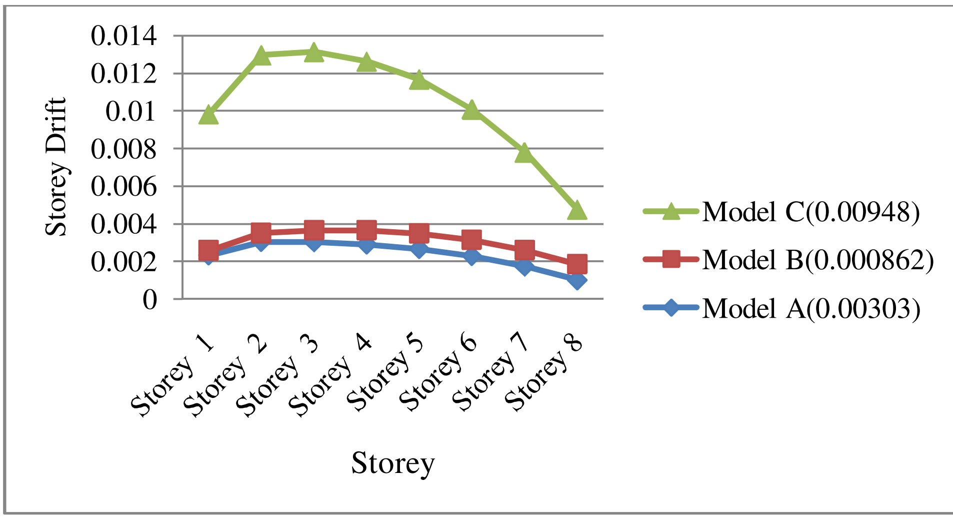

Figure 9

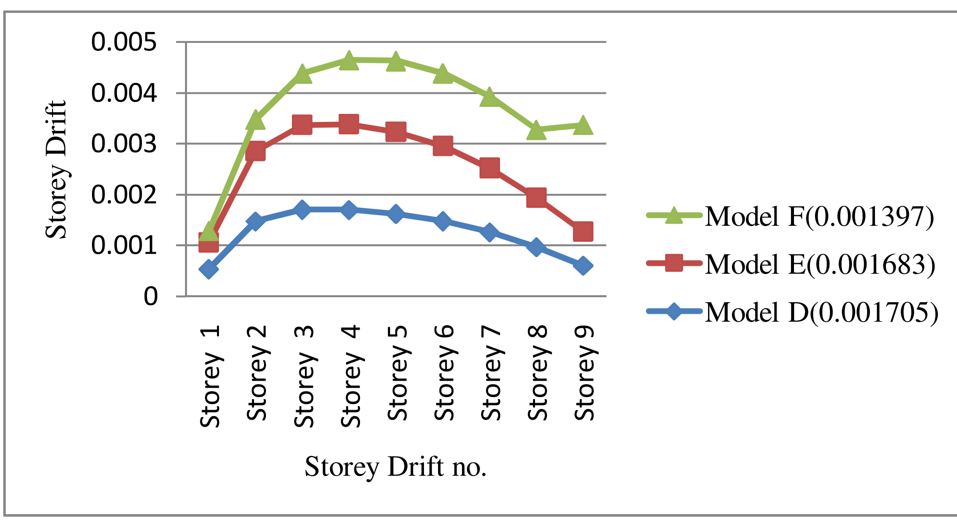

Figure 10

Torsional irregularity:-

Torsional irregularity results are shown in table 1. Regarding with the shifting of shear walls into inner core in unsymmetrical building the ratio of maximum storey drift (δmax) to average storey drift (δavg) is slightly less in model C as compare to model A and model B. And in unsymmetrical building the ratio of maximum storey drift (δmax) to average storey drift (δavg) is more in Model D as compare to model E and F. maximum ration is getting in model D due to high torsional irregularity (ref. Table 1).

Table 1

Model no.	δ_{max}	δ_{max}	Ratio = $\delta_{max/}$ δ_{avg}
Model A	0.00301	0.00237	1.27
Model B	0.00948	0.00730	1.29
Model C	0.000862	0.000682	1.26
Model D	0.001730	0.001227	1.4
Model E	0.001683	0.001488	1.13
Model F	0.001434	0.001908	1.30

6. CONCLUSION

1. Dynamic analysis of building requires careful structural modeling, understanding appropriate selection of ground motion records, and thorough knowledge and familiarity of the analyst with the procedures and computer software employed.
2. Seismic design of structures is typically based on the modal analysis with response spectrum that is generally considered a conservative approach.
3. Base shear is calculating using IS 1893-2002 method for all four models in figure 8 illustrates the comparison of base shears using lateral equivalent method. The lower base shear is getting *in model A and the higher base shear is getting in model E.*
4. Torsional irregularity results shows that when shear walls moved to outer periphery in unsymmetrical building, the ratio of maximum storey drift to average storey drift is less than the allowable value of 1.2 and moment resisting RC frame has high value of ratio than allowable value of 1.2.

REFERENCES

[1] Romy Mohan C Prabha (2011): Dynamic Analysis of RCC Buildings with Shear Wall.

[2] IS1893. Bureau of Indian Standards code, IS1893-2002, "Criteria for earthquake resistant design of structures", part I: General Provisionsand Buildings, Fifth revision, Bureau of Indian Standards, New Delhi, India, 2002.

[3] Pankaj Agarwal, Manish Shrikhande, Earthquake Resistant design of Structures (Prentice Hall India Publication).

[4] Chopra A. K, Dynamics of structures theory and applications to earthquake engineering, Prentice-Hall, Englewood Cliffs, N.J. 1995.

[5] Ashraf, M., Siddiqi, Z.A., and Javed, M.A. (2008).”Configuration of a multi -storey building subjected to lateral forces.” Asian Journal of civil Engineering (Building and Housing), Vol. 9, No.5 Pages 525-537.