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# Study of Shear Wall Frame Interaction for Multistoried Buildings under Seismic Loading

**Mayank Soni[1], Lavina Talavale[2],**

[1]*M. E. Student, Dept. of Structural Engg., Shiv Kumar Singh College of Science and Technology, Indore, India*

[2]*Asst. prof., Dept. of Structural Engg., Shiv Kumar Singh College of Science and Technology, Indore, India [3]*

***Abstract*—The seismic performance of shear wall and frame structures which essentially comprises of analysis and design of the structure when subjected to earthquake loading. The paper studies about the structural analysis of multistoried frame with and without shear wall using staad pro and determine lateral displacement, storey drift, and contribution factor and storey stiffness.**

**Analysis of behavior of dual structural configuration using moment resisting frame and shear wall with emphasis to frame shear wall interaction. (Presence of shear wall modifies the behavior of moment resisting frame. In lower storey frames relives load to shear wall where as in upper storey shear wall get supported over frame.)**

***Index Terms*—Shear wall, Drift reduction, seismic forces and earthquake loads.**

## I. INTRODUCTION

Reinforced concrete framed buildings are adequate for resisting both vertical and the horizontal loads acting on them. When the buildings are tall say more than 10 storey's or so, beam and column sizes work out large reinforcement at beam-column junctions work out quite heavy, so that there is a lot of congestion at these joints and it is difficult to place and vibrate concrete at these places, which fact, does not contribute to the safety of buildings. These practical difficulties call for introduction of shear wall in multistorey buildings. A shear wall is a structural element used to resist lateral/horizontal/shear force parallel to the plane of wall is called shear wall. Shear wall can resist the lateral or horizontal force by cantilever action for slender wall where bending deformation is dominant and lateral or horizontal force by truss action for short wall where shear deformation is dominant.

There are many types of reinforced concrete shear walls:

1. Simple rectangular types
2. Coupled shear walls
3. Rigid frame shear walls
4. Framed walls with in filled frames
5. Column supported shear wall
6. Core type shear walls

Seismic Behavior of shear wall-frame: Under the action of lateral forces, a frame will deform primarily in a shear mode, whereas a wall will behave like a vertical cantilever with primary flexural deformations, it is found the walls and frames share in the resistance of story shear forces in the lower stories, but tend to oppose each other at higher levels. The mode of sharing the resistance to lateral forces between walls and frames of a dual system is also strongly influenced by the dynamic response characteristics and development of plastic hinges during a major seismic event, and it may be quite different that predicted by an elastic analysis.

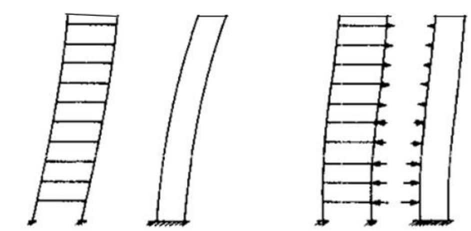


Fig. 1. Frame

## II. LITERATURE REVIEW

"Marie-Jose Nollet and Bryan Stafford Smith" Behavior of Curtailed wall Frame Structure:

This analysis conclude elimination, reduction in number, or reduction in size of shear walls at certain level up the height of a wall-frame structure is not necessarily detrimental to the lateral load performance of the structure. Indeed, if the structural changes are made at a level or levels above the point of contra flexure in the wall of equivalent uniform wall-frame structure, the top deflection changes negligibly. At the same time the moment resisted by the frame above the changes level is reduced, without creating any significant transfer of horizontal interaction between the wall and the frame.

"Malik ATIK, M. Mulham Badawi and Isam Shahrour" The Optimum Level for Wall Curtailment in Wall-Frame Structures to Resist Lateral Loads:

This analysis concluded in many cases, the shear walls in the upper part of wall-frame structures take negative role in deflection of the curtailed wall-frame is a minimum eliminates the reverse force which applied by the walls on the frames, this level of curtailment always lies between the point of inflection

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and zero wall shear in the corresponding full-height wall structure resisting the lateral loads, the interruption of the shear walls at the optimum level for which the top.

"Umesh. N. Karadi and Shahzad Jamil Sardar (2013)" Effect of Change in Shear Wall Location on Storey Drift of Multistory Building Subjected to Lateral Loads:

The analysis has been performed by using standard package ETAB. Creation of 3D building model for both linear static and linear dynamic method of analysis and influence of concrete core wall provided at the center of the building. This analysis conclude that the presence of shear wall can affect the seismic behavior of frame structure to large extent, and the shear wall increases the strength and stiffness of the structure. It has been found that shear wall at exterior corners of the structure is subjected to less displacement against the structure with shear wall at Centre since lateral displacement and inter-storey drift are less as compared to other models.

## III. Methodology and Modeling Approach

The shear wall shows excellent performance under seismic forces, survey of building after earthquakes have consistently shown that loss of life due complete collapse was minimal in buildings with some sort of reinforced shear wall. Shear wall have good ductility under reversible and repeated overloads. The shear wall meant to resist earthquakes should be designed for ductility and Concrete frame is designed to resist lateral forces. When a wall-frame structure is loaded laterally the upper part of shear wall play a negative role in resisting this load because of the difference in the free deflected forms of the wall and the frames so required the optimum level for curtailment in the shear wall. The most important results in this research are: the interruption of the shear walls at the optimum level for which the top deflection of the curtailed wall-frame is a minimum eliminates the reverse force and this level of curtailment always lies between the point of inflection and zero wall shears in the corresponding full-height wall structure.

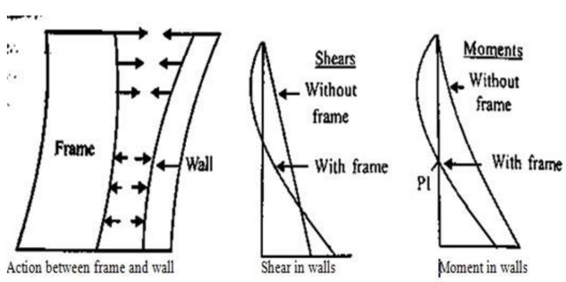


Fig. 2. Interaction between structural frame and shear wall

## IV. Building Details

The 40 Storied Building design for Hard soil Located in seismic zone V and for earthquake loading, the provisions of the IS: 1893(Part1) - 2002 is considered. The plan of building is shown in figure. The plan dimension of the building is 20mX30 m. Height of each storey is 3m. The floor plans were divided into four by six bays in such a way that center to center distance between two grids is 5 meters by 5 meters respectively. Total 5 multi-storey models are prepared for 40 storied building.

B-S (W) - Bare Frame without Share wall

B-S (F) - Frame having 300 mm thick RC shear wall apply on all both corner of the bare frame throughout full height of Building

B-S (1) - Frame having 300mm,250mm, 200mm and thickness RC Stepped shear wall apply on all both corner of the bare frame throughout full height of Building.

B-S (2) - Frame having 300mm. 250mm, 200mm, 150- & 100-mm thickness stepped RC shear wall and apply on all both corner of the bare frame throughout full height of Building.

BS-(3) – Frame having 300mm,250mm,200mm,150mm, and thickness RC Stepped shear wall apply &Curtailment at upper 5 floors are applied on all both corner of the bare frame

TABLE I
Detail of the Building

| Specifications | 40 Storey Building |
|---|---|
| Plan dimension | 20 m X 30 m |
| Total Height of Building | 123 m |
| Height of each storey | 3 m |
| Thickness of slab | 125 mm |
| Grade of reinforcing steel | Fe 500 |
| Density of concrete | 25 KN/m³ |
| Grade of concrete for Beams, Column and Shear Wall | M 25 |
| Types of Support | Fixed |
| Seismic zone | V |
| Seismic Zone factor | 0.36 |
| Soil condition | Hard |
| Soil interaction Factor | 1 |
| Response Reduction Factor | 5 |
| Importance factor (I) | 1 |
| Type of Structure | 1 |
| Damping ratio (DM) | 0.05 |
| Column size R.C.C. | 800X800,700X700, 600X600,500X500 for up to each 10 storey |
| Beam size R.C.C. | 300 mm X 500 mm |
| Thickness of Shear Wall | 300,250,250 150 mm |

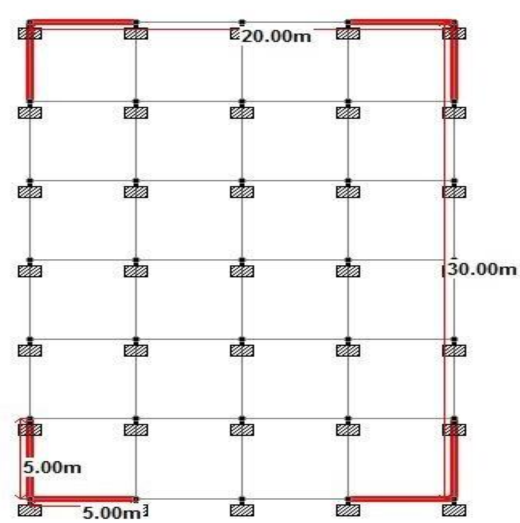


Fig. 3. Plan of building with position of shear wall

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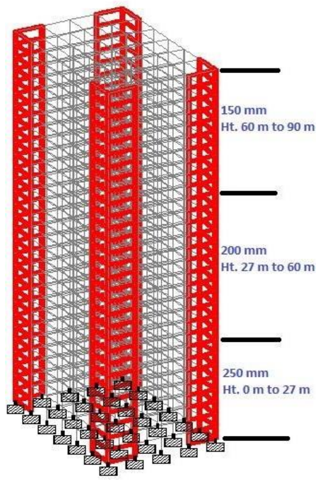


Fig. 4. 3D view of frame with position of stepped shear wall

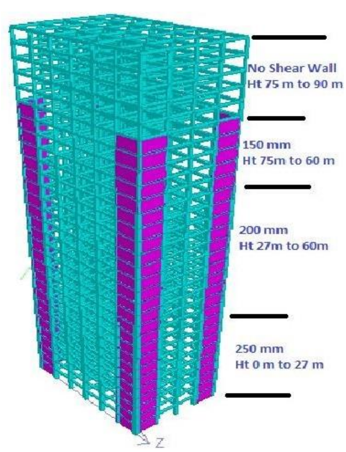


Fig. 5. 3D view of frame with position of stepped shear wall with curtailment at top stories

## V. LOAD COMBINATIONS

The gravity loads and earthquake loads will be taken for analysis. The basic loads are Dead loads (DL), Imposed load (LL), Earthquake load (EQ) along X and Z in positive and negative direction. As per IS 1893 (Part I): 2002 Clause no. 6.3.1.2, the following Earthquake load cases have to be considered for analysis.

1.5(DL + LL) 0.9DL ± 1.5EQX
0.9DL ± 1.5EQZ 1.5(DL ± EQZ)
1.5(DL ± EQX) 1.2(DL + LL ± EQX)
1.2(DL + LL ± EQZ)

## VI. ANALYSIS OF BUILDING

Multi storied G+40 building with fixed support base subjected to seismic forces and Gravity force were analyzed under different hard soil condition. The dead load and live load are considered as per IS-875(part 1 &2) and earthquake loading IS: 1893 (Part1)-2002 is used. The buildings were analysis carried out for Zone 3, 4 & 5 using Equivalent Static Method. The software used for analysis is STAAD-Pro. V8i. Different parameters such as Lateral Displacement, Contribution of Shear wall story drift, deflection and base shear are studied for the models.

## VII. RESULTS AND DISCUSSION

The performance of full, stepped and part shear wall is assessed for building areas and different building heights through various cases each having different models for three earthquake zones. The results obtained from analysis are given in various figures are as follows:

### *A. Results for drift vs. building height in Zone III*

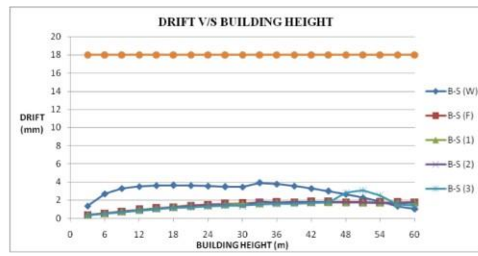


Fig. 6. 40 Storied building (Static Analysis)

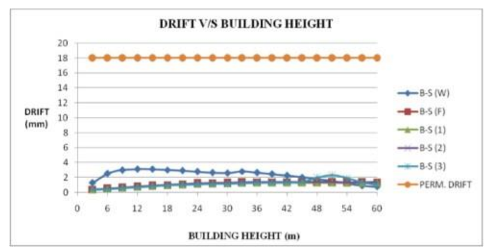


Fig. 7. 40 Storied building (Staic Analysis)

### *B. Results for drift reduction vs. building height in Zone V*

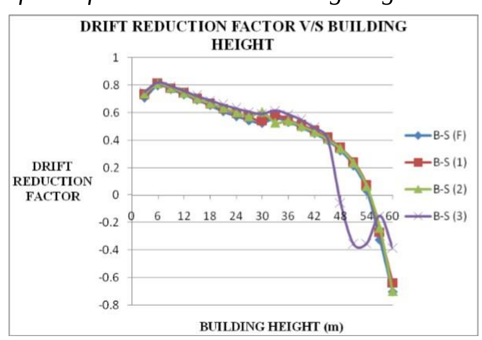


Fig. 8. 40 Storied building (Static Analysis)

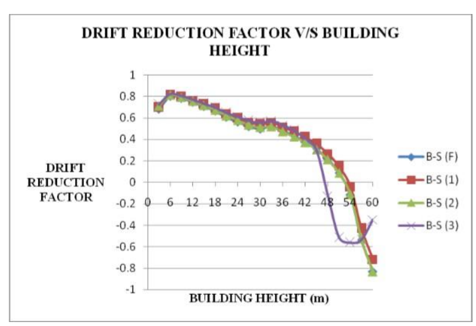


Fig. 9. 40 Storied building (Static Analysis)

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### *C. Results for contribution vs. building height Zone V*

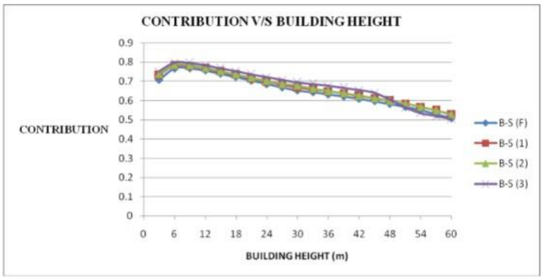


Fig. 10. 40 Storied building (Static Analysis)

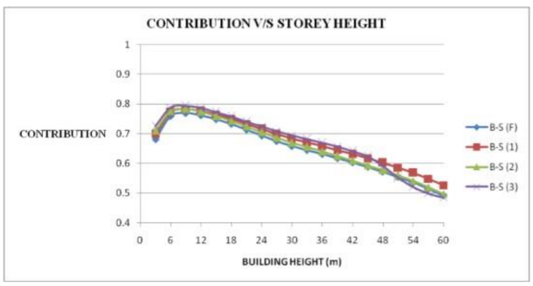


Fig. 11. 40 Storied building (Static Analysis)

## VIII. CONCLUSION

1. In building having no shear wall drift increases in initial 5 or 6 stories there after it remain constant about 3/5 of total height and then it decreases. A twist or bend is observed where column and shear wall sections are changed.
2. Model with shear wall show better drift control.
3. Gradual reduction in thickness of shear wall has better drift control.
4. The contribution of shear wall in lower storey may be about 60 to 70 % for 40 storied building. As we move in intermediate to upper storey contribution may be reduced to 50 to 60 % or it may be constant. Especially in upper 5 storeys the shear wall imparts negative role due to reversal of earthquake load.
5. In the case where shear wall is curtailed there after drift is less than that in frame having shear wall (in higher stories) though in lower stories it has increased still it does not result in soft storey. Hence investment in shear wall may be saved without impairing the structural strength.
6. Irrespective of type of provision of shear wall. In case of 120m height building drift increases gradually up to ½ of total height and there after it is almost constant in all the cases. In all the cases it is well within permissible. Removal of top five stories has no significant effect on drift.

## REFERENCES

[1] Malik A., M. Mulham B., Isam S., "The Optimum Level for Wall Curtailment in Wall-Frame Structures to Resist Lateral Loads", pp.1-7.

[2] Natarajan, S. Veeraragavan, 2016 "A Review on Analysis and Design of Shear Walls in High Rise Irregular Building" 2016, International journal of scientific Engineering and Technology research (IJSETR), vol.05. pp. 0808-0815.

[3] Ravikanth C., Ramancharla P., "Significance of Shear Wall in High-rise Irregular Buildings", International Journal of Education and applied research (IJEAR), vol-4, pp-35-37.

[4] T. Paulay, "Performance of shear wall building during seismic excitations the shear strength of shear walls", pp. 148-162.

[5] Malik Atik, 2010 -The Effect of Curtailed Walls in Wall-Frame Structures to Resist Lateral Loads. Master degree. thesis, University of Aleppo, Aleppo, Syria.

[6] Nollet. M.J and Stafford Smith.B, 1993, "Behavior of Curtailed Wall- Frame Structures" Journal of Structural Engineering, Vol. 119, No. 10, pp: 2835-2854.

[7] Nollet, M. J. ,1991, "Behavior of wall-frame structures: a study of the interactive behavior of continuous and discontinuous wall-frame structures" Ph.D. thesis, McGill University, Montreal, Canada.

[8] R. S. Malik, S. K. Madan, V. K. Sehgal, 2011, "Effect of Height on Seismic Response of Reinforced Cement Concrete Framed Buildings with Curtailed Shear Wall", Journal of Engineering and Technology, Vol 1, Issue 1.

[9] Anshuman S., Dipendu B., Bhavin R., 2011, "Solution of Shear Wall Location in Multi-Storey Building", International Journal of Civil and Structural Engineering, vol. 2. pp. 493-506.

[10] Varsha R. Harne, 2014, "Comparative Study of Strength of RC Shear Wall at Different Location on Multi-storied Residential Building", International Journal of Civil Engineering Research, Vol. 5, pp. 391-400.

[11] K S Sable, V A Ghodechor, S B Kandekar, 2012, "Comparative Study of Seismic Behavior of Multistory Flat Slab and Conventional Reinforced Concrete Framed Structures", International Journal of Computer Technology and Electronics Engineering (IJCTEE) Vol. 2, pp.17-26.

[12] Sharad P. D., Swapnil B. C., 2013, "Seismic Behaviour of Flat Slab Framed Structure with And Without Masonry Infill Wall", International Journal of Engineering Research & Technology (IJERT), Vol. 2, pp.1595- 1599.

[13] IS 1893 (Part 1)-2002, Indian Standard Criteria for Earthquake Resistant Design of Structures, Part 1–General Provisions and Buildings (Fifth Revision), Bureau of Indian Standards, New Delhi.

[14] IS-456.2000, Indian standard "plain and reinforced concrete" -code of practice, Bureau of Indian standards, New Delhi.