STRUCTURAL EFFECTIVENESS OF SHEAR WALL IN LOW RISE BUILDINGS FOR VARIOUS SEISMIC ZONES: A CASE STUDY

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Abstract : **In Bhuj earthquake 2001, there were collapses of many low rise buildings. After a very severe seismic shaking, it may be far cheaper to repair, or even rebuild the damaged structure, than to build a no damaged structure in the first place. With the help of shear walls the structure can be made which will not collapse in earthquake. It is general perception in minds of people that shear walls are effective and economical for high rise buildings. Therefore it is necessary to find out effectiveness of shear wall in low rise buildings for various zones.**

1. INTRODUCTION

Moment Resisting frames and shear walls frames are two principles structural systems used in reinforced concrete buildings to resist lateral forces generated due to wind and earthquake. Moment resisting frames are considered efficient for buildings having 10 to 15 stories. Tall moment resisting frames are undesirable for resisting lateral forces because if there is an the increase in number of stories, then the size of frame members required to ensure adequate rigidity will lead to corresponding increase in storey height. Large inter storey displacement for such frames can cause severe damage to the moment resisting frames as well as to the non-structural elements.

Moment resisting frame & shear wall combined together to form one structural system is called dual system or hybrid system. Dual systems may have combine advantages of their constituent elements. Ductile frames interacting with walls can provide significant amount of energy dissipation due to large stiffness of wall, thus in case of multi storey building it is possible to achieve a good storey drift control.

Despite the attractiveness and prevalence of dual systems, this approach is developed since long at world level and recently in India; a research effort has been directed towards the development of relevant seismic design methodologies. The common practise of allocating a portion of the lateral forces to the frames and remainder to the walls, each of which then independently analysed is entirely inappropriate. Compatibility of deformation between two elements must be considered. In this study, with the help of case study, we concentrate on the effect of dual system on overall deflection of structure.

2 Types of Seismic Load Resisting System

There are four basic systems for high-rise buildings

1) Moment Resisting Frames
2) Moment Resisting Frames With Shear walls
3) Framed Tube System
4) Tube in Tube System

Table 1 below show the Guide for selection of Structural System

Table 1 Guide for selection of structural System

Type of Structural System	**Number of storey**		**Seismic behaviour**
	Office Buildings	**Residential Buildings, Hotels etc**	
Moment Resisting Frames	Up to 15	Up to 20	Very good
Shear walls	Up to 40	Up to 150	Good
Shear wall in conjunction with frame	Up to 40	Up to 70	Very Good
Single framed Tube	Up to 40	Up to 60	Very Good
Tube in Tube	Up to 80	Up to 100	Good

2.1 Moment resisting frames

Moment Resisting Frame is space frame designed to carry all vertical and horizontal loads by developing bending moments in the members and at joints. Lateral load resisting capacity of reinforced concrete framed structures depend mainly on rigidity of member connections.

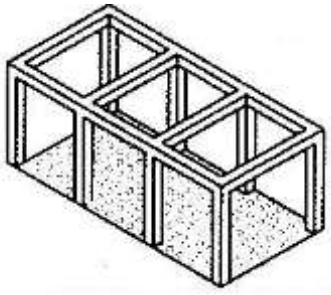


Fig 1 Moment Resisting Frames

2.2 Shear wall

Shear walls are essentially columns with a large depth and a small width. The walls are quite stiff in their own plane and flexible in the perpendicular plane. Thus a shear wall transfers the lateral force in its own plane by developing moment and shear resistance. Large amount of lateral force will be transferred to walls because of moment of inertia and large stiffness of wall.

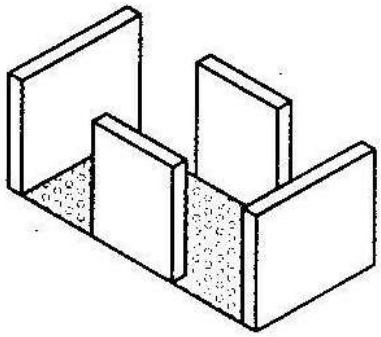


Fig 2 Shear walls

2.3 Moment resisting frames with shear walls (dual system)

Moment resistant frame with shear walls also termed, as dual system is a space frame with moment resistant joints, strengthened by shear walls to assist in carrying out horizontal loads. This shear wall – frame interactive system, is considered as the best structural system for reinforced concrete multi-storey structures in region of high seismcity. This system combines the gravity load carrying qualities of frames with the lateral load resisting quality of the shear walls.

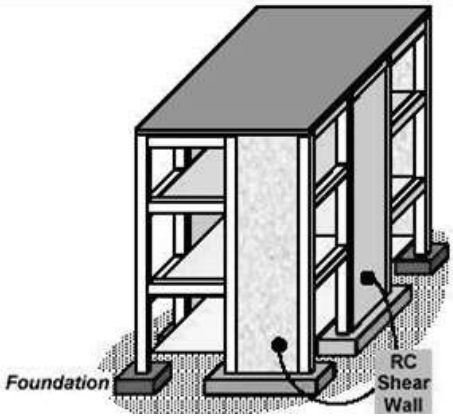


Fig 3 Moment Resisting Frames with Shear walls.

2.4 Interaction between shear wall and frame

The interaction between the frame and the shear wall reduces the lateral deflection of the structural wall at the top, while the wall helps in supporting the frame near the base. In the building, in plane rigidity of the floor slab forces the deflection of the walls and the frames to be identical at each storey level. To force the wall and the frame into the same deflected shape, internal forces are generated that equalizes the deflected shape, of each. Thus the frame in the upper stories pulls back the wall while in lower stories the wall pushes back the frame.

Interaction between shear wall and moment resisting frames greatly reduces the deflection of the overall combine system, creating a considerably overall higher stiffness than the sum of the individual components, each resisting a portion of exterior loads. In this distinctive feature of increasing the stiffness through a set of internal forces lies the great advantage of shear wall frame

interactive systems. Like columns shear wall also resist the vertical loads in addition to lateral loads. The biggest qualification of this system of shear wall frame is in the interaction and due to the lateral rigidity provided by the shear walls the inter storey displacements are reduced and thus, it minimizes the non-structural damages and gives a better performance from the point of view of damage control.

3 Formulation of case study

3.1 General Information of case study building

For the purpose of case study the apartment building having 4 flats on each story located at Pune and regioted n was taken.

3.2 Methodology of Analysis

Analysis is done in Staad Pro 2003 and Staad Pro 2004 Software. Building modelled as 3D frame with Shear wall as plate element. Base Shear is applied as per IS 1893-2002. Base shear is distributed as storey shear. Every floor slab is considered as infinitely rigid. For considering rigidity of slab master slave command is used. Support condition is taken as Hinge for column and Shear walls. Study is carried out for Seismic Zones III, IV and V.

Loadings

- Slab loading specified in terms of floor load command for two way distribution loading
- Wall load specified in terms of member loading
- Self-weight of columns and beams specified in terms of self-weight command

Earth quake analysis

- Earth quake loading is specified in terms of code 1893 -2002 parameter related to zone factors.
- Dead load and % of live loads are use to find out base shear.
- Load combinations are specified for all load specifications
- Location of shear wall is finalized after placing shear wall in different locations. Shear wall having lesser length and attracting more than 75% of base shear as per code requirement is selected.
- In our both case studies buildings are symmetrical about both axes except mass of stair case is only unsymmetrical which generate eccentricity of 2 Cms only between centre of mass and centre of rigidity. Space frame analysis is performed which takes care of eccentricity.

The case is existing building. Following are silent features of case study.

Case Study: This building is G+3 storey residential building. Four flats on each storey.Floor area of each floor is = 176.64 m^2. Total built up area of the building = 706.56m^2.Total height of building including OHWT is 15.82 m. The structural plan of the selected building has been decided. Shear wall is placed at various locations to Suit architectural requirements. Out of Different locations, A location where Shear wall having lesser length in both Directions and attracting more than 75% base Shear is selected for Analysis. Building is analysed for only Moment Resisting frames and Moment Resisting frames with Shear wall. Figure below shows architectural plan and structural system of building.

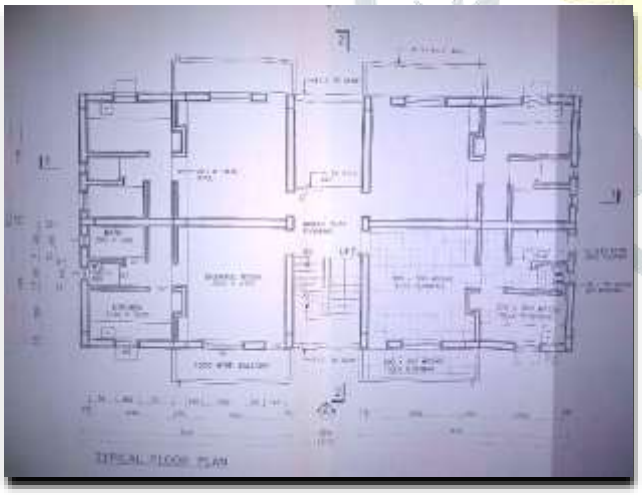


Fig 4 Architectural Plan of Building

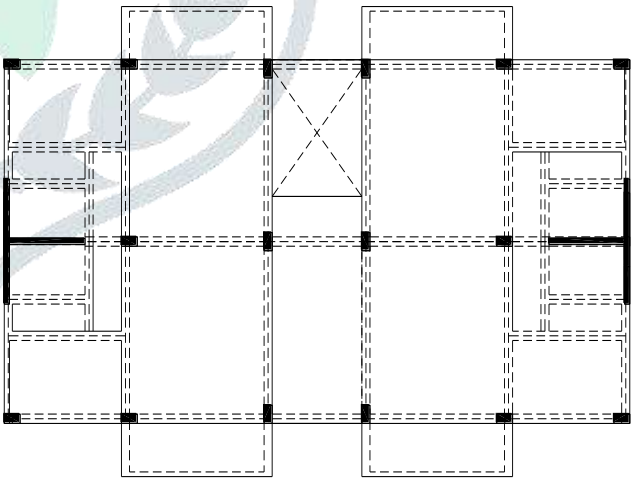
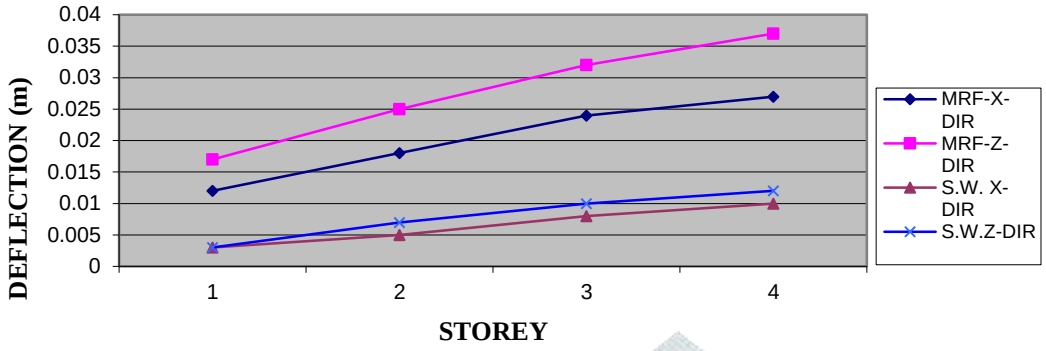


Fig 5 Structural System at Typical Floor

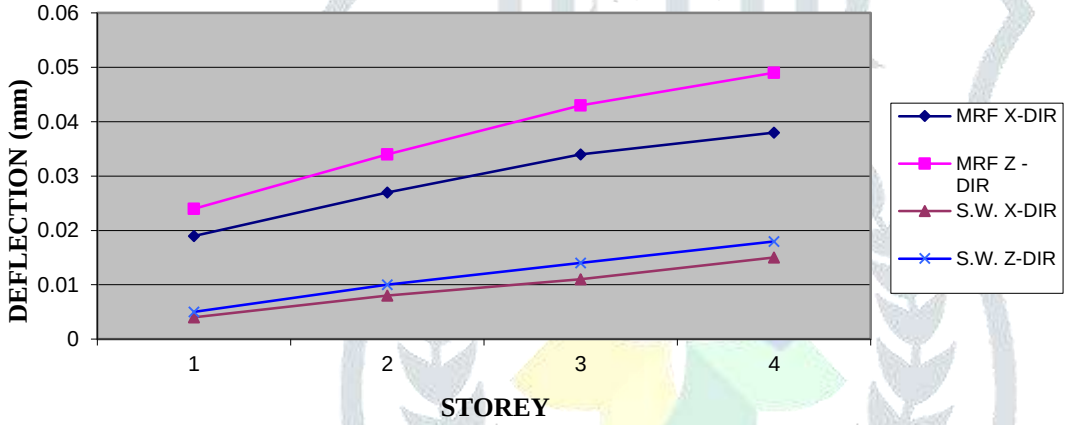
4 RESULTS

Building is analysed with software Staad pro 2003 and 2004. Building is modelled as Moment Resisting Frame only and Moment Resisting Frames with Shear Wall for Seismic Zone III, IV and V. Results for overall deflection are obtained as shown in Diagrams given below.

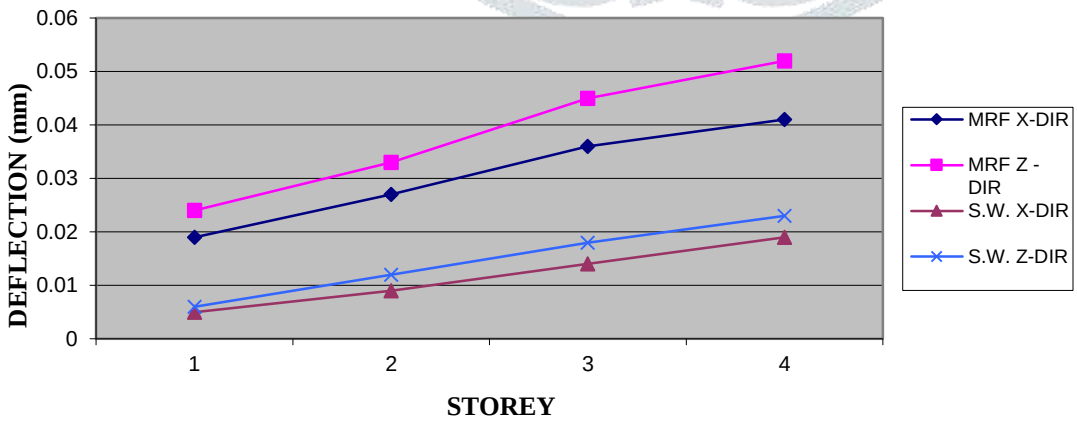
MAX. DEFLECTION FOR ZONE III CASE STUDY



MAX. DEFLECTION FOR ZONE IV CASE STUDY



MAX. DEFLECTION FOR ZONE V CASE STUDY



5 Conclusion

(1) Deflection of Building Analysed with shear wall reduces greatly than Building designed with Moment Resisting Frames.

(2) By Reducing Deflection with Shear walls we can reduce inter storey drift considerably. N

(3) With help of Shear wall we can assure 100% safety of building from collapse hence lives can be saved
(4) There should be change made in building bylaws so that every important building like Hospital, schools and Institute must be designed with shear walls in both directions.

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