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Analysis and Design of R.C. Moment Resisting Frames with and without Shear Wall for Different Seismic Parameters

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Abstract

The objective of this study was to compare seismic analysis and design of RC moment resisting space frame with shear wall (Dual System). In moment resisting frame and dual system, two different cases were selected for the study. In moment resisting frame Special Moment Resisting Frame and Ordinary Moment Resisting Frame were considered with Variations of heights, i.e. (G+4), (G+6),(G+8), (G+10) , and bays viz. (2x2),(3x3),(4x4),(5x5),(6x6) for bare frame and frame with brick infill, and in dual system, structure with shear wall and without shear wall were considered with (G+8) storey for (5x5) bay for frame with brick infill with same loading conditions. Frame has been analyzed and designed using STAAD ProV8i software referring IS: 456-2000, IS: 1893 (Part-1)2002 and detailing is made according to IS: 13920-1993. From these data, cost is calculated and economic structure is being found out.

Keywords: *Moment Resisting Frame (MRF), Shear Wall, Dual System, Storey Driftand Base Shear.*

Introduction

In urban areas, increase in population and scarcity of land, the horizontal development gets restricted that's why most of the owners, building contractors, engineers are adopting vertical development of buildings for the construction. Natural hazard like earthquake affects the stability of such structures. Previous studies reveal that major failures of structures occurred due to improper design procedures. Therefore,it is need of time to analyse & design such hazard resisting structures so as to save human life and avoid property damage.Hence our project aims analysis and design of Reinforced concrete Moment Resisting Frame with Shear Wall for different zones with different seismic parameters.

Moment Resisting Frame: It is a system in which members and joints are capable of resisting vertical and lateral loads primarily by flexure. Frames may be designed using concept of strong column-weak girder proportions. There are two types of MRF: OMRF and SMRF.

Ordinary Moment Resisting Frame (OMRF): It is a moment-resisting frame not meeting special detailing requirements for ductile behaviour.

Special Moment Resisting Frame (SMRF): It is a moment-resisting frame specially detailed to provide ductile behaviour and comply with the requirements given in IS 4326 or IS 13920 or SP6.

Shear Wall: It is wall designed to resist lateral forces acting in its own plane. It also referred as vertical diaphragm or structural wall.Shear walls in buildings must be symmetrically placed along exterior perimeter of the building to reduce ill-effects of twist in buildings.

Dual System: MRF with shear wall also termed as Dual System. The interaction between the frame and the shear wall reduces the lateral deflection of the structural wall at the top, while the wall helps support the frame near the base. The MRFs are designed to independently resist at least 25% of design base shear, even if shear walls share more than 75% of the total lateral force. This is to take care of effect of displacement during earthquake.

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Storey Drift: It is lateral displacement of one level relative to level above or below.
Base Shear: It is total design lateral force or shear at base of structure.

MathematicalFormulation

Two kind of R.C.C. buildings were taken for analysis- MRF and Dual System. Different types of models to simulate real field problem were developed.

A) Modeling of MRF Building:

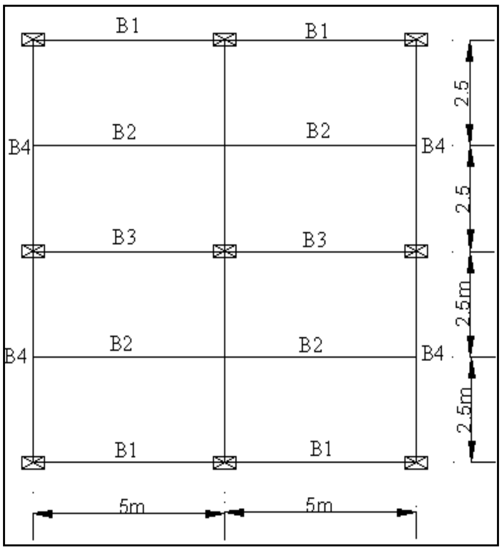
In moment resisting frame SMRF and OMRF were considered with Variations of heights, i.e. (G+4), (G+6),(G+8), (G+10) , and bays viz. (2x2),(3x3),(4x4),(5x5),(6x6) for bare frame and frame with brick infill. The models are developed for all seismic zones.

Depending upon height of building depth of foundation is taken as 1.5m (G+4), 2.25m (G+6), 3m (G+8) and (G+10). This model consists of bays of 5m each in global X and Z direction, size of beam (B1, B3, and B4) is 230mmX600mm and of beam (B2) is 230mmX530mm.

B) Modeling of Dual System Building:

In dual system, structures with shear wall and without shear wall were considered with (G+8) storey for (5x5) bay for frame with brick infill. Thickness of shear wall is taken as 230mm. All beams are of 230mmX600mm. The support of shear wall is assumed as fixed.

Following parameters are considered same for both the buildings size of columns varies according to loading conditions and support is assumed to be fixed, foundation soil type is taken as hard, density of concrete 25 KN/ m^3, density of brick masonary 20 KN/m^3, density of brickbat coba 20 KN/ m^3, thickness of slab 130 mm, thickness of external wall 150 mm, thickness of internal wall 150 mm ,thickness of brickbat coba 200 mm, height of parapet wall 1.1m,floor finish load 1.25 KN/m^2,LL on floor slabs 4 KN/ m^2,LL on terrace slabs 1.5 KN/ m^2.
A mathematical model is considered with view to have different types of beams such as, fixed beams and continuous beams. The plans and elevations of the moment resisting frames of (2x2) bay and frames without shear wall and with shear wall are as shown in Fig.1-6 respectively.



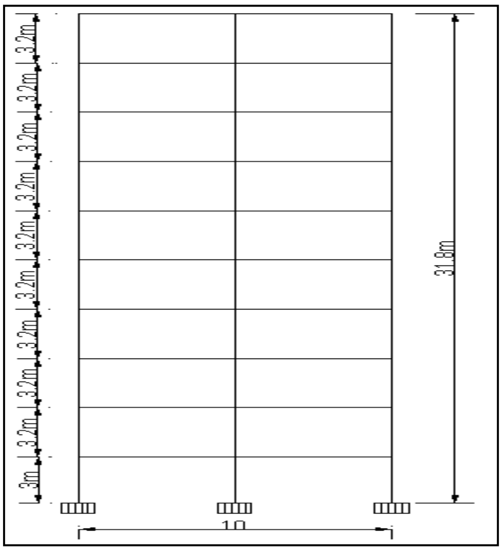


Fig.1 Plan for Moment Resisting Frame (2x2)

Fig.2Elevationfor Moment Resisting Frame (2x2)

Results and Discussions

The variations for different parameters like Storey Drift and Base Shear, Cost of central frame of MRF (2X2, G+8) building and Cost of whole structure for Dual System building are represented in following Fig.7-12.

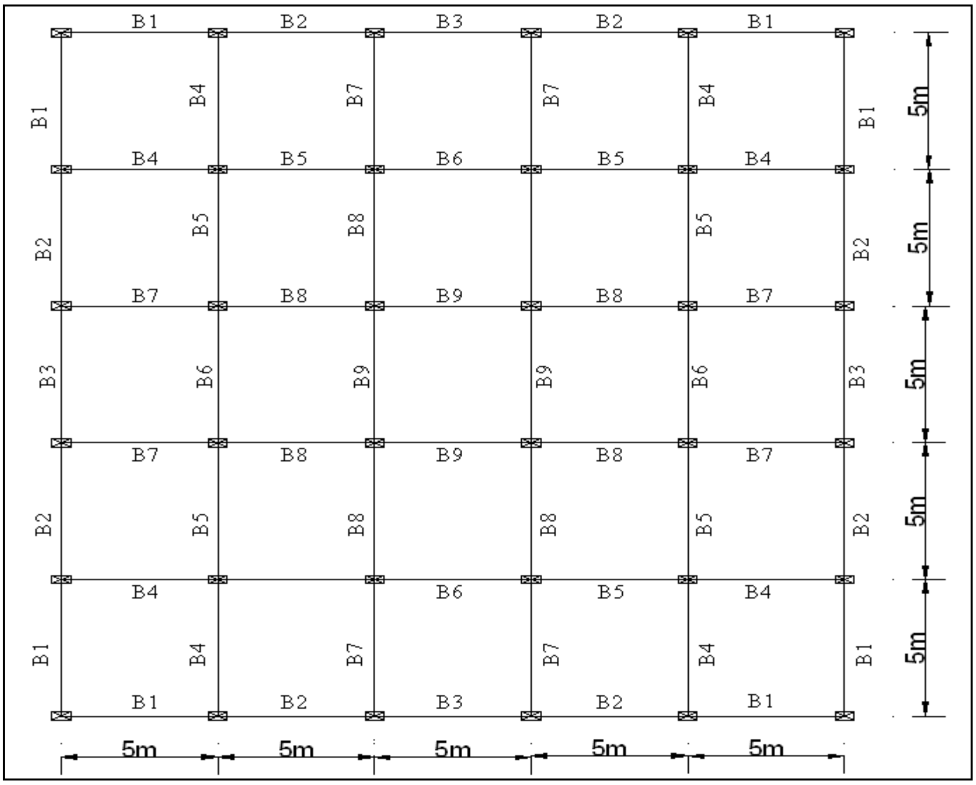


Fig.3 Plan for Frame without Shear Wall

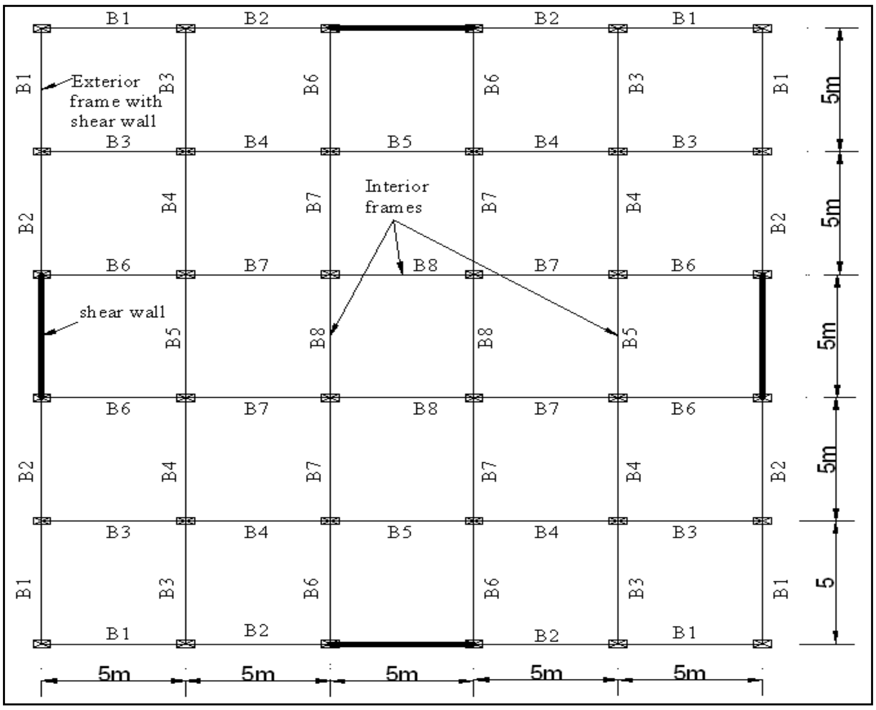


Fig.4 Plan for Frame with Shear Wall

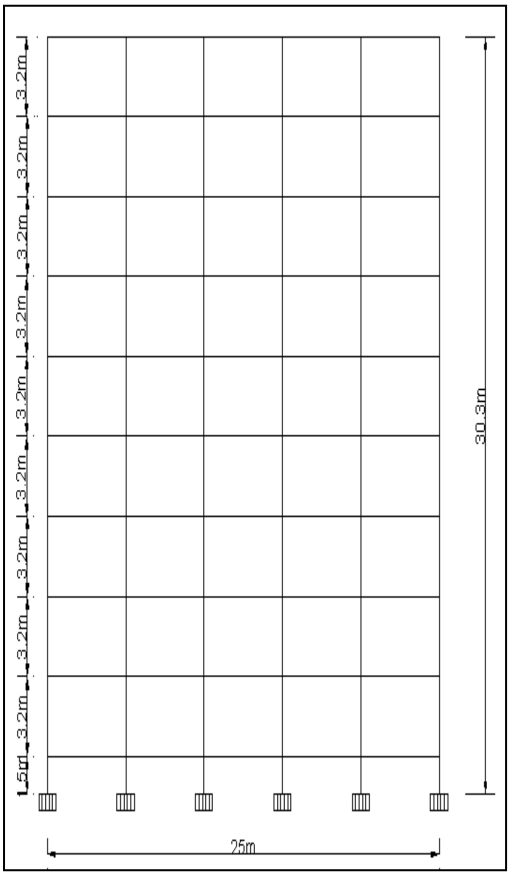


Fig.5 Elevation for Frame without Shear Wall

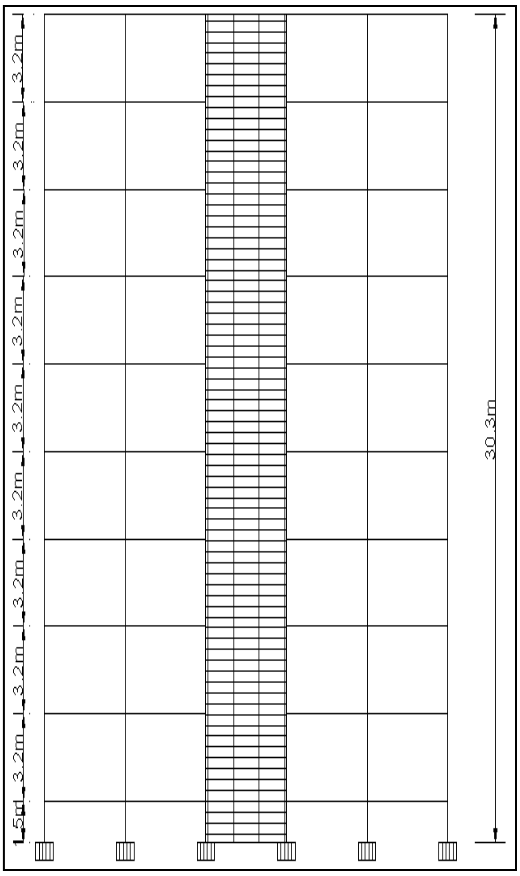


Fig.6 Elevation for Frame with Shear Wall

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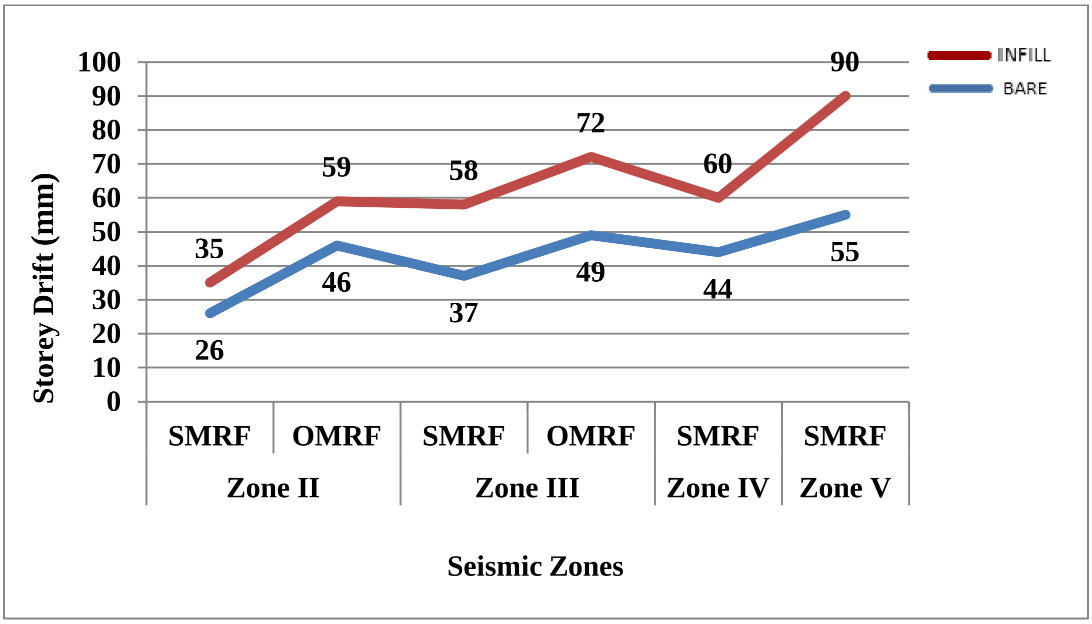

Fig.7Storey Drift v/s Seismic Zones for G+8 (2x2)

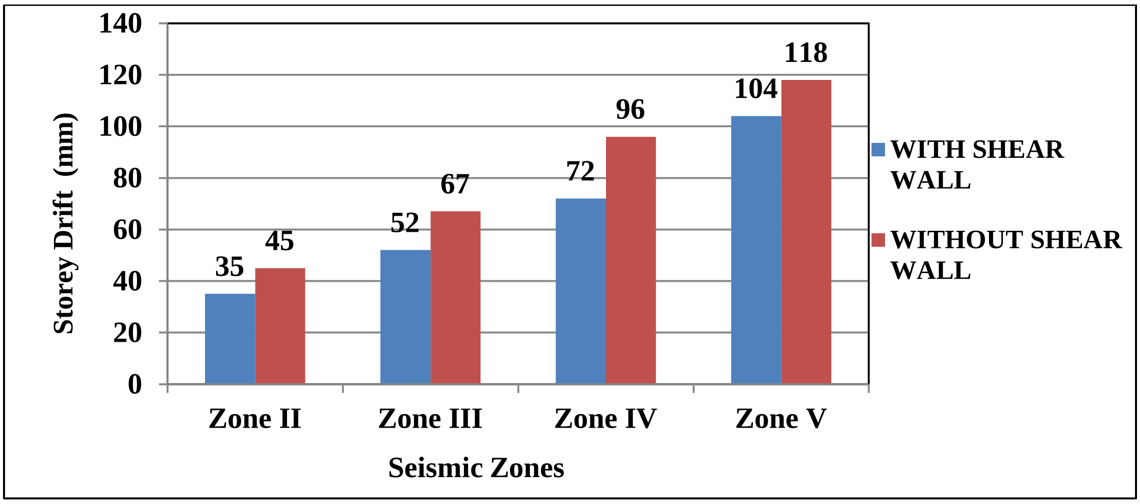

Fig.8Storey Driftv/s Seismic Zones for Dual System

Discussion on Storey Drift and Base Shear

From our study following observations are made

1. Storey Drift and Base Shear is more in case of ordinary moment resisting frame as compared to special moment resisting frame for same zone.
2. Storey Drift and Base Shear of structure increases as we go to higher Seismic Zones in case of both ordinary moment resisting frame and special moment resisting frame for same zone.
3. Storey Drift and Base Shear of bare structure is less as compared to structure with brick infill for same zone.
4. Storey Drift and Base Shear increases as number of bays increases of building for same zone.
5. Storey Drift and Base Shear increases with increase in height of building for same zone.

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6. Storey Drift and Base Shearfor frame with shear wall structure are less as compared to frame without shear wall structure.

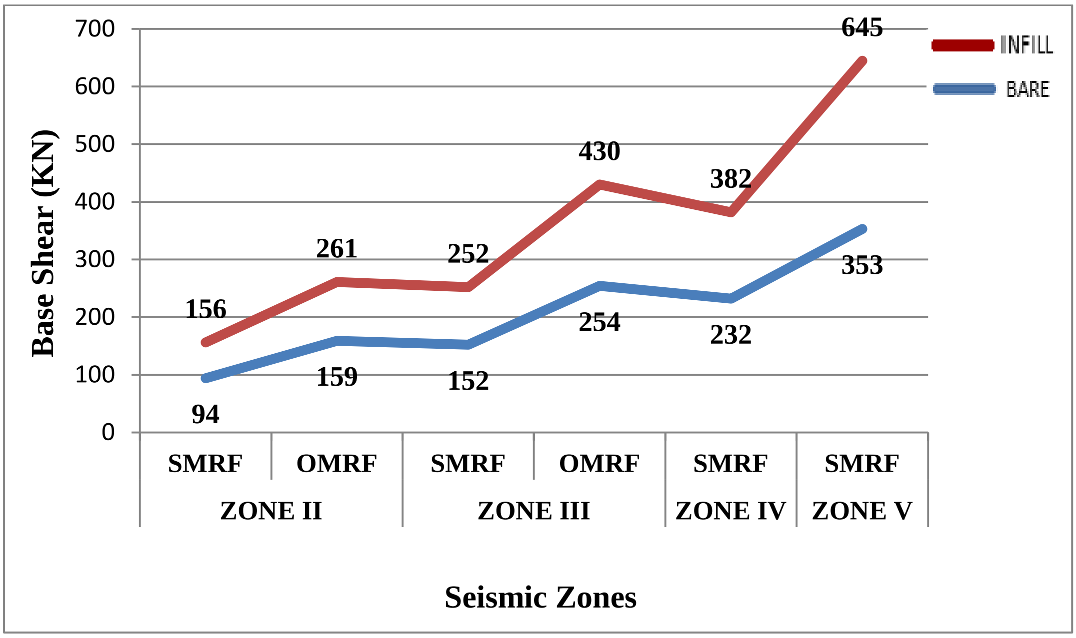

Fig.9 Seismic Zone v/s Base Shear for G+8 (2x2)

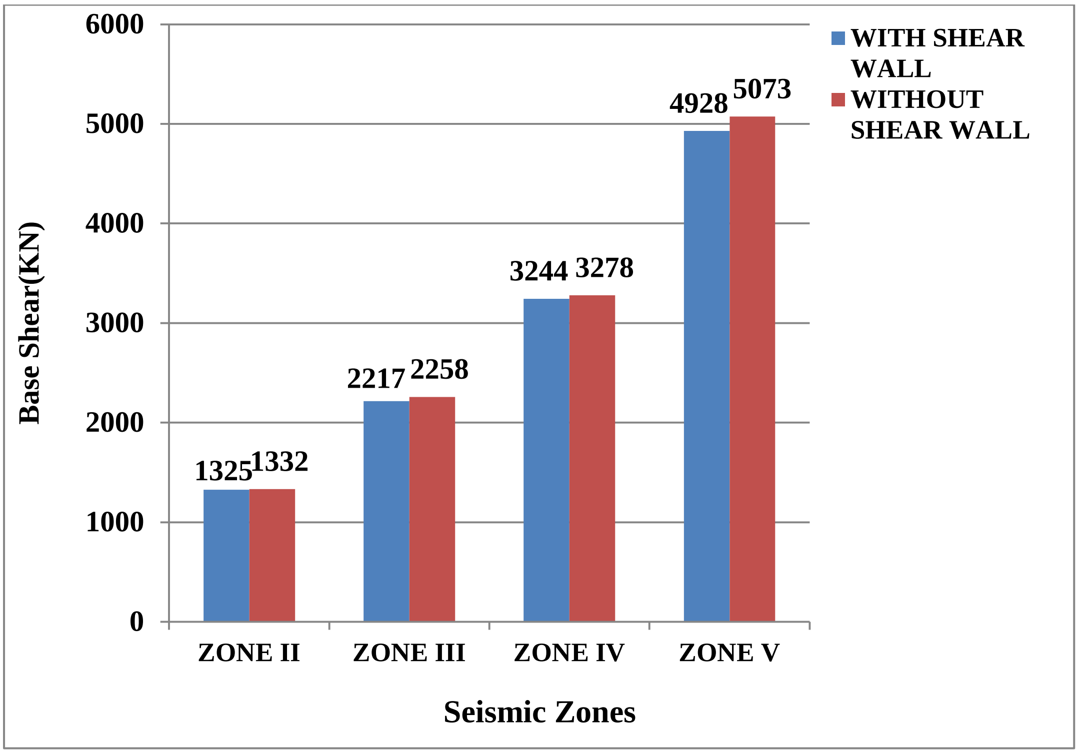

Fig.10 Variations of Base Shear for Dual System

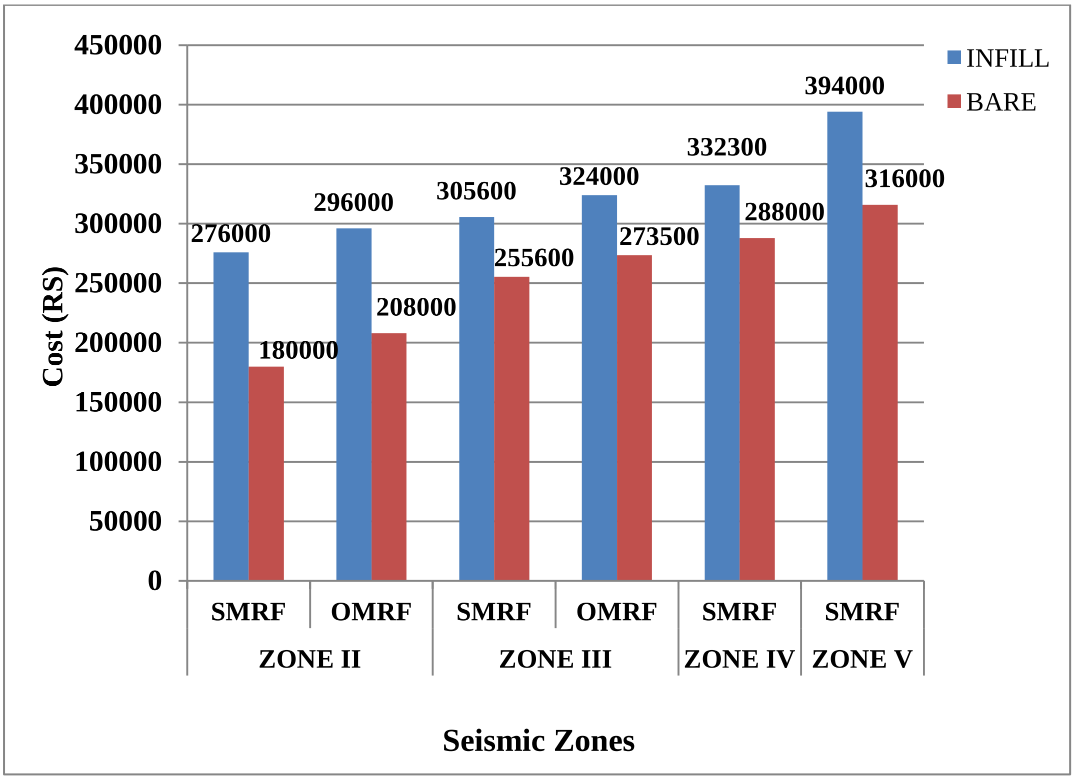

Fig.11 Cost of Central Frame v/s Seismic Zones for G+8(2x2)

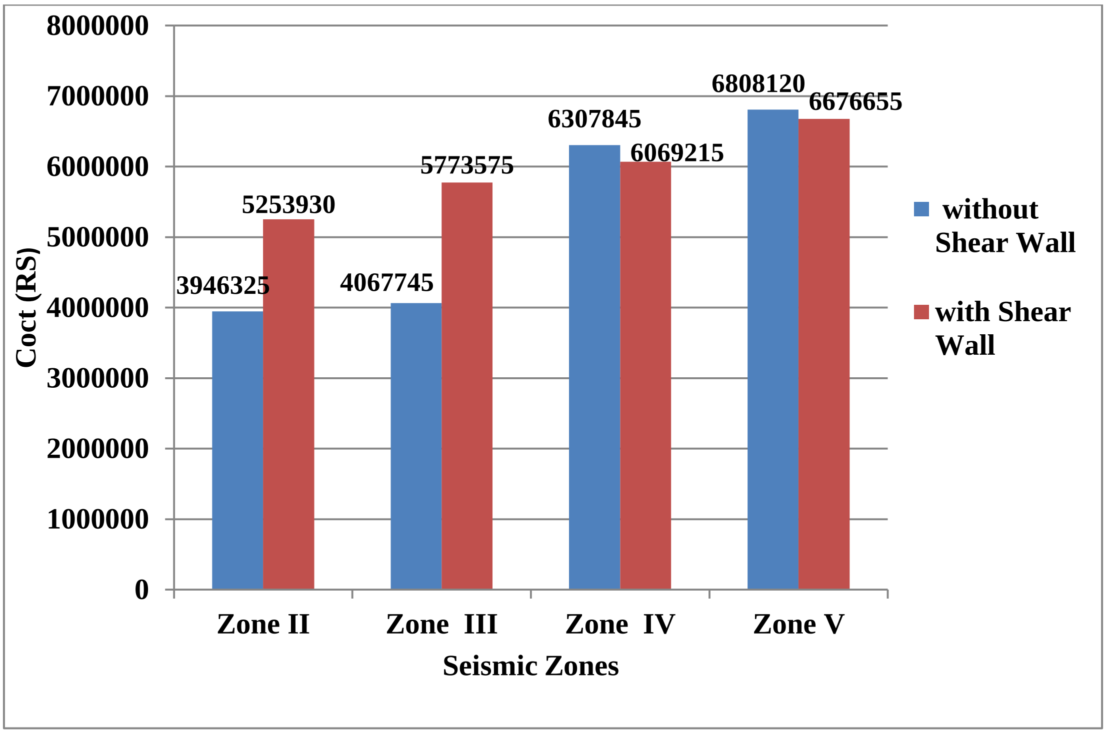

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Fig.12 Cost of Whole Structure v/s Seismic Zones for Dual System

Discussion on Cost

Following observations are made on cost of structure

1. The Response reduction factor (R) has significant effect on the variation of cost
2. The cost difference in SMRF is comparatively less than OMRF.
3. In case of Zone –II, frame with infill wall, SMRF is economical than OMRF, whereas in case of bare frame, OMRF is economical than SMRF.
4. As we go to higher seismic zone the cost of structure for frame with infill wall and bare frame goes on increasing.
5. MRF structure with Shear Wall (Dual system) is economical as compared to MRF structure without Shear Wall for seismic zone IV and V.

Conclusions

1. In case of MRF structure, Storey Drift and Base Shear are increasing for bare frame and frame with infill walls with increase in bays for same storey and same seismic zone, with increase in height for same bay and same seismic zone and with change in seismic zone from II to V for same bay and same storey.
2. For seismic zone II and III, SMRF is economical than OMRF.
3. Storey Drift and Base Shear are more for MRF structure without Shear Wall than MRF structure with Shear Wall (Dual system) for same storey, same bays, same seismic zone, in bare frame and frame with infill walls.
4. MRF structure with Shear Wall (Dual system) is economical as compared to MRF structure without Shear Wall for seismic zone IV and V.

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