A STUDY ON EcBc TECHNOLOGY AS COMPARED TO COVENTIONAL TECHNOLOGY FOR A HIGH RISE BUILDING

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Abstract

Analytical Study on structural aspects and Behaviour of Tall Structure using Ec Bc Dc technology is performed using E-Tabs software. Basic concept of Technology is to improve strength and stiffness properties by providing entire shear wall at external portion of building. This technology is conceptualized to bring out changes in present construction scenario by eliminating use of vibrators, removal of wet curing process, and also uses single level shuttering. Stiffness rather than strength parameter becomes dominant factor for tall structures, which can be achieved efficiently with this system to resist the lateral loads. Result interpretation and various outcomes of the system are compared with other structural systems.

In this study, 3 different systems are considered for analysis i.e. Beam column system, EcBc system and RC wall/Mivan system. A G+31 storey residential building is considered under the different seismic zone conditions. Models are analyzed for linear static and dynamic analysis. Results and discussions of different systems under different seismic zone conditions are compared.

Keywords: *Earthquake Resistant Structures, Beam Slab system (Framing system), Mivan system (R C Walls), External core, Beamless ceiling, Dry construction (Ec Bc Dc).*

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1. INTRODUCTION

An earthquake is a geological event of the earth that causes strong vibrations on the surface of the earth. This event causes the earth to experience a trembling effect Earthquake occurs due to different reasons. However, motion along the fault is the most general source of earthquake. Due to earthquake forces a building behaves in dynamic way. Dynamic actions are due to both wind and earthquake. But the design of wind and earthquake resistant structures are uniquely different. Since earthquake results in the forces of inertia that is proportional to the mass of structure and rigidity of the building plays an important role.

To counter forces, designing of the buildings is done such that the buildings behave elastically during earthquakes without damage can make the project economical. Damage limitation methods are adopted for dynamic design of earthquake prone buildings which include Reinforced construction material, anchoring the foundation, Basic Insulation, Pile Foundation etc.

2. LITERATURE REVIEW

C. G. Quintero has done a study on a RCC structure where the concrete connection sub assemblages were subjected to reversible lateral displacement cycles with storey drift of maximum 5%. It can be concluded that, torsional cracking was found to be acceptable for spandrel beam whereas yielding of longitudinal and transverse torsional reinforcement was not acceptable.**[1]**

G.V. Sai Himaja **et al** have done non-linear static analysis. The design procedures for both with and without vertical irregularity are as per IS 456-2000 and IS 1893-2002 (part 1). G+3 and G+9 RCC residential building frames are analyzed by ETABS 2013 software. It was concluded that bare frame had higher displacement and less base shear Brick in filled frame has least displacement than bare frame It is concluded from the result that Ferro cement in filled frame with 300% irregularity shows least displacement.**[2]**

O. Esmaili **et al** have studied tallest RC buildings which is located in very high seismic zone consisting of 56 stories. Non-linear analysis was performed for the seismic evaluation of the towers. In conclusion it was seen that Concrete structural elements that are having different longitudinal stiffness make the tower to be very sensitive for different displacement structural elements. Ductility level for seismic bracing systems must be provided for absorption of energy. Shear walls can be used for both bracing and gravity systems since it is economical.**[3]**

Chaitanya Kumar **et al** have analyzed G+11 storey home buildings along with the precast reinforced concrete load bearing walls. Load bearing walls and one-way slabs are used as structural system. Different combination of loads, several wall forces, moments and displacements are worked out. In conclusion it was seen that linear variation in axial forces between stories are 7.26% the difference in maximum out-of-plane moment storey is 9.04 %. The difference in maximum lateral loads between storey 11 and 12 is 0.54 %. **[4]**

G.H.Basavaraj has conducted research on the new technology, namely lead-free ceiling construction technology (Ec Bc Dc). This research implies that outer core wall improves the stiffness and torsional stiffness of the structure and eliminates the internal bundles to give a flat soffit to the slab and the freedom to plan and execute the service lines comfortable. From the analysis it is concluded that this system has a relatively high rigidity due to an external core and the simplicity and flexibility in design, use and effortless construction thanks to the endless ceiling roof system to large buildings.**[5]**

3. PARAMETERS TO STUDY

- ❖ Time Period
- ❖ Base Shear Absorption
- ❖ Maximum Storey Displacement
- ❖ Maximum Storey Drift
- ❖ Cost Estimation

4. ANALYSIS RESULTS

The Response Spectrum Analysis results obtained using ETABS software is represented in the form of graphs. The different structural systems are compared for the following parameters which include Maximum Storey Displacement, Time Period, Maximum Storey Drift, Base Shear and Cost Estimation for different zones.

4.1 Time Period

The time period for different structural systems of all cases is shown in Figure 1.

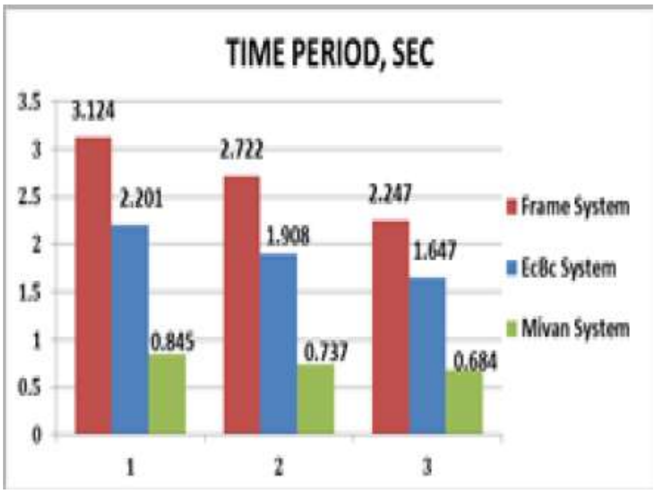


Fig. 1 Time Period for 3 modes

From the figure 1, we can observe that, the time period is less in Ec Bc & Mivan systems compare to Beam Slab because of less flexibility in Mivan & Ec Bc systems & they are more rigid comparatively.

4.2 Base Shear

Comparison of various structural systems is carried out to find the different zone base shear variations including the base shear comparison. Figure 2 to Figure 4 represents different zones with different structural systems base shear represented in bar graph.

1) Zone – III:

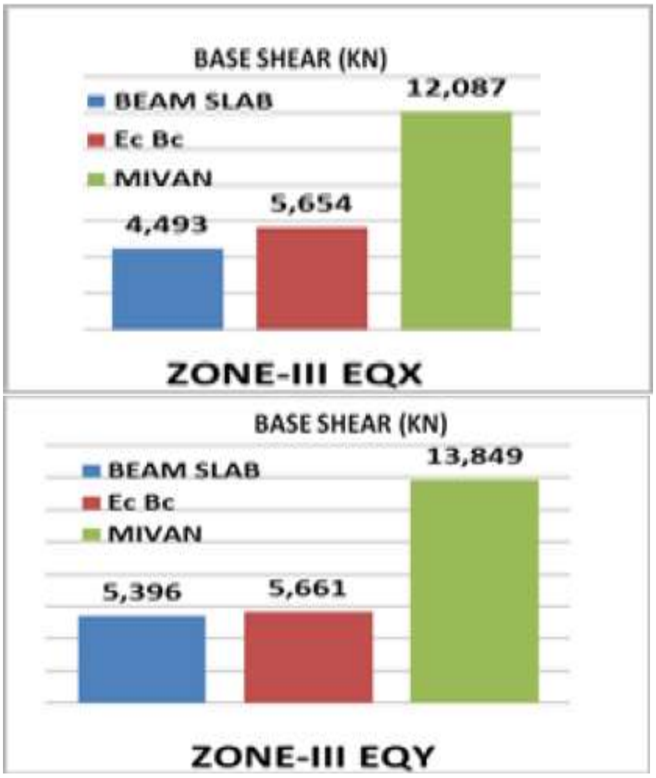


Fig. 2 Zone–III Base Shear (KN) for EQX & EQY

2) Zone – IV:

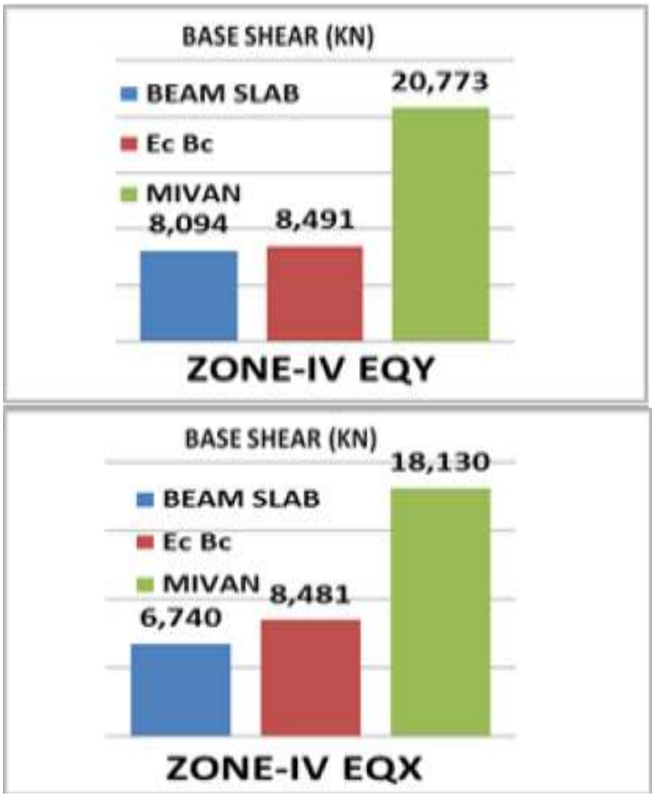


Fig. 3 Zone–IV Base Shear (KN) for EQX & EQY

3) Zone – V:

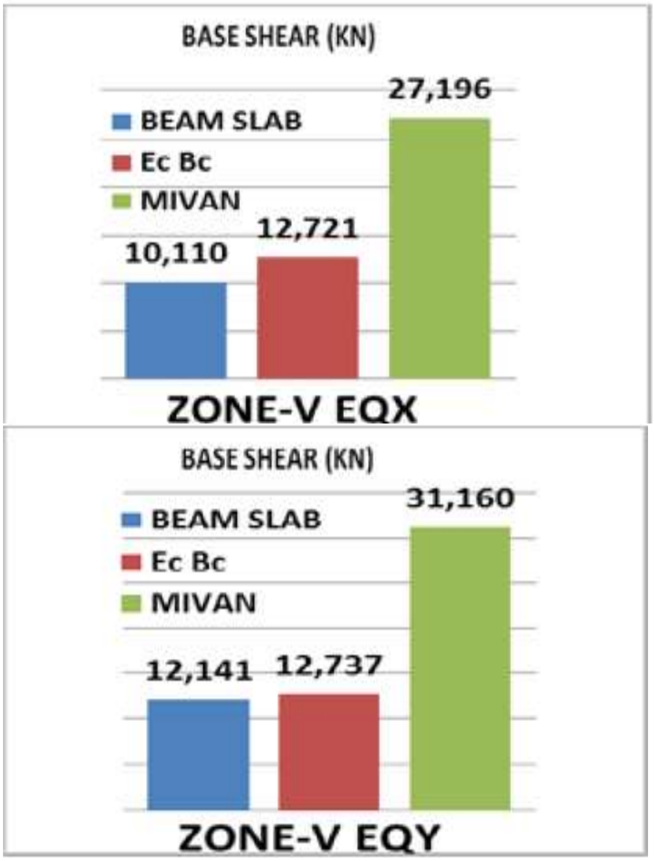


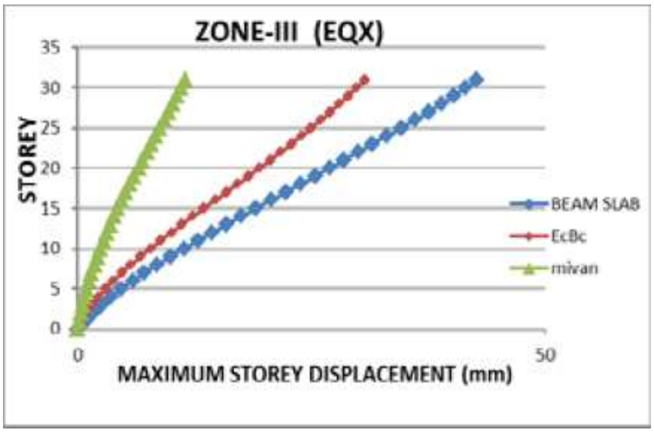
Fig. 4 Zone–V Base Shear (KN) for EQX & EQY

Base shear increases with increase in seismic mass. Building dimensions in x & y directions also alter the base shear value as the base shear value varies along various structural systems considered with various calculations of earthquake infill.

4.3 Maximum Storey Displacement

The point with maximum storey displacement is considered. Figure 5 to Figure 7 shows the different zones graphical representation with different structural system with lateral displacement variations.

1) Zone – III:



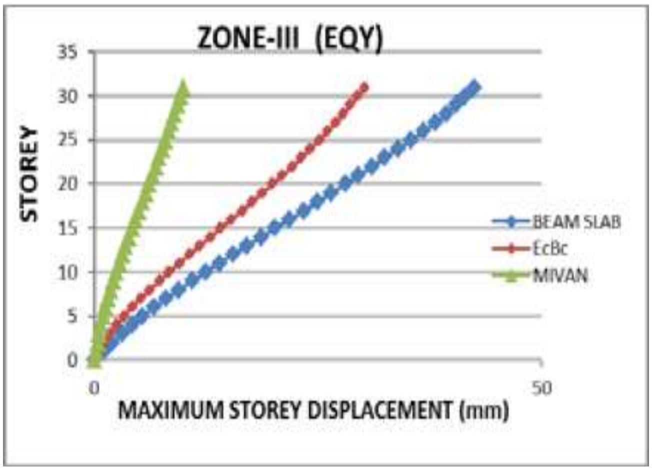


Fig. 5 Zone–III Maximum Storey Displacement vs Storey level for EQX & EQY

2) Zone – IV

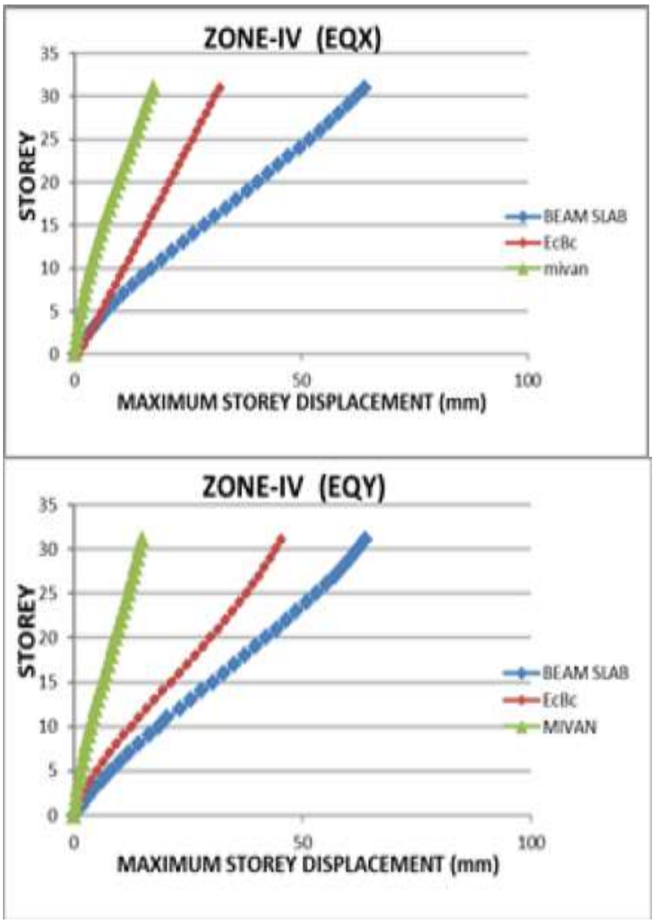


Fig. 6 Zone–IV Maximum Storey Displacement vs Storey level for EQX & EQY

3) Zone – V

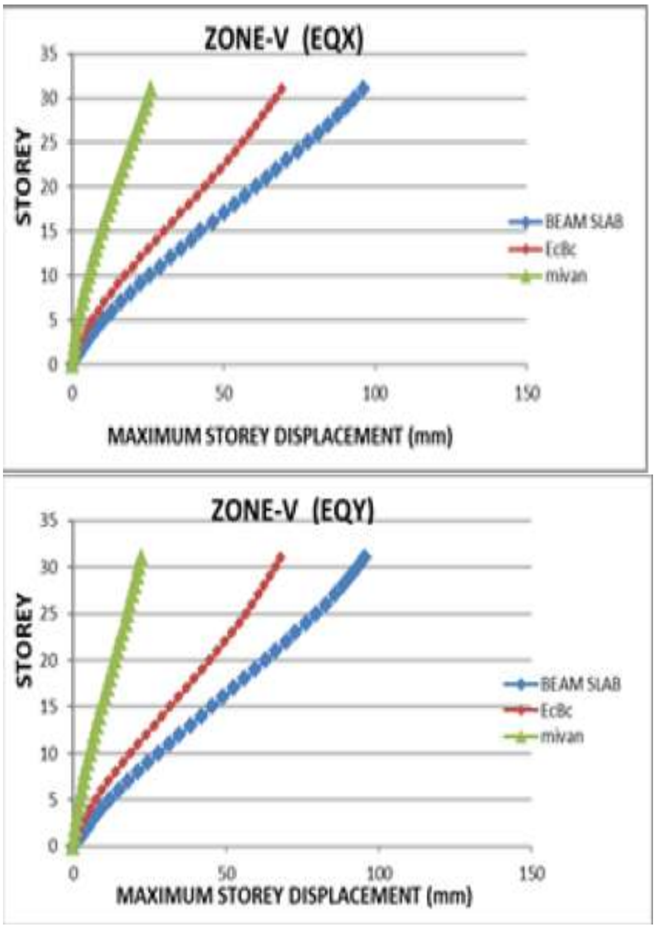


Fig. 7 Zone–V Maximum Storey Displacement vs Storey level for EQX & EQY

The limiting value for Maximum Storey Displacement for Earthquake case is 0.004 times of total height (H/250) of the building.

The figure 5 to figure 7 represents different zones with different structural systems with maximum storey displacement. Ec Bc systems and Mivan are the high stiffness structures will have less displacement compared to beam slab systems with high flexibility.

4.4 Maximum Storey Drift

Storey drift is the difference between displacements of two stories to the height of one story.

$$\text{Storey drift} = \frac{\textit{Difference between displacements of two stories}}{\textit{Height of one storey}}$$

Figure 8 to Figure 10 represents different zones with different structural systems storey level plotted vs. storey drift.

1) Zone – III:

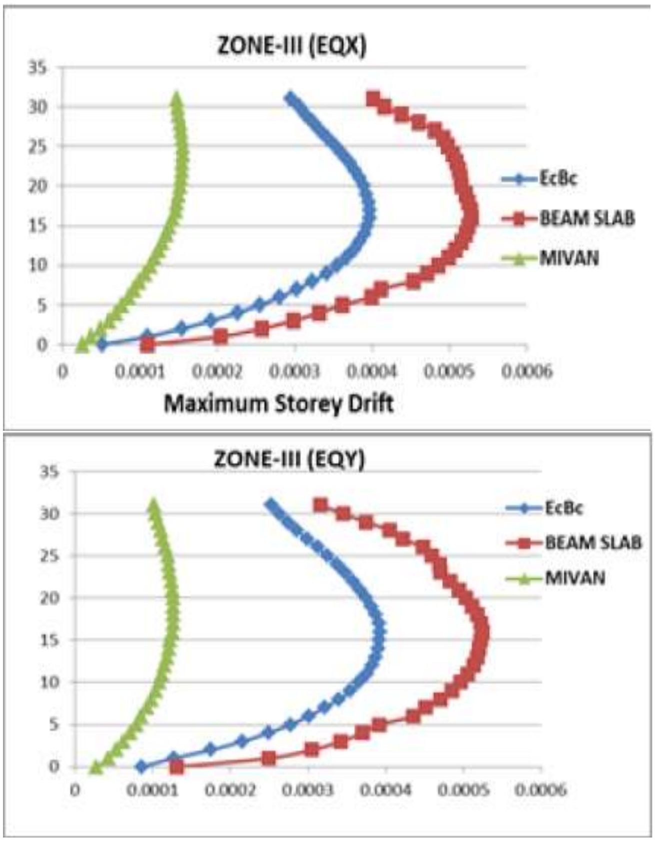


Fig. 8 Zone–III Maximum Storey Drift vs Storey level for EQX & EQY

2) Zone – IV:

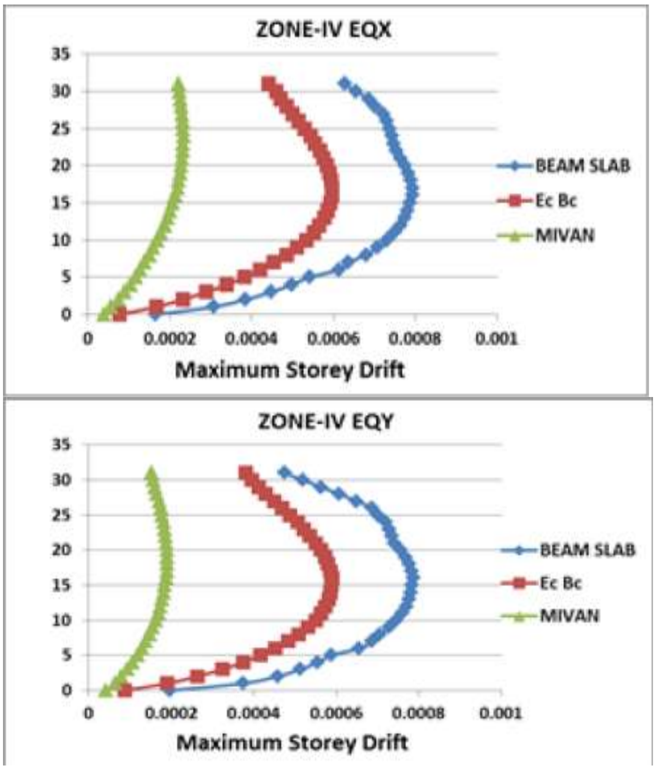


Fig. 9 Zone–IV Maximum Storey Drift vs Storey level for EQX & EQY

3) Zone – V:

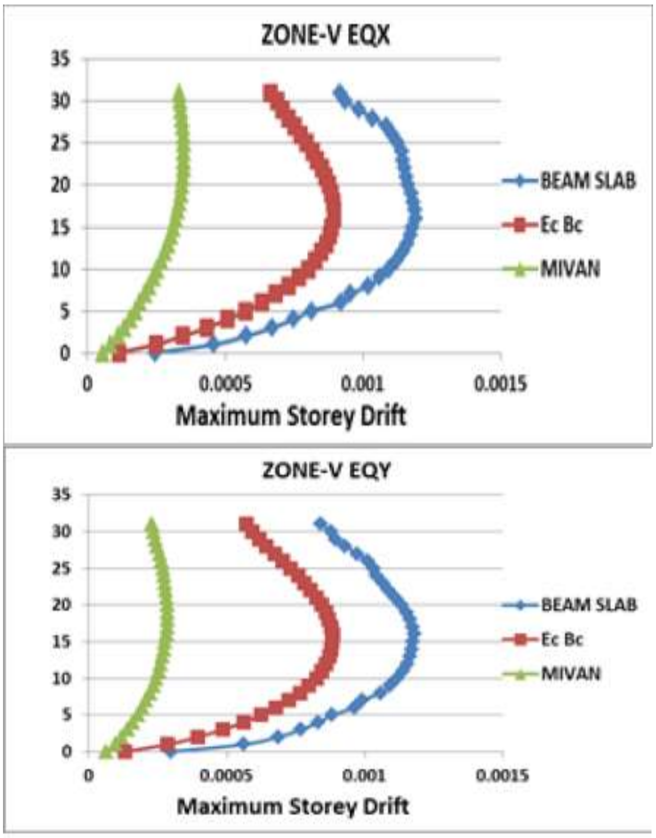


Fig. 10 Zone–V Maximum Storey Drift vs Storey level for EQX & EQY

The limiting value for Maximum Storey Drift for Earthquake case is 0.004 times the storey height (h/250).

Maximum storey drift is similar to storey displacements, but with respect to one storey.

4.5 Cost Estimation Results

Figure shows the plot of Cost Estimation of different structural systems for different zones.

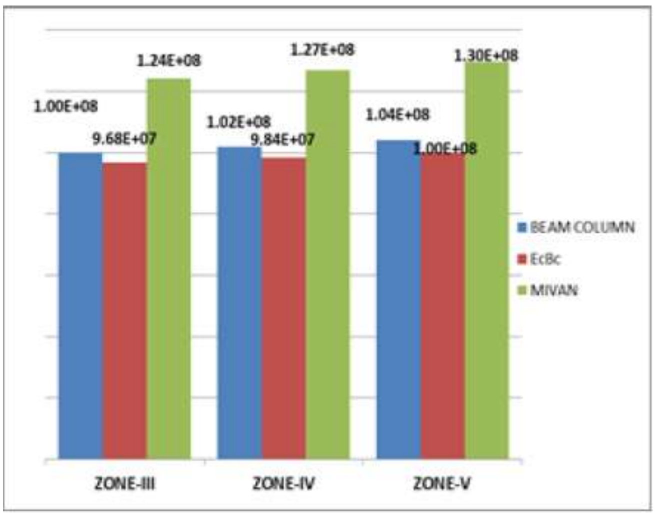


Fig. 11 Cost Estimation (Rs.)

Figure 11 represents the results of different zones with different structural systems cost estimation. By minimizing the steel quantity, we can obtain most economical structural system. Cost increases with increase in steel quantity in shear walls, beams and columns in Ec Bc systems compared with the Mivan systems and beam slab with more number of structural elements. The cost of Mivan systems increases compared to all other structural systems as it consists number of shear walls both internally and externally which require large quantity of steel, as we know increase in steel quantity increase cost. Whereas in Ec Bc system have less cost comparatively as it consists only external shear walls and it acts as cuboid systems with internal part consists less structural elements with absence of beams, the slabs directly rest on columns.

5. CONCLUSION

In this dissertation, efforts are made to understand the performance evaluation of new form of structural system i.e. External core and beamless ceiling (EcBc) technology. Various analytical parameters which govern the design of high rise structures has been tabulated and also comparative study with other commonly used structural systems has been performed.

Based on the results and discussions following conclusions were drawn:

- The structures with lesser value of time period (in case of EcBc, mivan system) attract large seismic forces due to large spectral accelerations along with small drift or lateral displacement. It can be observed from the results that the time period in case of mivan system and EcBc system is less when compared to framing system.
- With the help of this new system, reduction in storey displacement at top is 62% along X-direction and 55% along Y-direction for earthquake loads when compared to that of conventional system.
- In case of the Mivan system, reduction in storey displacement is 90% along X-direction and 92% along Y-direction for earthquake loads when compared to that of conventional system.
- Reduction in the storey drift is 57.08% along X-direction and 51.5% along Y-direction for earthquake loads in case of EcBc system compared to beam column along Y-direction in case of mivan system compared to beam column system.
- Brings the most practical solutions to the speed and structurally most efficient, economy to the construction technology for tall residential buildings.
- Freedom for conversion of usage of the building to commercial-residential purpose.

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