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Seismic Analysis of Monolithic Coupling Beams Considering Effect of Dimensions of Coupling Beam on Shear Wall

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ABSTRACT

This paper presents a study deals with effect of coupled shear wall under seismic forces. The analysis of high rise building with different height 15, 25, and 35 stories building are evaluate the effect of span/depth ratio and aspect ratio of height of building to width of building effect on coupling beam. The analysis of a RC high rise building is done by using ETABS software in this study. The behavior of coupled shear wall is mainly due to coupling beam.

Keywords : Coupling Beam, Coupled Shear Wall, Base Moment, Coupling Degree, Seismic Response, Drift, High Rise Building

I. INTRODUCTION

A coupled shear wall is part of a shear wall system, made of coupling beams and wall piers . It provides more openings , which increase the functional flexibility in architecture . Furthermore , by coupling individual flexural walls , the lateral loads resisting behavior changes to one where overturning moments are resisted partially by an axial compression–tension couple across the wall system rather than by the individual flexural action of the walls.

The key parameter in coupled shear walls, stiffness ratio of coupling beams to wall piers, is a representative of the degree of coupling between wall piers. Over coupling should be avoided, which causes the system to act as a single pierced wall with little frame action. Similarly, light coupling should also be avoided as it causes the system to behave like two isolated walls. Since the coupling action between wall piers is developed through shear force in the coupling beams, correct modeling of coupling beams may substantially affect the overall response of coupled shear walls.

COUPLING BEAM

Coupling beams are a very important member of a lateral force resisting system. It couples or combines two independent systems.

"when two independent shear walls or concentric braced frames or anything that is helping to resist lateral loads and you want to connect them to reduce the overturning effect or increase the overall stiffness of the system then you will use a coupling beam to connect both the systems."

Coupling beam should be designed in such a way that over coupling and under coupling is prevented or avoided, because the former would make the system to behave as a single solid wall with small frame action and the latter will cause the system to act like two separated walls.

Moreover, if coupled beam proportioned properly above second floor of building, plastic hinges are developed and subjected to similar rotations at the beam end over structure height at the same time.

This lead to distribute input energy dissipation over the height of the structure in the coupling beams instead of concentration mostly in the wall piers of the first story.

The main function of coupling beam is dissipation of energy and improving stiffness and strength of the lateral load system of the structure.

Favored coupling beam performance is obtained when it is designed to be adequately strong and stiff. Additional, coupling beams should yield before the wall piers, exhibit ductile behavior, and possess considerable energy absorption characteristics.

“The coupling beams provides transfer of vertical forces between the adjacent walls, which is creates a frame-like coupling action that is resists a portion of the total overturning moment induced by the seismic action.

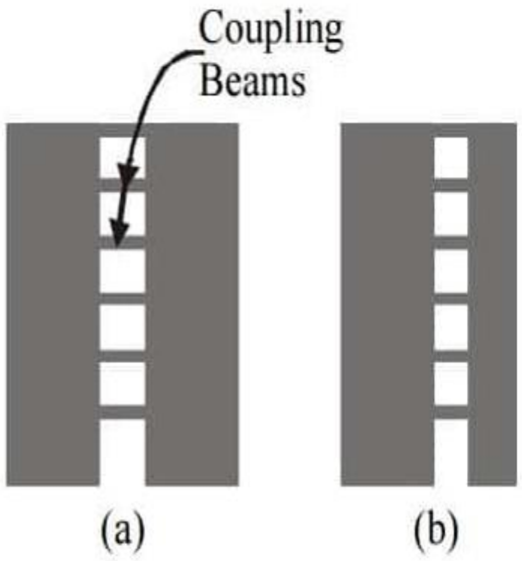

Figure 1: example of coupling beam in structure

COUPLING DEGREE

The total base moment, M_w of the coupled wall structures.

$$M_w = M_{tw} + M_{cw} + N_{cwb}L_c$$

Where, M_{tw} and M_{cw} are the base moments in the tension and compression side walls, respectively, N_{cwb} = N_{twb}, and L_c is the distance between the centroids of the tension and compression side walls. Then, the contribution of the wall axial forces from coupling to the total lateral resistance of the system can be expressed by the Coupling Degree.

$$CD = \frac{N_{cwb}L_c}{M_w} = \frac{N_{cwb}L_c}{M_{tw} + M_{cw} + N_{cwb}L_c}$$

II. METHOD OF ANALYSIS

The analysis will be carried out by preparing different models in ETABS 2016 software. Equivalent static analysis and response spectrum analysis is carried out using guide lines according to IS:1893-2002.

III. MODELLING PARAMETERS

Type of frame: Special RC moment resisting frame fixed at the base

Seismic zone: IV

Number of storey: 15,25 and 35

Type of soil : Hard

Floor height: 3 m

Depth of Slab: 150 mm

Size of beam: (300 × 600) mm

Thickness of shear wall : 200 mm

Thickness of coupling beam : 200 mm

Spacing between frames: 4.5 m along x

and y-directions

Live load on floor: 3 KN/m^2

Materials: M 30 concrete, Fe 415 steel Material

Damping of structure: 5 percent

Response spectra: As per IS1893(Part-1) : 2002

Column size : 1-10 story : (950×950) mm

11-20 story: (750×750) mm

21-30 story: (600×600) mm

31-35 story: (500×500) mm

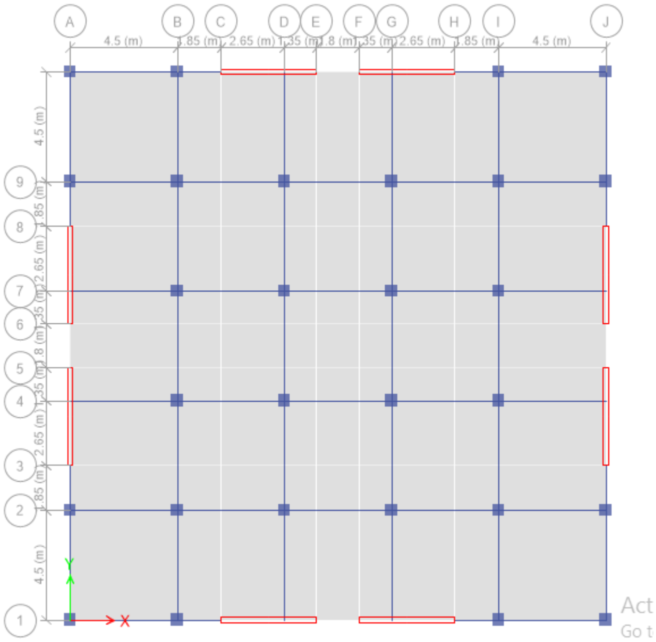

Figure 2: Plan of a structure

IV. RESULTS AND DISCUSSION

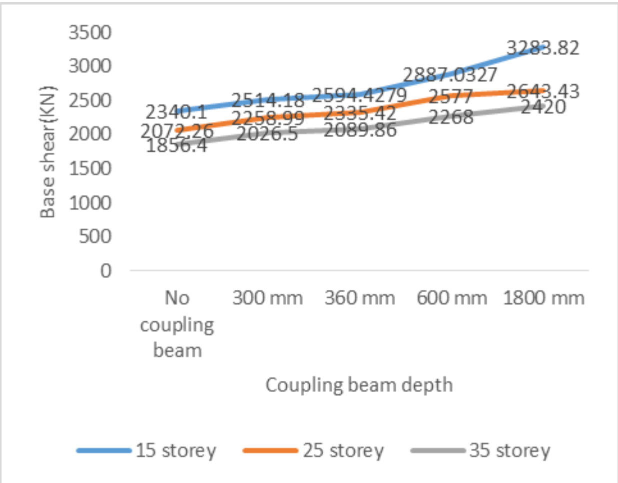

Figure 3: Comparison of Base shear

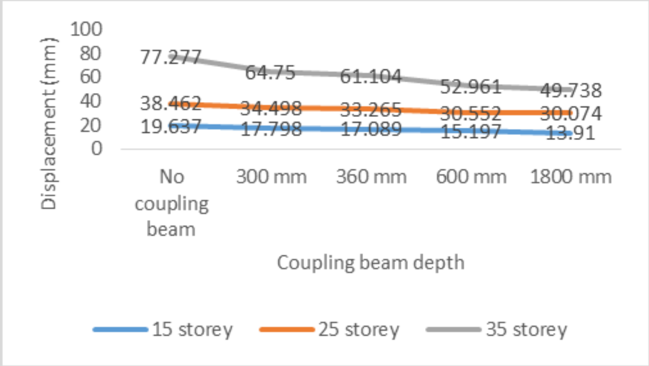

Figure 4: Comparison of Displacement

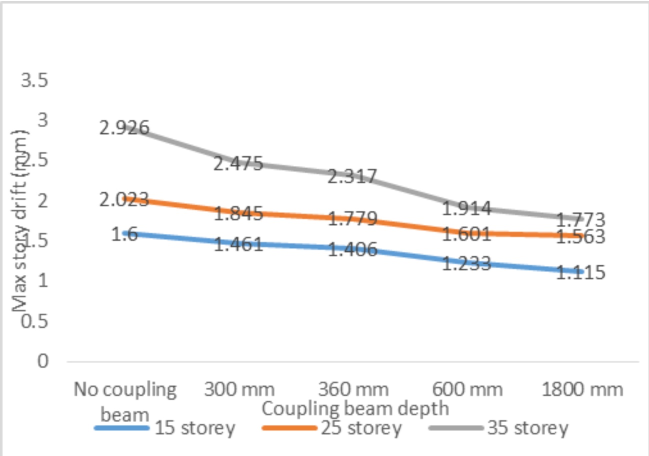

Figure 5: Comparison of Max story drift

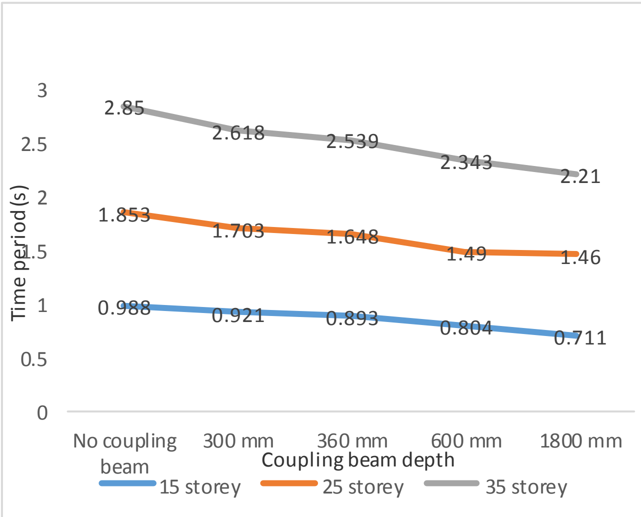

Figure 6: Comparison of Time period

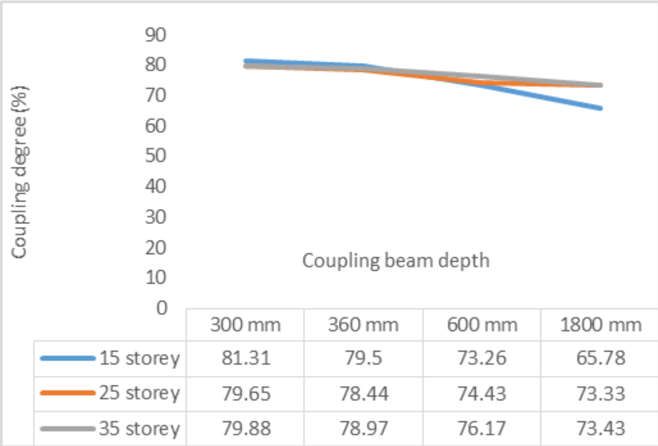

Figure 7: Comparison of Coupling degree

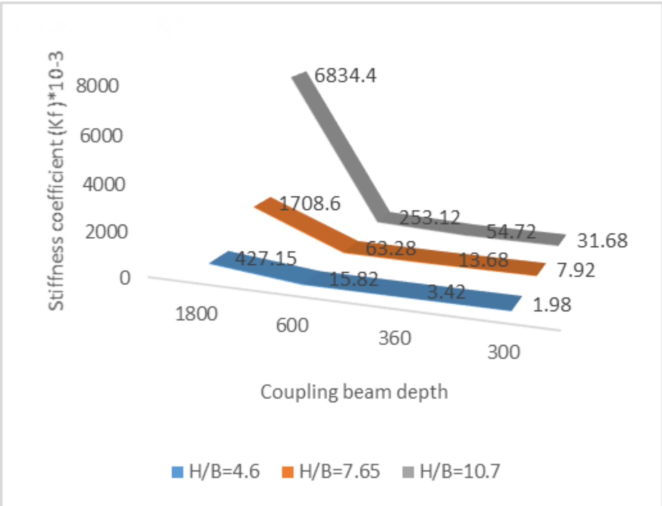

Figure 8: Comparison of Stiffness coefficient

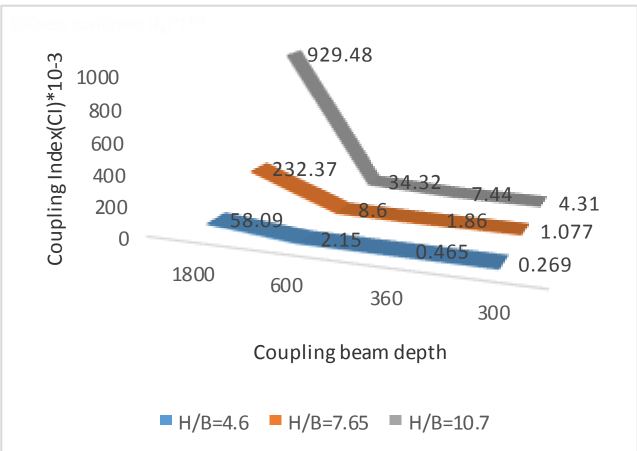

Figure 9: Comparison of Coupling Index

V. CONCLUSION

- From the result it is observed that for hard soil stratum, lateral displacement is maximum for 35 storey with no coupling beam as compared to the other model and minimum for 15 storey with 1800mm depth coupling beam.
- Base shear is maximum in 15 storey building with 1800mm depth of coupling beam as compared to the other model and minimum for 35 storey with no coupling beam for hard soil .
- Drift is maximum for 35 storey with no coupling beam as compared to the other model and minimum for 15 storey with 1800mm depth of coupling beam for hard soil.
- Coupling degree is decreases as depth of coupling beam increases.
- As the depth of coupling beam decreases, stiffness coefficient and coupling index decreases.
- Time period is decreases as the depth of coupling beam increases.

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