Seismic Response of Buildings with Column Reinforcement Lapped Just Above Floor Level

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ABSTRACT

The response of beam-column joints have long been recognized as a significant factor that affects the overall behavior of reinforced concrete (RC) framed structures subjected to large lateral loads. The reversal of forces in beam-column joints during earthquakes may cause distress and often failure, when not designed and detailed properly. The principle objective of this work is to analyze several "G+10" storey buildings having reinforcement joint (lap) just above the floors. An attempt is made to study the behavior of such structures with the conventional modeling. As a common practice, the structures are constructed by lapping the 100% of the reinforcement just above the floor instead of lapping it at mid height. It is assumed that column joints near the base where 100% lapping is being done, behaves as a hinge which will transfer only vertical/horizontal loads without moments. The response of such structure is compared with those where the detailing is done properly by maintaining the reinforcement joint at mid height and not more than 50% lapping is done.

Key words: column joints, joints in RCC structures.

I. INTRODUCTION

Column joints in a reinforced concrete moment resisting frame are critical parts for transfer of loads effectively between the connecting elements (i.e. beams and columns) in the structure. In the analysis of reinforced concrete moment resisting frames the joints are generally assumed as rigid. In countries like India, the joint design is usually given lesser attention being restricted to provision of sufficient anchorage for beam longitudinal reinforcement. This may be acceptable when the frame is not subjected to earthquake loads. There have been many catastrophic failures reported in the past earthquakes, in particular with Turkey and Taiwan earthquakes occurred in 1999, and in bhuj Gujrat earthquake which have been attributed to column joints. Unsafe design and detailing within the joint region make unsafe and unwarned the entire structure, even if other structural members confirm to the design requirements. The paper is aimed by comparing the forces occurred in buildings with poor column joints with hinges (as detailed and constructed without seismic considerations) and with detailed as per recommendations that making designers aware of the theoretical background on the design of column joints highlighting important parameters affecting seismic behavior of joints.

II. PERFORMANCE ANALYSIS: ANALYSIS OF G+10 BUILDING MODELS

Several models of (G+10) buildings with storey height 3.15m, 3.6m and 4.2m are analysed. Each of these floor height are modeled for different bays in each direction (like 4 x 4 bays , 4x5 bays and 5 x 5 bays) with different bay widths. The behavior of Exterior, edge and interior (C1, C2, and C3) are studied and the response is compared. The behavior of peripheral, outer bay and inner bay beams (B1, B2 and B3) is also studied. An unsymmetrical building is chosen for case study for the purpose of authentication of the symmetrical models studied above.

The responses of all above models are studied by applying the Earthquake force equivalent to 0.3g acceleration.

III. COMPARISION AND CONCLUSIONS

All total nine models are studied along with the case study of unsymmetrical building. Every Model is prepared as a conventional and as modified hinge joint at base due to critical location of lap. The response is compared in terms of Axial Force, Bending Moment and Shear force in columns as well Bending Moment and shear force in the beams.

Table 1: Comparison of Axial Force in Columns (Model 1, Floor height 3.15m, 4 x 4 bays)

GROUP	**A.F. (Modified Model) kN**	**AF (Conventional Model) kN**	**% Difference**
C1	2.4E3	2.46E3	2.43
C2	3.69E3	3.7E3	0.27
C3	4.88E3	4.83E3	1.02

The trend of axial force is same and not significant in all bays like 4x4, 4x5 and 5x5 hence not shown. The other response is graphically presented here after.

Table 2: Comparison of Shear Force in Columns (Model 1, Floor height 3.15m, 4 x 4 bays)

GROUP	**S.F. (Modified Model) kN**	**S.F (Conventional Model) kN**	**% Difference**
C1	56.620	45.869	18.98
C2	53.036	53.842	1.51
C3	53.925	55.200	2.36

The response for other models is graphically presented here after

Table 3: Comparison of Bending "My" in Columns (Model 1, Floor height 3.15m , 4 x 4 bays)

GROUP	**My (Modified Model) kNm**	**My (Conventional Model) kNm**	**% Difference**
C1	133.927	71.396	46.69
C2	152.069	81.879	46.15
C3	153.097	83.070	45.74

The response for other models is graphically presented here after

Table 4: Comparison of Bending "Mz" in Columns (Model 1, Floor height 3.15m, 4 x 4 bays)

GROUP	**Mz (Modified Model) kNm**	**Mz (Conventional Model) kNm**	**% Difference**
C1	134.761	127.491	5.70
C2	167.062	129.634	22.4
C3	169.864	131.940	22.32

The response for other models is graphically presented here after

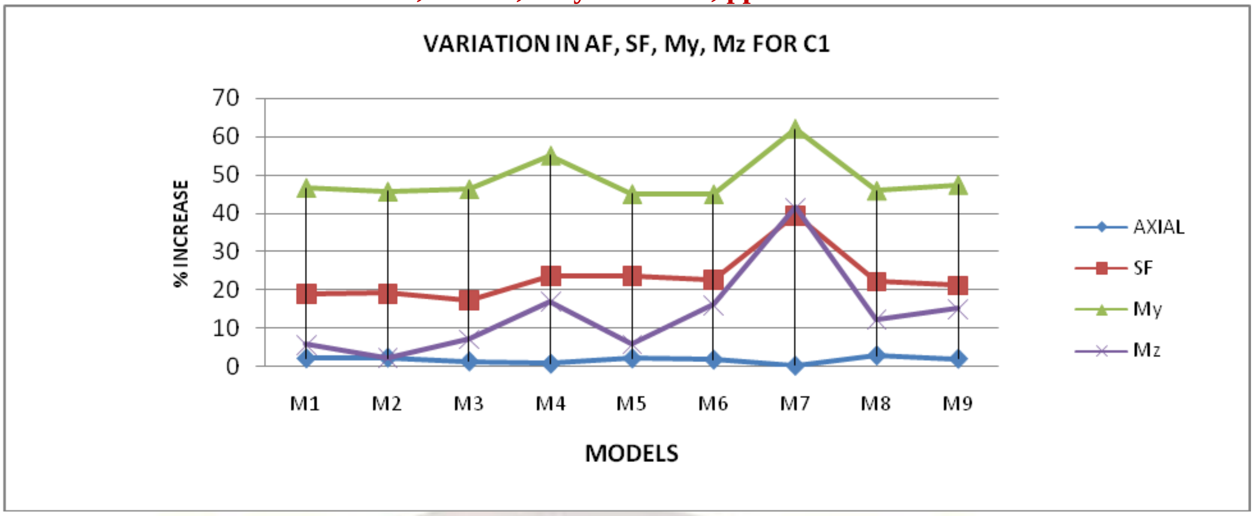

Chart 1: Variation in A.F., S.F., and Bending moments for column group "C1"

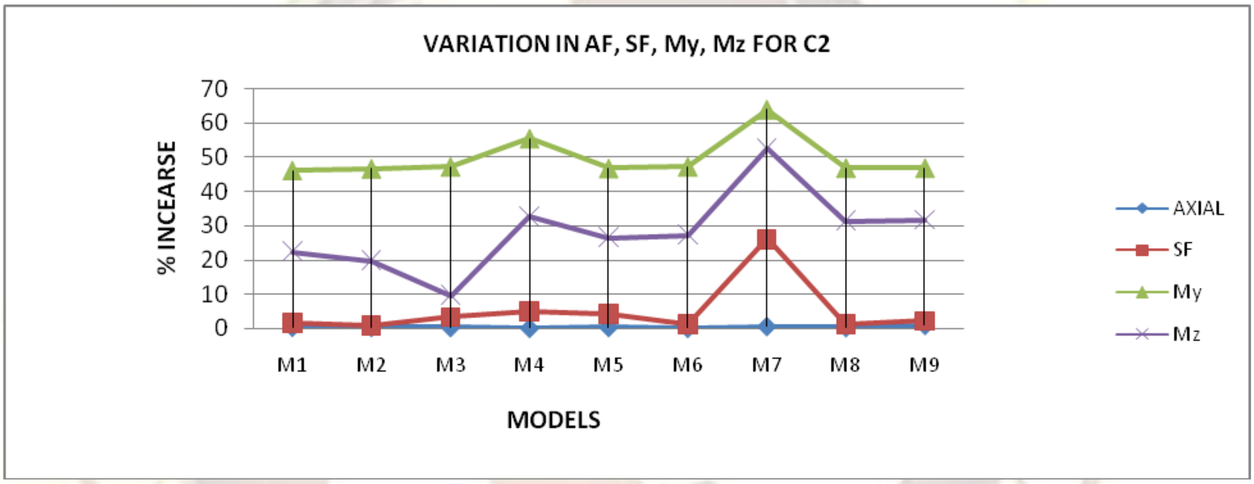

Chart 2: Variation in A.F., S.F., and Bending moments for column group "C2"

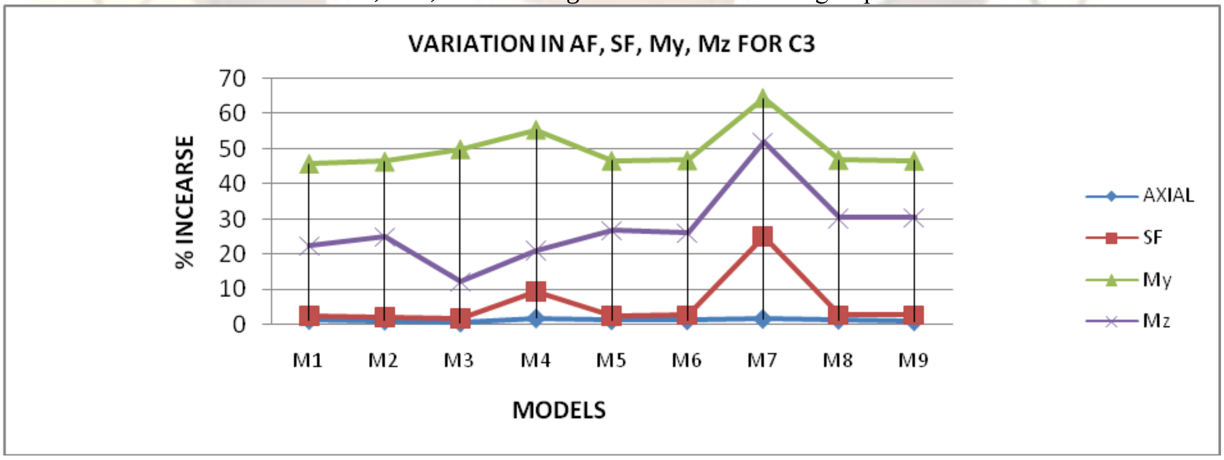

Chart 3: Variation in A.F., S.F., and Bending moments for column group "C3"

IV. CONCLUSION:

The output of the study is really an attraction to the structural engineer. Though, there is no significant change in Axial force in columns (as it should be), the variation in Shear force and Bending Moment is of very much concern. The variation in shear force upto the extent of 40% where as the variation in My moment is having maximum value of 65% which really cannot be a tolerable. Hence, it is recommended to analyse the RCC framed structure by considering the hinges at the base of columns at every floor for the purpose of safety at least if someone can't rigorously go for the joint design.

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