Study Of Exterior Reinforced Concrete Beam Column Joint

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Abstract — Beam–column joints in higher seismic zones are critical regions in the reinforced concrete framed structure. For proper anchorage with joints, details of reinforcement are essential, innovative joint designs that are able to reduce reinforcement congestion, the use of crossed inclined bars in the joint region is one of the most effective ways to improve the seismic resistance of exterior reinforced concrete beam-column joints. Beam column joint is an important component of a reinforced concrete moment resisting frame and should be designed and detailed properly, especially when the frame is subjected to earthquake loading. Non linear analysis is carried out in STAAD Pro software.

Keywords — Exterior beam column joint, reinforced concrete, earthquake resistant structure.

I. INTRODUCTION

Concrete is one of the most widely used construction material. It has good compressive strength, durability, fire resistance and can be cast to fit any structural shape. Earthquakes have exposed the vulnerability of existing reinforced concrete beam column joints to seismic loading. Considerable efforts have been made in recent years to develop improved seismic design provisions for reinforced concrete beam column joint. It is important that members are able to withstand large deformations whilst maintaining strength capacity in situations where a requirement to withstand significant overloads arises. Beam column joints in a reinforced concrete moment resisting frame are crucial zones for transfer of loads effectively between the connecting elements (i.e. beams and columns) in the structure. The quickness and ease of construction in the concrete is a great advantage, but it has its own shortcomings. It has poor tensile strength and limited impact resistance. An important feature of the coarse aggregate matrix interface is that it contains very fine cracks even before any load has been applied to the concrete. In the analysis of reinforced concrete moment resisting frames, the joints are generally assumed as rigid.

II. LITERATURE STUDY

1. Naveen Hooda et al. “An Experimental Investigation on Structural Behaviour of Beam Column”

Conventional concrete loses its tensile resistance after the formation of multiple cracks. However, fibrous concrete can sustain a portion of its resistance following cracking to resist more loading. The strength of concrete is appreciably increased by the crack arresting mechanism of the fibres and the ultimate strength is also increased because extra energy is needed to cause fracture of the fibre reinforcing the concrete. Beam-column joints have a crucial role in the structural integrity of the buildings. For this reason they must be provided with adequate stiffness and strength to sustain the loads transmitted from beam and columns. For adequate ductility of beam-column joints, use of closely spaced hoops as transverse reinforcement was recommended. In the present study an attempt has been made to investigate the behaviour of exterior beam-column joint with different detailing of reinforcement, different spacing of connecting ties and with different percentage of steel fibres. It was also observed in the study that the deflection and curvature also increases with the decrease in spacing of hoops/tie.


The performance of exterior beam column joints with non-conventional reinforcement detailing was examined experimentally and numerically. Aims to study the seismic performance of exterior beam column joint with non-conventional reinforcement detailing. Four joint sub assemblages were tested under reverse cyclic loading applied at beam end. The specimens were sorted into two groups based on the joint reinforcement detailing. The experimental investigations are validated with the analytical studies carried out by finite element models using ANSYS. The experimental results and analytical study indicate that additional cross bracing reinforcements improves the seismic performance. The test specimens with diagonal confining bars have shown better performance, exhibiting higher strength with minimum cracks in the joint. From the analytical study it is observed that the provision of cross diagonal reinforcement increased the ultimate load carrying capacity and ductility of joints in the both upward and downward loading conditions.

III. REINFORCED CONCRETE

Tensile strength of concrete is typically 8% to 15% of its compressive strength. This weakness has been dealt with over many decades by using a system of reinforcing bars (rebars) to create reinforced concrete; so that concrete primarily resists compressive stresses and rebars resist tensile and shear stresses. The longitudinal rebar in a beam resists flexural (tensile stress) whereas the stirrups, wrapped around the longitudinal bar, resist shear stresses. In a column, vertical bars resist compression and buckling stresses while ties resist shear and provide confinement to vertical bars. Use of reinforced concrete makes for a good composite material.

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with extensive applications. Steel bars, however, reinforce concrete against tension only locally.

IV. BEAM COLUMN JOINTS

The behavior of reinforced concrete moment resisting frame structures in recent earthquakes all over the world has highlighted the consequences of poor performance of beam column joints. Beam column joints in a reinforced concrete moment resisting frame are crucial zones 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. For adequate ductility of beam column joints, use of closely spaced hoops as transverse reinforcement was recommended in the IS13920-1993. Due to the congestion of reinforcement, casting of beam column joint will be difficult and will lead to honeycombing in concrete. In Indian practice, the joint is usually neglected for specific design with attention being restricted to provision of sufficient anchorage for beam longitudinal reinforcement. Beam column joints have a crucial role in the structural integrity of the buildings. Thus, beam column joints must be designed to resist earthquake effects. In fact failure due to over loading should occur in beams through large flexural cracking and plastic hinge formation, and not in columns. The shear in the joint is equal to:

\[ V_j = \sigma_y A_s - V_{col} \]

Where

\( V_j \) = Shear in the joint

\( A_s \) = Area of tension steel

\( V_{col} \) = shear in column

The joint shear causes diagonal tension and compression in the joints.

V. TYPES OF JOINTS IN FRAME

The joint is defined as the portion of the column within the depth of the deepest beam that frames into the column. In a moment resisting frame, three types of joints can be identified viz. interior joint, exterior joint and corner joint. When four beams frame into the vertical faces of a column, the joint is called as an interior joint. When one beam frames into a vertical face of the column and two other beams frame from perpendicular directions into the joint, then the joint is called as an exterior joint. When a beam each frames into two adjacent vertical faces of a column, then the joint is called as a corner joint. The severity of forces and demands on the performance of these joints calls for greater understanding of their seismic behaviour. These forces develop complex mechanisms involving bond and shear within the joint.

(1) Interior joint

(2) Exterior joint

(3) Corner Joint

VI. REQUIREMENT OF BEAM COLUMN JOINT

The essential requirements for the satisfactory performance of a joint in an RC structure can be summarized as follow:-

(1) A joint should exhibit a service load performance equally to or greater than that of the members it joins, that is, the failure should not occur within the joints. If at all, failure due to overloading should occur in beam through larger flexural cracking and plastic hinge formation, and not in column.

(2) A joint should possess a strength that corresponds at least to the most adverse load combinations that the adjoining members could possibly sustain repeatedly several times, if possible.

(3) The strength of the joint should not normally govern the strength of the structure, and its behaviour should not hinder and development of the full strength of the adjoining members.

(4) Ease of fabrication and good access for placing and compacting concrete are the other significant parameter of joint design.

VII. MODELING OF BEAM COLUMN JOINT

Beam column joint has been analysed and designed using STAAD Pro. A beam column joint has been modeled to a scale of 1/5 th from the prototype and the model has been subjected to cyclic loading to find its behaviour during earthquake.
VIII. CONCLUSION

In the present study of beam column joint was analysed and designed using STAAD Pro software. The future work is experimentally carried out to provide sufficient closer spacing of transverse reinforcement in beam column joints to increase the strength and ductility during earthquake. It will lead to reduce the larger cracks appear on a structure and helps to improving the seismic performance.

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