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A Review on "Analysis of Beam-Column Joint Subjected To Seismic Lateral Loading"

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Abstract: In reinforced concrete structures, portions of columns that are common to beams at their intersections are called Beam-Column Joint. Beam-column joint is an important part of reinforced concrete frames in terms of seismic conditions. The two major failure at joints are, joint shear failure and end anchorage failure. As we know that nature of shear failure is brittle so the structural performance cannot be accepted especially in seismic conditions. This study presents design as well as detailing of beam-column joint of the structure. Design and detailing provisions on beam-column joints in IS13920:1993 do not adequately address prevention of anchorage and shear failure during severe earthquake shaking. From this paper we get a review on the behavior of joints under ACI 352R-02 and IS13920:1993 code. A careful study and understanding of joint behavior is essential to arrive at a proper judgment of the design of joints. This paper presents seismic action on various type of joints and even on the parameters which affect joints and all component parts will be check for stability and strength.
Keyword: Beam-column joint, seismic action, shear reinforcement, shears failure, reinforced concrete frames, moment resisting frame.

I. INTRODUCTION

Structures subjected to earthquake shaking at their base oscillate back and forth in all three directions. Under low levels of shaking, their amplitudes of shaking and directions of shaking are dependent on how they are proportioned geometrically and in terms of stiffness throughout the building in plan and elevation. Under strong earthquake shaking, buildings undergo damage also. Controlling the damage type and sequence of damage in various structural elements is the main focus of *earthquake-resistant design*. It is possible to get a reasonable understanding of the overall mechanism of failure of the building by suitable nonlinear static analysis. Many deficiencies discussed in this document can be identified at the design stage itself, and the structural configurations and design and detailing of members modified to make the building resist the earthquake effects generated in the building during strong earthquake shaking. Analysis of damages incurred in moment resisting RC framed structures subjected to past earthquake show that failure may be due to utilization of concrete not having sufficient resistance, soft storey, beam-column joint failure for weak reinforcements or improper anchorage, column failure causing storey mechanism [6]. An earthquake resistant building is able to accumulate a lot of energy without major failure. It will swing and sway and it might be damaged. But it would not collapse before giving very visible signs. Therefore, people would be able to leave the building before it would collapse. An earthquake resistant building, which has been damaged, could most of the time be repaired.

A. Theoretical Development of Beam-Column Joint

Beam-Column Joint is the zone of intersection of beams and columns which enables the adjoining members to develop and sustain their ultimate capacity. The joints should have proper adequate stiffness and strength to resist the internal forces induced by the framing members.Beam-Column joints are the weakest link in RC moment resisting frame.Design and detailing of beam-column joints reinforced concrete frames are critical in assuring the safety of these structures in earthquakes. Such joints should be designed and detailed to Preserve the integrity of the joints sufficiently to develop the ultimate strength and deformation capacities of the connecting beams and columns; Prevent excessive degradation of joint stiffness under seismic loading by minimizing cracking of the joint concrete and by preventing the loss of bond between the concrete and longitudinal beam and column reinforcement; and Prevent brittle shear failure of the joint.As a consequence, seismic moments of opposite signs are develop in columns above and below the joints and at the same time beam moment reversal across the joints.

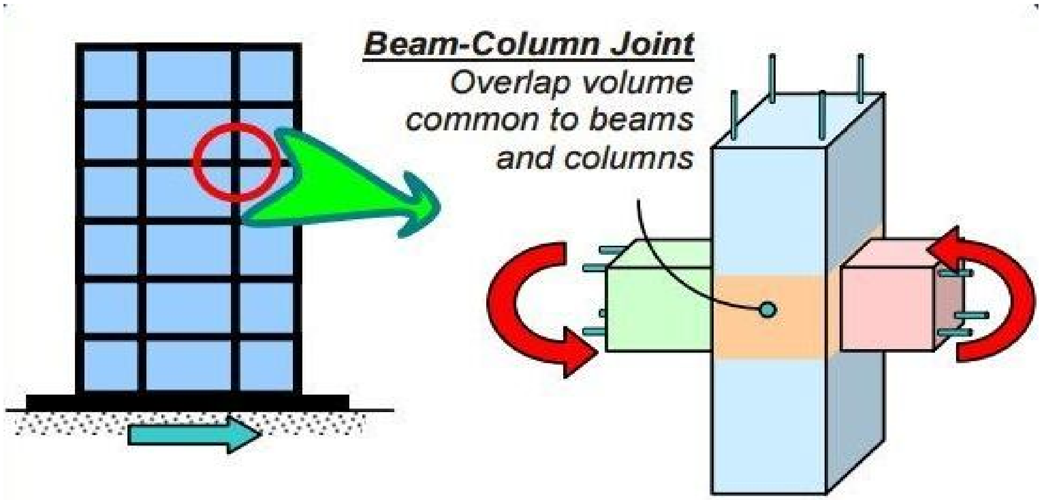

Fig. 1Beam-column joints are critical parts of a building- they need to be designed.

Under the action of seismic forces, beam-column connections are subjected too large shear stresses in the joint region. These shear stresses are a result of moments and shear forces of opposite signs on the member ends on either side of the joint core. Typically, high bond stresses are also imposed on reinforcement bars entering into the joint. The axial compression in the column and joint shear stresses result in principal tension and compression stresses that lead to diagonal cracking and or crushing of concrete in the joint core. Figure 2 shows the geometric distortion of the joint. If column cross-section size is insufficient, the concrete in the joint can develop diagonal cracks.

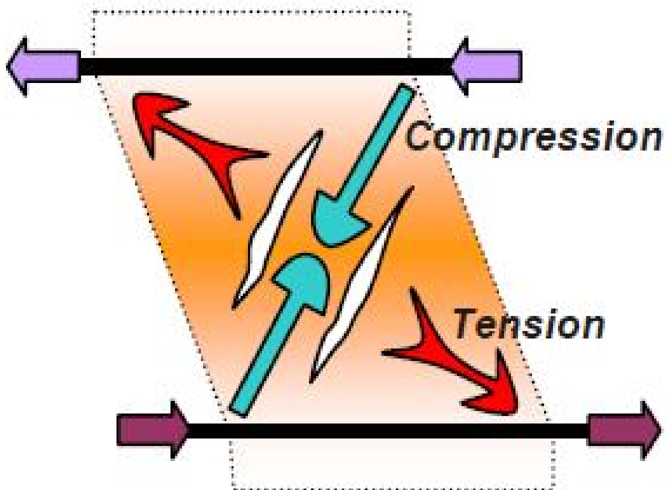

Fig. 2Geometric Distortion of the Joint

The design of Beam-column joint is mainly focused on providing joint shear strength and adequate anchorage within the joint. IS 13920:1993 code of ductile detailing of reinforced concrete structures subjected to seismic forces has given recommendations for the strengthening of the joint [3].

B. Types of Beam-Column Joint

On the basis of location of joint in structure, this paper is mainly focusing on the fundamental differences in the mechanisms of beam longitudinal bar anchorages and the shear requirements, three types of joints such as;

1) Interior Joint
2) Exterior Joint
3) Corner Joint

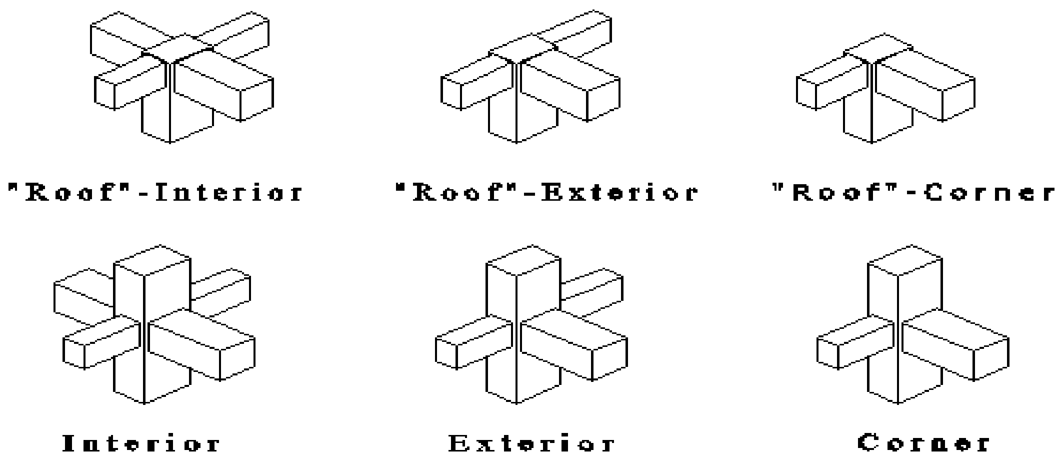

Fig. 3 Typical Beam-Column Joints

1) *Interior Joint:*When four beams frame into the vertical faces of a column, the joint is called as an Interior Joint.

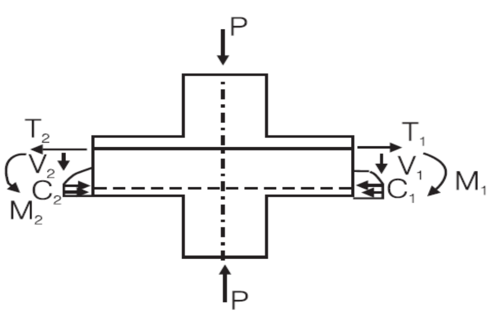

Fig. 3 (a) Gravity loading,

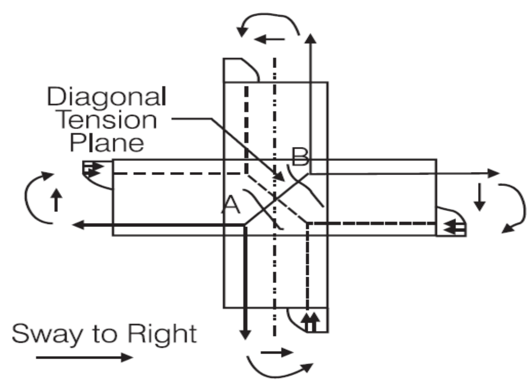

Fig. 3 (b) Seismic loading

2) *Exterior 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.

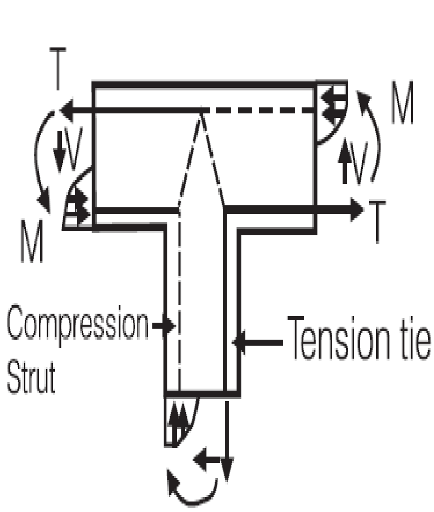

Fig. 4 T-Joints (a) Forces and strut-and-tie model,

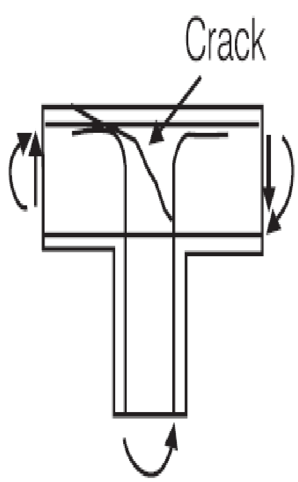

Fig. 4 (b) poor detail,

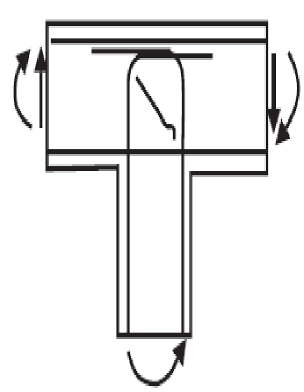

Fig. 4 (c) Satisfactory detail

3) *Corner Joint:* When a beam each frames into two adjacent vertical faces of a column, then the joint is called as a Corner Joint.

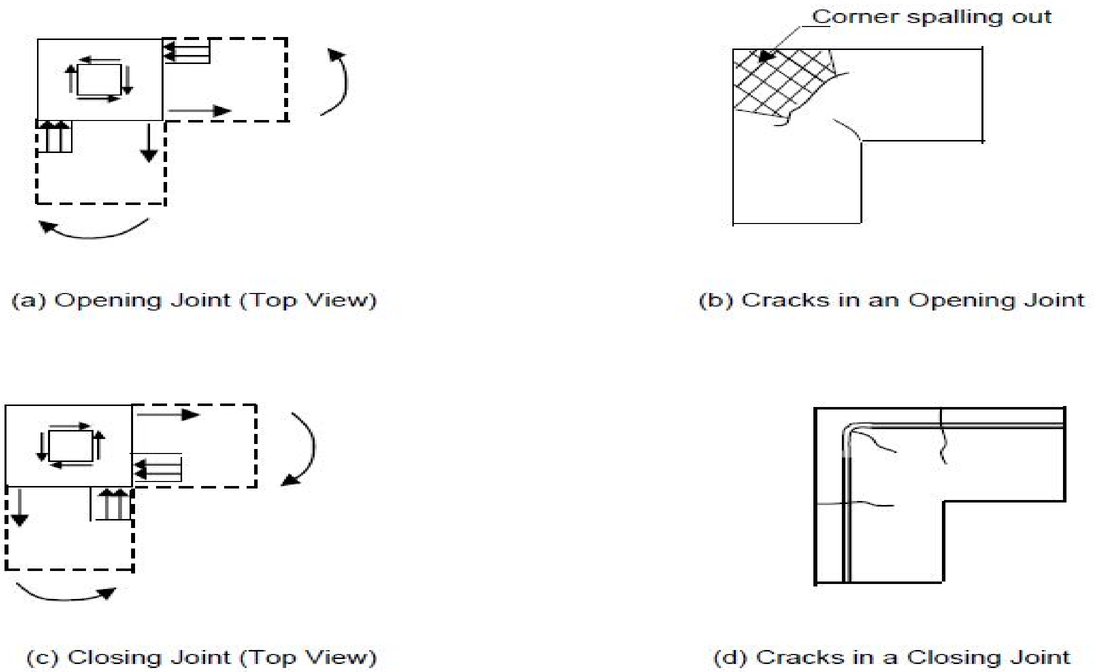

Fig. 5 Corner Joint

II. LITERATURE REVIEW

A. Recommendation for design of Beam-Column Joint in RC Structure (1997)

These recommendations are for determining joint proportions and design of the longitudinal and transverse reinforcement at the intersection of beams and columns in cast-in place concrete frame construction. Because of the use of high-strength materials (concrete and steel), smaller member sections, and larger reinforcing bas, special attention to the design and detailing of the joint has become more important.

B. Dr. S. R. Uma (2006)

presented critical review of recommendations of well established codes regarding design and detailing aspects of beam column joints. The codes of practice considered are ACI 318M-02, NZS 3101 (Part 1) :1995 and the Eurocode 8 of EN 1998-1:2003. All three codes aim to satisfy the bond and shear requirements within the joint. It is observed that ACI 318M-02 requires smaller column depth as compared to the other two codes based on the anchorage conditions. NZS 3101:1995 and EN 1998-1:2003 consider the shear stress level to obtain the required stirrup reinforcement whereas ACI 318M-02 provides stirrup reinforcement to retain the axial load capacity of column by confinement. Significant factors influencing the design of Beam- Column Joints are identified and the effect of their variations on design parameters is compared. The variation in the requirements of shear reinforcement is substantial among the three codes.

C. N. Subramanian and D. S. Prakash Rao (2012),

discussed the behaviour and design of two-, three- and four-member beam - column joints in framed structures are; obtuse and acute angle joints are included. Detailing of the joints based on experimental investigations is also explained. The specifications of American, New Zealand and Indian codes of practice are appraised. An equation for calculating the area of joint transverse reinforcement has been proposed for the Indian code, based on recent research.

D. S. S. Patil and S. S. Manekari (2013),

Studied various parameters for monotonically loaded exterior and corner reinforced concrete beam column joint. The corner as well as exterior beam-column joint is analyzed with varying stiffness of beam-column joint. The behavior of exterior and corner beam-column joint subjected to monotonic loading is different. Various graphs like load vs. displacement (deformations), Maximum stress, Stiffness variations i.e. joint ratios of beam-column joints are plotted.

E. P. Rajaram and G. S. Thirugnanam (2008),

According to them, a two bay five storey reinforcement cement concrete moment resisting frame for a general building has been analyzed and designed in STAAD Pro as per IS 1893:2002 code procedures and detailed as IS 13920:1993 recommendations. A beam column joint has been modeled to a scale of 1/5thfrom the prototype and the model has been subjected to cyclic loading to find its behavior during earthquake. Non linear analysis is carried out in ANSYS software.

III. CONCLUSION

The performance of framed structures depends upon the individual structural elements as well as the integrity of the joints. Based on literature studies the interior, exterior and corner beam-column joints were studied. The behavior and expected performance of flexural members of reinforced concrete moment resisting frames can be realized only when the joints are strong enough to sustain the severe forces set up under lateral loads. The beam-column joint are weakest member in seismic loading and have confined ductility and a little resistance to snaping. Hence, the design and detailing of joints is critical, especially in
Seismic conditions.

Large amount of research carried out to perceive the complex mechanisms and safe behavior of beam-column joints has gone among the codal recommendations. This study shows that there is a enough changes in the codal provisions on beam-column joints and also present a review of design and detailing of beam-column joint of the structure. And its object is to satisfy the bond and shear requirements inside the joints.

IV. ACKNOWLEDGEMENT

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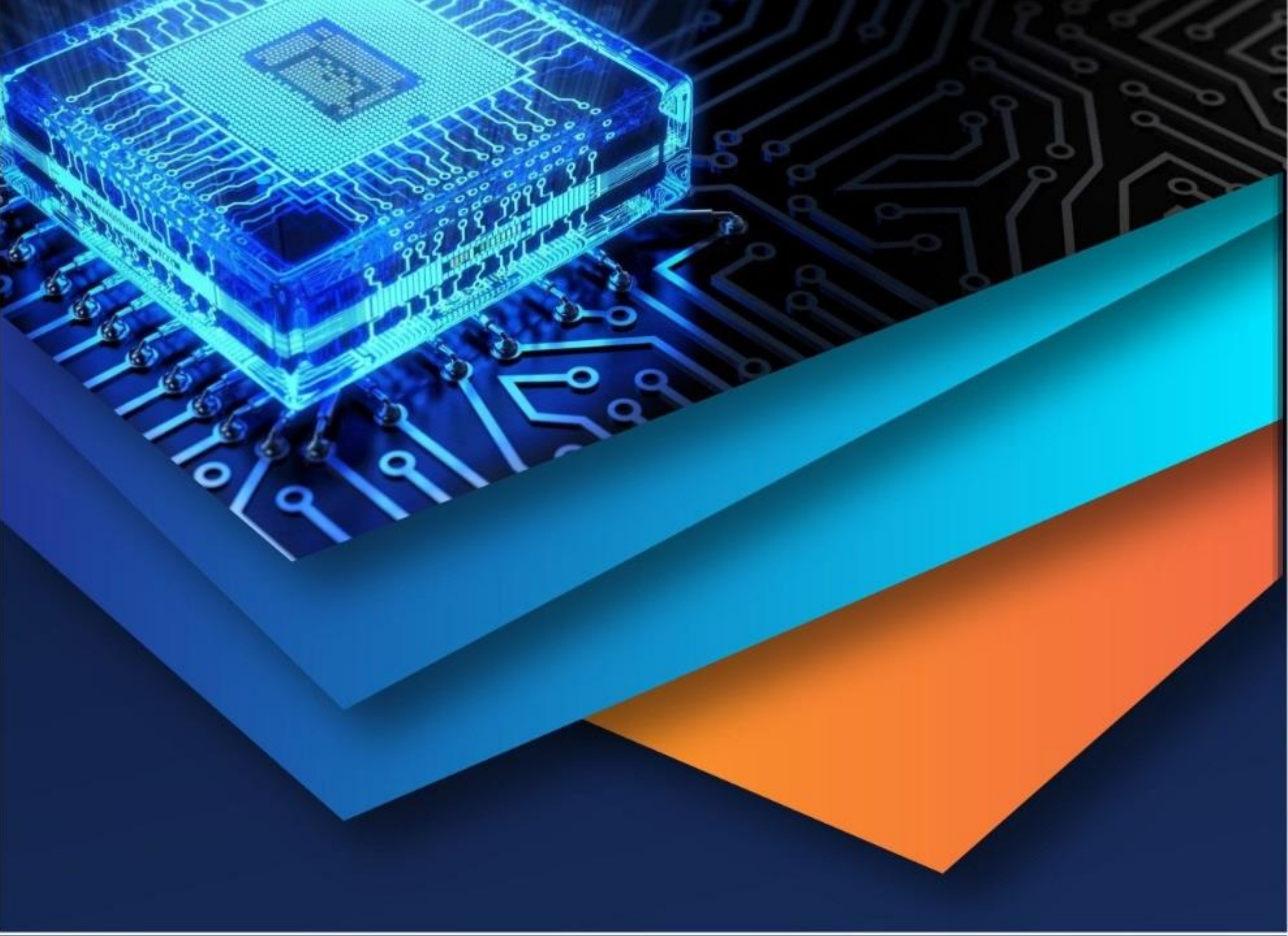
REFERENCES

[1] IS 1893 (Part 1): 2002 "Criteria for earthquake resistant design of structure".
[2] EN 1998-1:2003, Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings, European Committee for standardization, Brussels, 2003, 215 pp.
[3] IS 13920:1993, Indian Standard code of Practice- Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Edition 1.2, Bureau of Indian standards, New Delhi, March 2002, 16 pp.
[4] [4]. ACI 318-2014, Building Code Requirements for Structural Concrete and Commentary, American Concrete Institute, Farmington Hills, 473 pp.
[5] IS 456:2000, Indian Standard code of Practice- Plain and Reinforced Concrete, Fourth Revision, Bureau of Indian standards, New Delhi, July 2000, 100 pp.
[6] ACI-ASCE Committee 352. (2002), 352R-02: Recommendation for design of beam-column joints in monolithic reinforced concrete structures, American Concrete Institute, Farmington Hills, MI., 37 pp.
[7] IS 4326:1993 "Earthquake resistant design and construction of buildings"
[8] S. R. Uma, Department of Civil Engineering, University of Canterbury, March 16 2006, New Zealand "Seismic design of beam-column joints in RC moment resisting frames – Review of codes" Structural Engineering and Mechanics vol. 23, no.5, pg. 579-597.
[9] Dr. N Subramanian, USA (2015), "Design of RC Beam Column Joints"
[10] Clyde C, Pentelides CP, Reaveley LD. Performance-based evaluation of exterior reinforced concrete building joints for seismic excitation. Report PEER 200/05. Pacific Earthquake Engineering Research Center.2000.SUBRAMANIAN. N. and RAO, D.S.P., Seismic design of joints in RC structures. A review, The Indian Concrete Journal, February 2003, Vol. 77, No. 2, pp. 883-892.
[11] S. S. Patil, S. S. Manekari April 2013 " Analysis of Reinforced Beam-Column Joint Subjected to Monotonic Loading" International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 10
[12] P. Rajaram, A. Murugesan and G. S. Thirugnanam, 2010 Experimental Study on behavior of Interior RC Beam Column Joints Subjected to Cyclic Loading" international journal of applied engineering research.



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