A Review "Cyclic Performance of Beam-Column Joint under lateral loading"

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Abstract. Now a day there are fast developing of word population. Its required lot of housing space for living and growing of people on various filed due to less availability of land it's required to construction of tall structure in word. Due to seismic effect on structure damage of structure is very several problems. Out of this all problem beam column joint failure is one of the biggest problem.

In this paper we discuss various studies on problem about seismic effect of beam column joint in different shapes of high rise buildings. Here an overview of past experimental and analytical research carried out by different researcher across the world is presented. Along with this the several parameters affecting the performance of joints are categorized and discussed. Seismic behavior of RC beam-column joint depends on several parameters viz., concrete grade, column axial load, eccentricity, aspect ratio, joint reinforcement, bond strength and infilled frame.

INTRODUCTION

Moment-resisting frames comprise beams, columns, and beam-column joints. Common portion of this beam and column is call as bema column joint. The beam-column connection comprises the joint plus portions of the columns and beams. Bean-column joints are the very important part of reinforce moment resisting frame.

During a seismic activity, response of the structure is mainly affect by the behavior of the joints. The global response of structure depending on ingredient materials used during the contraction of structure, the joints have restricted lateral force carrying capability. Since, the joints have restricted lateral force carrying capability. Once forces larger than those are applied throughout earthquakes, joints occurs severely damages. Repairing of broken portion on joints is tough, and then harm should be avoided. So required proper design and detailing of joint for lateral loading by using standers codes.

If the joints behave in a ductile behavior, the performance generally will be ductile, whereas if the joints perform in a fragile fashion then the structure will display a brittle performance. The joints of old and non-seismically detailed structures are more defenseless and behave poorly under the lateral load.

Due to applying of lateral load, the beam-column joint is exposed to massive shear stress in the joint area. These sheet shear stresses are the result of moments and shear forces of opposite signs at the ends of the member on either side of the joint core. Therefore, high bond stresses are also mandatory for reinforcing bars extending into the joint. Axial pressure inside the column and shear stresses in the joint lead to principal tensile and compressive stresses. Due to this tension and compression at joint region cause of diagonal cracking or crushing of concrete within the joint core. These issues are highlighted in recent past by the injury discovered in devastating earthquakes in numerous countries. Out of this all major earthquake some earthquake history are noted here.

Turkey earthquake on August seventeen, 1999 is a typical example of a beam-column joint failure under the M7.4 earthquake at stricken western Turkey.[Rajagopal, 2014] A broken structure when the Kocaeli earthquake

is shown in Fig. 1. During this year, structure is designed for non-ductile behavior only. So Most of those joint failures Due to non-ductile performance and its poor anchorage of the most reinforcing bars or just inadequate cross reinforcement within the joints core of ferroconcrete moment-resisting frames. The Two major failure modes for the failure at joints are show in below fig. (a) Joint shear failure and (b) Finish anchorage failure.

(a) (b)

FIGURE 1: TURKEY EARTHQUAKE, 1999

On 26 January, 2001 Gujarat facing one of major earthquakes. Due to this Damage to RC building structures will be conjointly seen in major cities like Bhuj, Gandhidham, Anjar throughout Gujarat is shown in Fig. 2 of commercial two-story RC building in Bhachau. All columns have massive ratio so the within will be totally utilized as a commercial space. This type of columns, the anchoring of the beam reinforcement can't be secured in a very short distance of the weak axis direction and consequently ends of some beams utterly force out from beam column joints. The stiffness and strength in weak axis direction weren't enough and therefore the ground floor and therefore the second floor swayed within the wrong way.

FIGURE 2: RC BUILDING IN BHACHAU COLLAPSED DUE TO SWAY MECHANISM

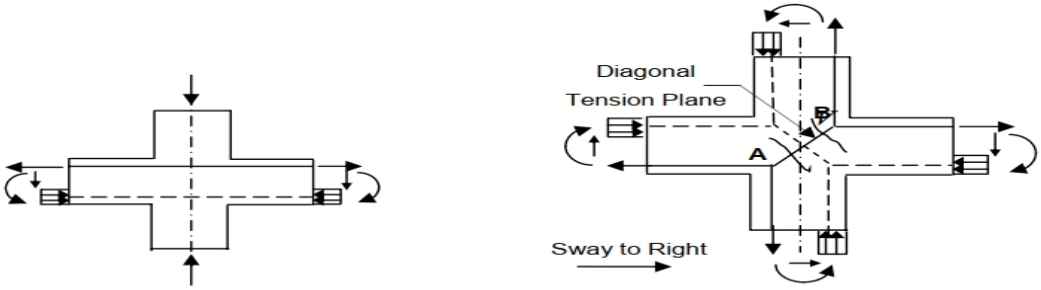
Third major earthquake with 7.9 magnitude Jolted Sichuan Province of China on 12 May 2008. Several buildings in Sichuan had inadequate construction quality together with too little reinforcement, poor detailing and poor quality concrete. A number of the poor detailing enclosed lack of reinforcement within the beam column joint, lack of crosswise ties within the beam and column and lack of embedment length for reinforcement anchorage. To assure a rise of the shear strength once the cracking of the joint core by diagonal tension and adequate move capability, joint shear reinforcement is required, that is thus prescribed by the newer style codes as ACI 318-2008; NZS 3101-1995; IS 13920-2002. Moreover, these codes order an oversized

anchorage length of the bars terminating just in case of exterior joints, in order that a bond failure could also be avoided. However, a huge majority of RC buildings worldwide accommodates structures styled before the appearance introduction of contemporary seismic design codes. It's been known that the deficiencies of joints square measure principally caused by inadequate crosswise reinforcement and too little anchorage capability within the joint.

SEISMIC BEHAVIOR OF BEAM-COLUMN JOINT UNDER LATERAL LOADING

The performance characteristics of connection due to factored seismic loading are quite unique and severe in seismic regions unlike joints designed only for gravity loading. Most international codes (ACI 318-05, NZS 3101 1995, EC8 2003) specify standard, design formulae and design factors mainly for moment resisting frames under seismic load. Though various codes attempt to clarify the design of joint, little attention was given to the design of reinforced structures. It appear that after the valuation of working stresses in adjacent part of building member, most designers normally assume that conditions within the joint, which often have somewhat larger dimensions than the members it joined, were not critical. The gradual adoption of the philosophy of limit stage design has exposed the weakness of this assumption. The truth is joints are often the weakest link in a structural system due to seismic loadings. Demand of joints is greatly affected by loading path in interior, exterior or corner type of joint and the type of loading system.

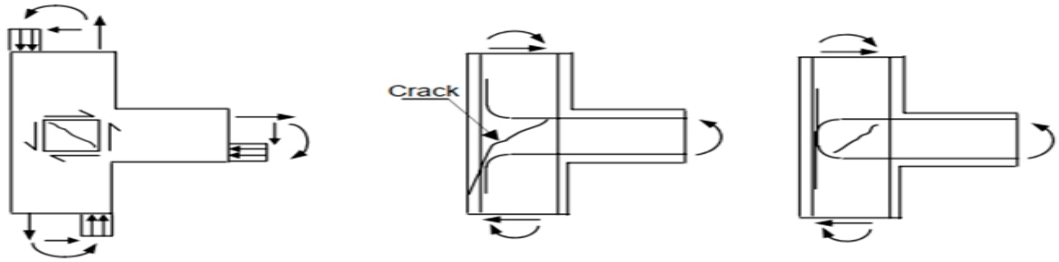
The gravity loading forces act on internal joint as per fig. 3(a) and the lateral loading impact shown in fig. 3(b). Cracks develop perpendicular to the strain diagonal A-B within the joint and at the faces of the joint wherever the beams frame into the joint. The compression struts area unit shown by dotted lines and tension ties area unit shown by solid lines. Concrete being weak in tension, thwart wise reinforcement's area unit provided in such some way that they cross the plane of failure to resist the diagonal tensile forces.



(a) Gravity Loading (b) Seismic Loading

FIGURE 3: INTERIOR JOINT

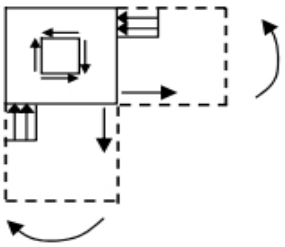
The forces performing on associate degree exterior joint may be idealized as shown in Fig. 4. The shear force within the joint offers rise to diagonal cracks so requiring reinforcement of the joint.[Uma] The particularization patterns of longitudinal reinforcements considerably have an effect on joint potency. a number of the particularization patterns for exterior joints square measure shown in Fig. 4(b) and Fig. 4 (c). The bars bent removed from the joint core (Fig.4 (b)) end in efficiencies of twenty five to forty take a while those passing through and anchored within the joint core show eighty five to hundred potency. However, the stirrups got to be provided to confine the concrete core inside the joint.



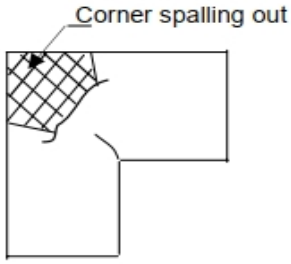
(a) Forces (b) Poor Detail (c) Satisfactory Detail

FIGURE 4: EXTERIOR JOINT

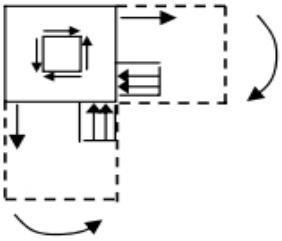
The forces in a very corner joint with a continual column on top of the joint (Fig. 5c) will be understood within the same method as that in associate degree exterior joint with regard to the thought of direction of loading. In, L-Joint connection, applied moment act on both side of corner likes open as well as closer side. Stresses and cracks developed in such joints of square dimensions shown in Fig. 5 (a).



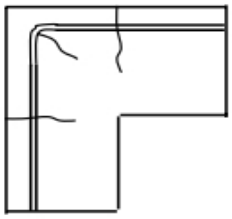
(a) Opening Joint (Top View)



(b) Cracks in an Opening Joint



(c) Closing Joint (Top View)



(d) Cracks in a Closing Joint

FIGURE 5: CORNER JOINTS

Corner joints produce crack at corner of connection due to a diagonal tensile on joint. The description of the longitudinal reinforcement considerably influences the behavior of such joints.[Uma] The force produced on closing and corner joint is exactly opposite to each other. The main crack is oriented on the corner diagonal. These joints show a higher potency than joint joints.

LITERATURE REVIEW

Many research papers have been published on the RC beam column joint of structure. A detailed review of some selected research papers is presented.

The seismic performance exterior beam column joint strengthen with unconventional reinforce have published by Venkatesan, Ilangovan and Sakthieswaranin 2016. They have do experimental studies to prove this beam column joint have do analysis studies by using software "ANSYS". There are two different sample have been selected among them. In that first specimen was non-ductility and study detailing about column joint have conducted by code India IS -456 2000 and second specimen was ductility and study in detail about column joint as per IS: 13920 1993.After the study and analysis of the all over study the result get ferrocement is needed for increased retrofitting to carelessly increased the energy of ferrocement and it use to increased strength of beam column joint in seismic region. The beam column joint showed higher strength in initial stiffness and tensile and non-ductile energy dissipation in detail.[Venkatesan, 2016]

After this study In, 2018 the author elmasry, abdelkarder and elkordy have published studied of various retrofitting technique and identity a suitable retrofitting for beam column joint. After this study and analysis of study the result get it the with carbon fibre reinforced polymer sheet strength use for increased serviceability of structure without get damage front of building.[elmasry, 2018]

In 2018 shaabanand Sid have published studied on the seismic performance of exterior beam column connection in ferrocement reinforced building frames using ANSYS software through nonlinear finite element analysis method . After analyzing of this studied the result found that's it's successfully help to increase capacity of joints in existing building through save time, money and lives in seismic zones. If ferrocement layer increased in strength scheme which led to increased resist higher level of axial load applied to column, in the bean column

joints and also the level of applied axial load to column, and longitudinal steel ratio in beam and comprehensive strength of the specimens has similar effect on their ultimate load, ultimate displacement and stiffness degradation before strengthening to different degrees. By change in orientation angle of expanded wire mesh from 60 and to 45 for per ferrocement layer which had minor effect on ultimate load but have higher effect on ductility specimens.[Sid, 2018]

The author johnson and hemalatha have published studied in 2017 ,seismic performance of exterior beam column joint to improve the joint ductility with non-conventional reinforcement and by using steel fibres during this data collection ANSYS software have used and verify by using experimental study by using different parameters. By this study they have found that cross diagonal bars and steel fibres at joint along with lateral reinforcement to prevented crack at edges of joint and it increased the ductility of the joint, yield load, ultimate load carrying capacity and energy absorption capacity but it decreased lateral reinforcement in beam in plastic hinge region and it higher effect on joint shear strength under higher load conditions.[Johnson, 2017]

In 2020 Ghosh have published study to and collected data through use experimental design and analysis data and dynamic behavior of exterior RC beam column joints. After study the result of experimental study have Been compare with model analysis by using ANSYS .In this study they find out that, under dynamic forces the joint that time it get linear and when it adequately load increased it behavior change into non-linear and exhibited where form of hysteresis loop get started.[Ghosh, 2020]

Vivek Kumar, Sadula have published study in 2020 ,The performance of high perform reinforced beam column joint replacement of cement with ground granulated blast furnace ,when worker for short period replace cement with glass fibre and use super plasticizer it requires work ability. After study on this ,The get to control specimen and specimen of beam column joint with 7.5%and 0.3%glass fibre replacement through IS 456:2000 and IS 13920:2016.The experimental study have down and numerically collect data by using software ANSYS. Then after they have found that's, directly load bearing ability of joints and also improve in specimen with GGBFS through glass fibre.[Vivek, 2020]

Majumder have published study in 2020 The effectiveness of geo-grid material on upgrade the cyclic performance of non-ductile exterior reinforced concrete (RC) beam column joint by take observation of experimental and non-linear finite element stimulation have use software ANSYS .After doing studies on it they have find out load displacement behavior and damage predicted form finite element through analysis study After all this the result get similar behavior assess by experiment result. Geo-grid through conventional steel bar used for hybrid reinforcement which have better ductile behavior for increased seismic performance of RC beam column joint.[Majumder, 2020]

Sivapriya, together with Sruthy, published a study in 2020 on improving the seismic behavior of stepped buildings by incorporating fibers into beam column joints. For well analysis of study step back for building by modified concrete is selected and structure through use software ANSYS, The transient analysis have done by using acccelerogram of EI-centro earthquake as loading .For modified efficiency have made by add steel fibres and PV fibre in vary percentage. A structure with modified concrete at the beam-column joints has a similar response as a conventional structure to study fiber efficiency. By embedding the fibers into the concrete, the seismic performance of the building has been improved in the time it can sustain a particular earthquake.[Shaaban, 2018].

Diro, kabeta published a study in 2020. A non-linear finite element analysis of a reinforced concrete exterior column beam joint subjected to lateral loading was performed to collect data on the shear failure mode of the joint in terms of joint shear capacity, deformation and cracking pattern while using ABAQUS Software. To analysis of study different parameters have been use for affect joint shear failure due to column axial load, beam longitudinal reinforcement ratio, joint panel geometry and concrete comprehensive strength have studied. After study they have concluded, this model included good comparison with test result in term of load displacement relation cracking pattern and joint shear failure modes.[Venkatesan, 2016].

In 2020, Balinen published to study behavior of precast concrete beam-columns joint connection using ABAQUS software. For analysis work, It’s use five number of models likes two dry, two wet and one monolithic types joint connection are used with include various changes on the variable likes light angles, use of dowels, and use of fiber reinforced concrete. After study they find out and have assess that dry connection perform less efficiency compared to monolithic and wet connections.[Elmasry, 2018].

CONCLUSION

From study of previous research papers, all research includes retrofitting technique, inelastic joint behavior, unconventional reinforcement detailing, bond strength, joint core shear deformation, transverse reinforcement etc. based on experimental and analytical investigation using ANSYS, ABAQUS, STAAD Pro, SAP2000. On

analysis of beam column joint there are different parameters have been use for affect joint shear failure due to column axial load, beam longitudinal reinforcement ratio, joint panel geometry and concrete comprehensive strength have studied.

From this research to increase capacity of joints in existing building through save time, money and lives in seismic zones and for increase capacity of joints it's found that various energy dissipation systems are used.

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