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To Investigate Eccentric Beam Column Joint Behavior Without Seismic Forces

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Abstract*: *The beam-column joints area unit crucial regions in concrete frames subjected to severe seismic attack. Beam moment reversal will manufacture high shear force and bond breakdown within the joint leading to cracking of the joint. Bond strength is influenced by many factors like bar diameter, clear cowl of concrete over the bar, grade of the concrete, thwart wise reinforcement. Typically most of the beam column joints in concrete building area unit homocentric however, for beaux arts reasons the beam column connections in concrete building is eccentric. In eccentric beam-column connections the axis of the spandril beams is offset from the axis of the column. Bending within the spandril beams produces internal compression associated tension forces that act on the joint at an eccentric with the column centre of mass, so manufacturing torsion within the joint. The torsion within the joint can manufacture extra shear stresses, and it's unclear to what extent this may have an effect on the shear capability of the joint. to attain the ductile particularization at beam column in concrete structures area unit given in IS 13920-1993 and conjointly in ACI-318-14. The thwart wise reinforcement within the joint helps to confine the concrete and conjointly increase the strength of the beam-column joint. once the shear forces at the joints become massive, diagonally cracking happens within the joint and so the crushing of concrete can present itself within the beam- column joints. within the gift study concrete building of G+15 stories having five bays in each the axis is analyzed exploitation ETABS. The finite component model of external beam-column joint is developed and analyzed exploitation ANSYS

Keywords : ANSYS,ACI-318-14,Deveiopment length, ETABS,.

I. INTRODUCTION

The behavior of concrete moment resisting frame structures in recent earthquakes all told over the planet has highlighted the consequences of poor performances of beam column joints. Beam column connections are essential regions in strengthened concrete frame and it are designed to endure the severe earthquakes. in keeping with the planning capability philosophy, the hinges should kind on beam solely. Since from last 3 decades, intensive analysis has been meted out to review the performance of the beam column joint below unstable forces through analytical and experimental studies. it's usually accepted that, it's uneconomical to style concrete structures for severe ground motion while not harm. Earthquakes are one amongst the foremost feared natural phenomena that are comparatively surprising and whose impact is fulminate because of the virtually fast destruction that a serious earthquake will turn out. Severity of ground shaking at a given location throughout associate degree earthquake may be minor, moderate and powerful that comparatively occur often, often and barely severally. Hence, the most intention is to create building earthquake-resistant that resist the impact of ground shaking though it should get broken severely however wouldn't collapse throughout even the robust earthquake.

Thus, the protection of individuals and contents is assured in earthquake-resistant buildings. This can be a serious objective of unstable style codes throughout the world. When a RC beam column joints is subjected to earthquake loading, the beams compression (C) and tension(T) from bending ar directly transmitted to the joint at the beam-column interfaces, that In eccentric beam column connections, due to eccentricity the transmitted forces within the joint will introduce torsion within the joint and joint shear stress will increase because of eccentric within the in the study, G +15 story building has been analyzed victimization ETABS that include five bays and story height of three.5m every for considering each unstable and while not unstable forces. Associate degree exterior beam column joint is taken within the analyzed building and designed for specific joint. Then the comparison is formed between Indian code, (IS: 13920-1993) reinforcement provisions of exterior beam-column joint with ACI (ACI 318-14). The subsequent parameters like development length of main bar, member sizes, and confinement reinforcement in columns are studied and analyzed, the behavior of exterior beam column joint considering the axial force on column and bending moment at the junction victimization ANSYS package.

II. LITERATURE REVIEW

D. Nikam, J.S.Kanase. 2017. [1]

The behavior of reinforced concrete moment resisting frame structures in recent earthquakes in all over the world has highlighted the consequences of poor performances of beam column joints. Beam column connections are critical regions in reinforced concrete frame and it is designed to endure the severe earthquakes. According to the design capacity philosophy, the hinges must form on beam only. Since from last three decades, extensive research has been carried out to study the performance of the beam column joint under seismic forces through analytical and experimental studies. It is commonly accepted that, it is uneconomical to design reinforced concrete structures for severe ground motion without damage. Earthquakes are one of the most feared natural phenomena that are relatively unexpected and whose impact is sudden due to the almost instantaneous destruction that a major earthquake can produce. Severity of ground shaking at a given location during an earthquake can be minor, moderate and strong which relatively occur frequently, occasionally and rarely respectively. Hence, the main intention is to make building earthquake-resistant that resist the effect of ground shaking although it may get damaged severely but would not collapse during even the strong earthquake. Thus, the safety of people and contents is assured in earthquake-resistant buildings. This is a major objective of seismic design codes throughout the world. When a RC beam column joints is subjected to earthquake loading, the beams compression (C) and tension(T) from bending are directly transmitted to the joint at the beam-column interfaces, which produces relatively large joint shear forces. In eccentric beam column connections, due to eccentricity the transmitted forces in the joint can introduce torsion in the joint and joint shear stress increases due to eccentric in the beam column joint.

Dattatreya S. Nikam1, V. S. Shingade . 2017. [2]

Carried out four cruciform eccentric beam-column connections and observed inclined (torsional) cracks in the beam-column joint and strain in the joint hoop reinforcement on the flush side were larger than compare to the offset side, and which leads to additional shear stress from torsion. The author suggested that shear strength of the eccentric beam-column connections were overestimated with the current joint. ACI-ASCE Committee 352 design recommendations and by this it could be rectified using a proposed equation for reduced effective joint width.

B. Burak, M. Unal. 2012. [3]

The shear distortions that beam-to-column connections undergo under earthquake loading have a majorcontribution to the story drift of a structure. However, the connection regions are generally modeled as rigidzones and the inelastic behavior of the joint is not considered in the dynamic analysis. Therefore, the story driftsare underestimated and the seismic performance of a building cannot be assessed properly. In this study, a modelthat predicts the joint shear strength versus strain relationship is developed. First, an experimental database isconstructed and the key parameters that affect the joint behavior are utilized to develop the joint model. Then,nonlinear analyses are carried out by using Perform 3D with and without the joint model and the analytical results are compared with the experimental ones. The results indicated that considering the developed joints model improves the prediction of the overall seismic behavior and member responses.

Xilin Lu, Tonny H. Urukap, et.al. 2011. [4]

The experimental research investigated the seismic behavior of typical interior beam-column joint subassemblies under simulated cyclic loading patterns. Comparisons of conventional concrete joints, additional diagonal bars along beams, additional diagonal bars along columns and additional straight bars along column were investigated after having ten specimens tested. Ten full-scale test specimens were fabricated primarily based on strong-column weak-beam concept as discussed previously. In particular, the parameters studied in these tests were the joint critical principal strength, ductility, joint behavior and energy dissipation capacity. The first four conventional seismic beamcolumn joints reinforced with various steel contents in the joint region were tested to examine the contribution of longitudinal reinforcement in the beam affecting the joint shear resistance capacity. These tests gave reasonable behaviourals information on the flexural behaviour mechanism at plastic hinge region as well as the seismic behaviour of the joint mechanism and damages under extreme.

Shyh-Jiann Hwang and Hung-Jen Lee. 1999. [5]

Studied that the analytical model derived from the strut-and-tie mechanism and it satisfies the force equilibrium, strain compatibility and the constitutive laws of cracked reinforced concrete. It is noted that the crushing strength of concrete in a strut and tie mechanism it is referred to as an effective compression strength. By this strut and tie mechanism it also satisfies the equilibrium compatibility and it also satisfies the stress and strain characteristics of cracked reinforced concrete. The average strength ratio is 1.05 and coefficient of variation is 22%.

Vollum and Newman. 1999. [6]

Explained 10 corner beam column connections each consist of a column and two perpendicular connections such as concentric and eccentric connection beams. The various load path have been checked to investigate beam-column connection behavior and performance improved significantly interms of both strength and crack control with reduction in eccentric connection. In his previous eccentric connection test floor slab were typically not included. By using floor slab it may reduce the torsional demand which is induced by the eccentricity in the joint region. By providing some confinement bars to the joint it may result in increasing the joint shear capacity by expanding effective joint width. On the other hand, a floor slab is expected to require additional shear strength in the joint and to reduce the column to beam moment strength ratio.

Myoungsu Shin and James M. LaFave. 2004. [7]
Investigated two RC eccentric beam-column-slab subassemblies were designed, constructed, and tested. In many cases of beam-column joint the outside face of column are flush with the beam outside face and the columns are constantly wider than the interfacing beam, and the transverse reinforcement is contributed to the shear limit by providing some confinement bars in the joint area. First beam bar yielding occurred during the 1.5 and 2% drift cycles in Specimens 1 and 2, separately. In every example, all longitudinal beams and slabs bars yielded at the beam-column interfaces, and yielding of the beam bars spread to half an effective-beam-depth away from the interfaces, by the 3% drift cycle, implying that beam hinging developed adjacent to the beam-column interfaces. Specimen 1 achieved its greatest story shear force during the 3% drift cycle, while specimen 2 did so during the 4% drift cycle. Both examples displayed progressive quality drops after the peak forces drift cycles, up to roughly 15% by the 6% drift cycle.

Sung-Chul CHU1, Dae-Young KIM. 2004. [8]
The standard hook is used to anchor longitudinal re-bars that terminates within an exterior beam-columnjoint and shear re-bars, where straight development length cannot be achieved (Chun [1], Chun [2]).However, the use of a standard hook results in steel congestion, making the fabrication and construction difficult (Wallace [3]). In addition, the poor concrete placement due to congestion sometimes degrades the quality of structures. In the future, the anchorage of re-bars is expected to be more difficult as the strength of materials becomes higher. Using a mechanical anchor offers a potential solution for these problems and may also ease fabrication, construction and concrete placement (Wallace [3], HRC [4], ERICO [5], KOBE STELL [6], and TOKYOTEKKO [7]). But, because of the complex stress flow in joints, there has not been a general model or design provision for the mechanical anchor. To develop the mechanical anchor for the longitudinal re-bar within the exterior beam-column joint, especially from the constructability and cost’s viewpoints, the new mechanical anchor (Figure 1), with the minimum head plate, was proposed. The objective of this research was to conduct tests on large-scale connections to show the mechanical anchor’s possibility to replace 90 degree standard hooks within exterior beam-column joints.

Takashi Kashiwazaki and Hiroshi Noguchi. 2004. [9]
The analytical results of shear force and story drift angle of specimen 1 and specimen 2 are compared with the test results. The initial stiffness of the experimental specimens is less than the analytical specimens. The analytical story shear force of specimen 1is higher than the test results about 4%. On the other hand, the story shear force of specimen 2 is higher than that of test results about 2%. It was observed that beam flexural failure occurs in both the specimens.

YasuakiGoto, Osamu Joh. 2004. [10]
Studied the analytical consequences of all examples were compared and the trial results, the crumbling of stiffness in the analysis became smaller than the test result, which brought about the larger ultimate strength. Nevertheless, the strength decreases as according to increasing of eccentric distance was acquired in the analytical results, and observed in the test results. The failure mode of all examples in the analysis was characterized as joint shear (J-type), which agrees with the experimental results. The analysis shows good concord with the experiment.

III. MODELLING, LOADINGS AND ANALYSIS OF STRUCTURES

3.1 Introduction
In this thesis, two G + 15 story buildings has been analyzed and having a story height of 3.5 m each for considering with and without seismic forces. Exterior beam column joint is taken from the analyzed building from 8th story of grid 2A and designed for the particular beam column joint. Then the RC beam column joint is modeled in ANSYS software and analyzed for different parameters by considering axial force on the column and bending moment at the junction obtained from analyzing the building using ETABS software.

3.2 Problem Definition
• A G+15 Storey RC office building is considered.
• Plan dimensions : 20 m × 20 m
• Location considered : Zone- IV
• Soil Type considered : Rock Soil

General Data of Building:

- Grade of concrete : M30
- Grade of steel considered : Fe 500
- Live load on roof : 2 kN/m^2
- Live load on floors : 3kN/m^2
- Roof finish : 1.0 kN/m^2
- Floor finish : 1.0 kN/m^2
- Brick wall in longitudinal direction : 230 mm thick
- Brick wall in transverse direction : 230 mm thick
- Beam Section : 230 × 450 mm
- Column Section : 300 × 600 mm
- Density of concrete : 25 kN/m

Density of brick wall including plaster : 20 kN/m^3

- Plinth beam(PB1) : 300×450 mm

A G+15 storey building is analyzed using ETABS software and 3D view and plan of the building is as shown in the Figure 4.1. An exterior beam column joint is taken from the analyzed building from 8th story of grid 2A is as shown in the Figure 3.1.

Beam 230 x 450mm	Column 300 x 600mm	
Axial Force = 200kN and Bending Moment = -70 kN-m		
Parameters Studied	Indian Code IS 13920-1993	American Code ACI 318-14
Development Length, mm	802	305
Deflection, mm	0.70443	0.70992
Min Stress, N/mm^2	-7.035	-9.148
Max Stress, N/mm^2	0.9070	1.18
Von Mises Stress, N/mm^2	8.447	8.447

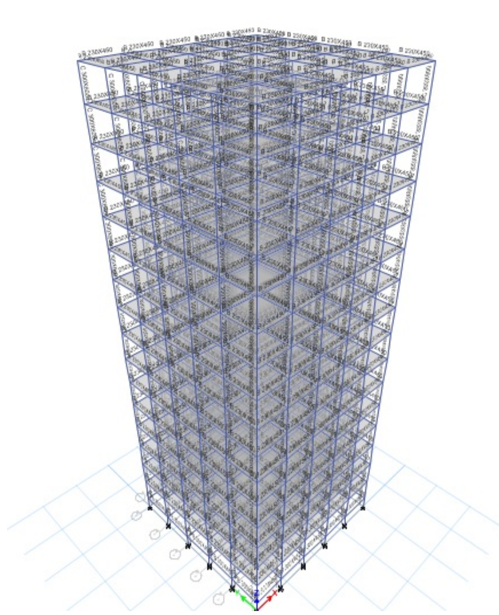

Fig. 3.1: 3D view of RC building without infill considering wall load

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Fig. 3.2: Plan view of RC building without infill considering wall load

IV RESULTS AND DISCUSSION

Table4.1 External B-C joint for varying development length as per different country codes without subjecting to seismic forces

In this part the correlation is made for exterior beam column joint with two International codes in particular, IS 13920-1993, ACI 318-14. The investigation is made for exterior beam column joint in terms of deflection, maximum stress, minimum stress, von misses stress utilizing ANSYS programming bundle for the axial loads and bending moment obtained from the ETABS results.

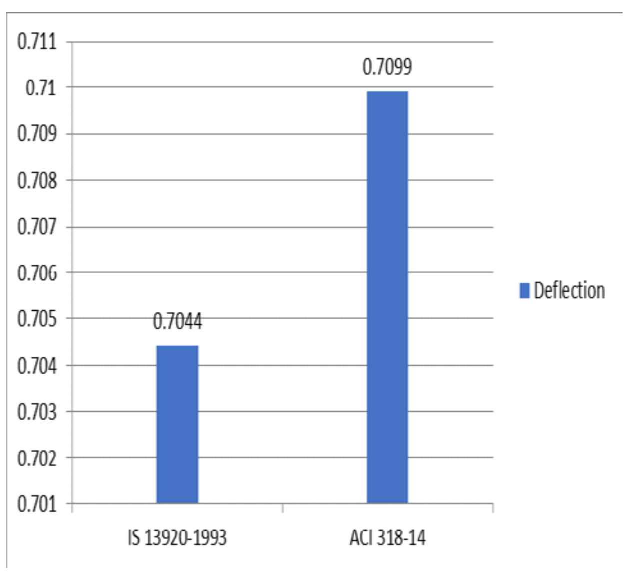

Fig4.1.1: Deflection graph according to different code without EQ

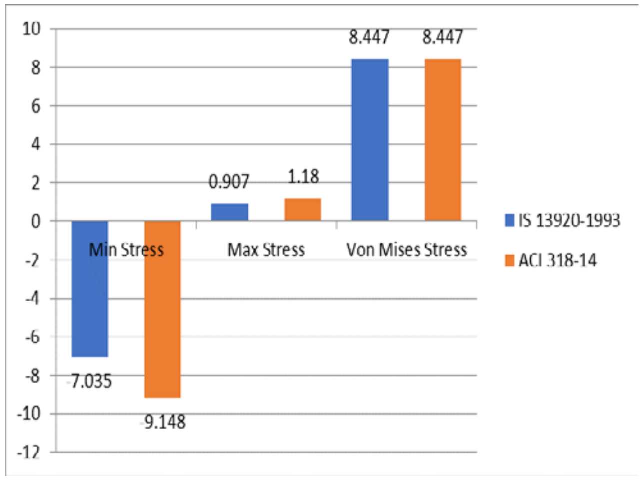

Fig4.1.2 :Min, max and von mises graph according to different code without EQ

Table4.2 Beam Column joint of 60mm eccentricity and varying development length according to different codes without considering seismic forces

Beam 230 x 450mm	Column 300 x 600mm	
Axial Force = 200kN and Bending Moment = -70 kN-m		
Parameters Studied	Indian Code	American Code
	IS 13920-1993	ACI 318-14
Development Length,mm	802	305
Deflection, mm	0.7071	0.71280
Min Stress, N/mm^2	-7.035	-7.035
Max Stress, N/mm^2	0.9498	0.9498
Von Mises Stress, N/mm^2	8.447	8.447

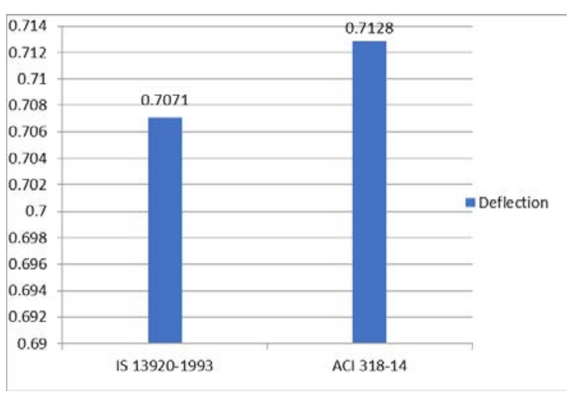

Fig4.2.1: Deflection graph according to different code without EQ

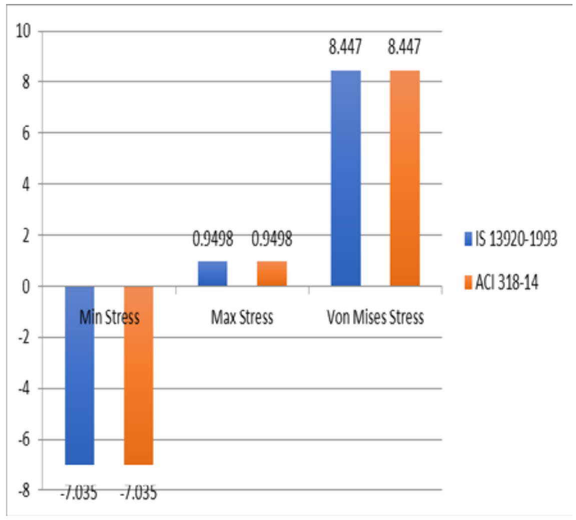

Fig.4.2.2: Min, max and von mises graph according to different code without EQ

Table 4.3: Beam Column joint of 120mm eccentricity and varying development length according to different codes without considering seismic forces

Beam 230 x 450mm	Column 300 x 600mm	
Axial Force = 200kN and Bending Moment = -70 kN-m		
Parameters Studied	Indian Code	American Code
	IS 13920-1993	ACI 318-14
Development Length, mm	802	305
Deflection, mm	0.0490	0.0495
Min Stress, N/mm^2	-7.597	-7.606
Max Stress, N/mm^2	1.218	1.239
Von Mises Stress, N/mm^2	8.443	8.443

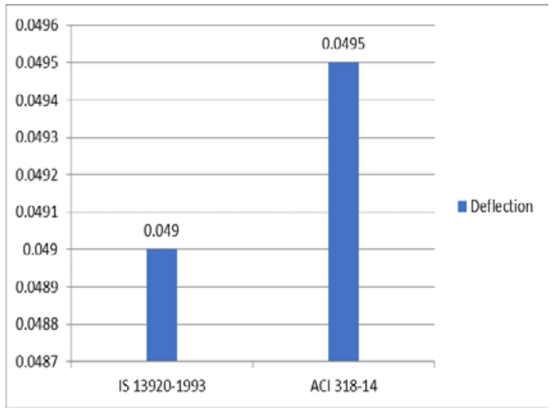

Fig.4.3.1: Deflection graph according to different code without EQ

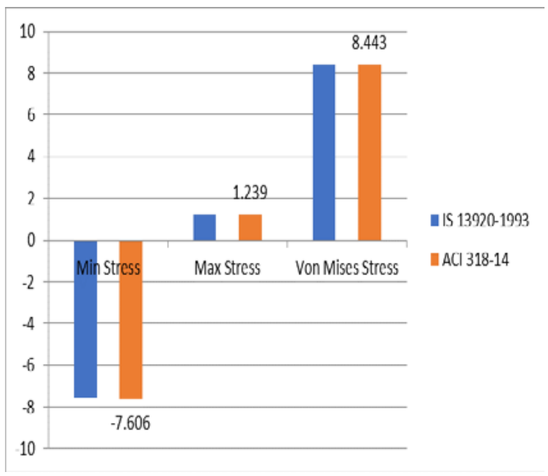

Fig.4.3.1: Min, max and von mises graph according to different code without EQ

V.CONCLUSIONS

- When the reinforced concrete frame building is analyzed without subjecting to seismic forces, and with subjecting to seismic forces, the development length at the exterior beam-column joint as mentioned by IS 456:2000, and IS 13920-1993 is more than required. From the present study, it is observed that 50% of development length is sufficient to provide in the beam-column joint.
- The confinement length suggested by the IS 13920-1993 is more than required. From the present study, it is observed that 300 mm is sufficient to resist.
- Shear stresses in the beam-column joint are increased with increase in eccentricity. When the beam-column joint is subjected to vertical loading, an average of 24.62% increment in the stresses is observed for Indian code (IS 13920-1993), whereas the increment is 7.5% for American code (ACI 318-14).
- When the beam-column joint is subjected to lateral loading average increase in the stress of 27.3% for Indian code (IS 13920-1993), whereas the increment is 32% for American code (ACI 318-14).
- The torsional moment induced in the beam-column joint due to increase in eccentricities can be sustained by strut and tie mechanism and truss mechanism.

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