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Analytical Behaviour on External Beam Column Joint Using Steel Mesh

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Abstract— In this work, a detailed three-dimensional (3D) nonlinear finite element model is developed to study the response and predict the behavior of beam–column connection subjected to cyclic loads that was tested at the karunya Institute of technology and sciences (KITS) laboratory. The beam column joint is modeled using 3D solid elements and surface-to-surface contact elements between the beam/column faces and interface grout in the vicinity of the connection. The model takes into account the pre-tension effect in the post-tensioning strand and the nonlinear material behavior of concrete. Fracture of the mild-steel bars resulted in the failure of the connection. In order to predict this failure mode, stress and strain fields in the mild-steel bars at the beam–column interface were generated from the analyzed model.. In addition, the magnitude of the force developed in the post-tensioning steel tendon was also monitored and it was observed that it did not yield during the entire loading. Steel mesh was developed in the beam to increase the shear capacity. Finite element modeling will provide a practical and economical tool to investigate the behavior of such connections.

KEYWORDS: BEAM COLUMN JOINT, STEEL MESH, CYCLIC LOADING

I. INTRODUCTION

In general beam column joint is generally assumed as rigid structure. Many catastrophic failures reported that beam column joint has failed due to earthquake. Improper design and detailing in the joint region jeopardizes the entire structure, even other part of the structure may properly designed and detailed. The seismic design philosophy provides sufficient ductility to the structure which dissipate seismic energy. During earthquake joints may severely damaged when the seismic forces are larger than the shear strength of joints. It is difficult to repair the joints. So that the beam column joint should be designed to resist earthquake effects. Beam column joint is the critical zone in the structure. Structures should make large margin for joint concrete volume to decrease joint shear stress for preventing joint failure. Horizontal ties and stirrups are used to resist the shear. The damages of plastic hinges in seismic design are accept in beams rather than in columns. The sufficient flexural strength in above column and below joint when adjoining beams develop flexural over strength at their plastic hinges. Flexural strength ratio of column to beam is an important factor in beams rather than in columns. To resist the internal forces induced by the framing member adequate strength and stiffness in the joint is required. Connectors are used in the beam column joint to increase the shear strength.Beam column connections have been diagnosed as potentially vulnerable components when reinforced concrete frame buildings are subjected to seismic loads. All buildings are normally designed for gravity loads and they are safe against it. Buildings when subjected to seismic loading of unknown magnitude are subjected to damages and the most affected areas are the structural beam column joints, particularly the corner joints or the exterior joints. The interior joints are also affected due to seismic load, but the damage is relatively smaller in magnitude. The analysis of building frame under seismic loading shows that the points of contra-flexure appear approximately at midspan of the beam and at the mid-height of the lower and upper column of beam column subassemblage. The simulation of seismic load and proper boundary conditions either in the laboratory or in the numerical model for beam column sub-assemblage similar to that in the building frame is also a very tedious task. The nonlinear dynamic analysis of reinforced concrete structural member is a highly complex problem. To simplify the problem, a pushover analysis under static condition or modal super positioning method is used for analysis under seismic loading.

II. MODELLING

All the information and requirement planning is done in the proper manner. The planning phases have namely data collection like parameters and finding the objective function and constrains. Literature studies schedule are done to get more information. All the materials are collected by the journal and research paper. From five storey building beam column structure has been reduced to 1:3 scale ratio.The reinforcement has been modelled using solidworks. For design of IS 13920:2016, IS 456:2000 with and without steel mesh the dimension of the beam is 677x133x100mm and column dimension is 177x1120x100mm In beam 6 mm diameter bar is used for every design and 8 mm diameter is used in column. 4 mm diameter stirrups is used for beam and column. The spacing of stirrups in beam is 100 mm and 90 mm in column. Steel mesh is modelled which is rapped in the beam at a dimension of 235x83x50mm.

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Fig 3.1 IS 13920:2016 DESIGN

Fig 3.2 IS 456:2000 DESIGN

This figure 3.1 represents IS 13920:2016 design is the ductile detailing of reinforced concrete structures subjected to seismic forces.This figure 3.2 represents IS 456:2000 design is plain and reinforced concretecode of practice.

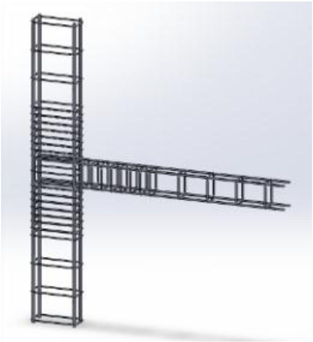


Fig 3.3 IS 456:2000 WITH STEEL MESH

The fig 3.3 represents IS 456:2000 design with beam steel mesh to increase the shear capacity in the beam column joint

III. RESULTS:

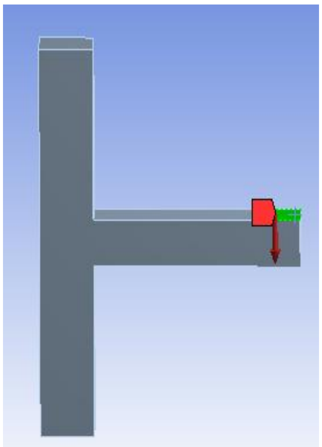


Fig 4.1 LOADED AREA

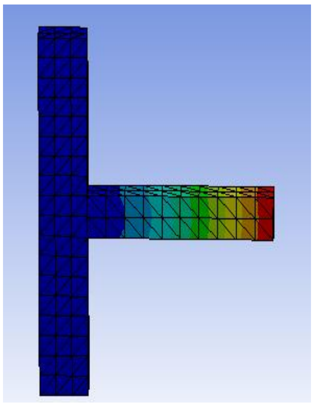
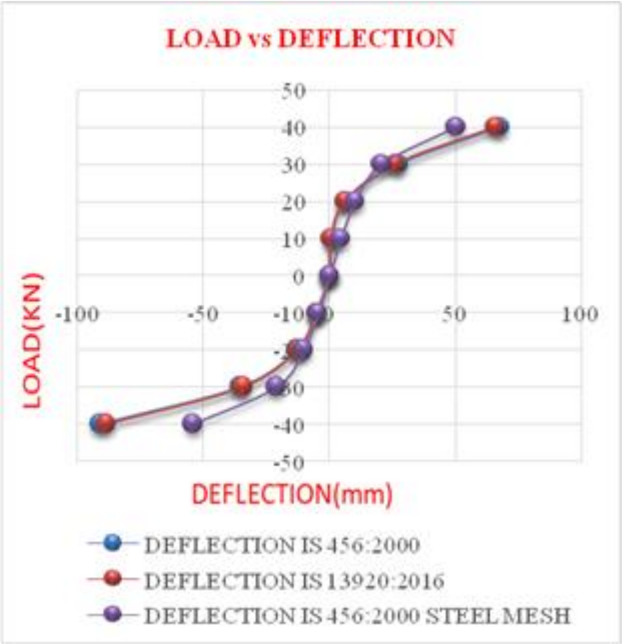


Fig 4.2 MESHING

The load has been applied at the end of the beam in vertical section shown in fig 4.1.Meshing and deformation shown in fig 4.2.



S.NO	LOAD (KN)	DEFLECTION OF IS 13920:2000 (mm)	DEFLECTION OF IS 456:2000 (mm)	DEFLECTION OF IS 456:2000 WITH BEAM STEEL MESH
1	0	0	0	0
2	-10	-5.02	-5.06	-4.53
3	10	0.81	0.74	4.52
4	-20	-12.7	-13.02	-10.32
5	0	6.27	6.38	10.2

6	-30	-34.31	-35.51	-21.17
7	30	26.13	27.64	20.67
8	-40	-88.51	-91.21	-54.29
9	40	65.88	67.5	50

Fig 4.1 GRAPHICAL COMPARISON OF LOAD vs DEFLECTION

Cyclic loading is applied at the tip of the beam. The load of upto 40KN is applied.From the graph it is observed that deflection of IS 456:2000 with steel mesh is more stiffer than IS 456:2000 and IS 13920:2016. Depending upon the deflection the stiffness can be determined. If more stiffness .

4.1 TABULATION OF LOAD vsDEFLECTION

eam column joint result in good result. IS 456:2000 with steel mesh at 40 KN load the deflection is 50 mm. For 50 mm deflection IS 13920:2016 takes load of 33 KN and IS 456:2000 takes 34 KN load.From this shear capacity will increase in IS 456:2000 with steel mesh as compared to other designs.

S.NO	LOAD (KN)	SHEAR OF IS 13920:2000 (MPa)	SHEAR OF IS 456:2000 (MPa)	SHEAR OF IS 456:2000 WITH BEAM STEEL MESH (MPa)
1	10	116.9	100.47	277.51
2	20	371.06	340.88	495.91
3	30	1055.9	974.83	1007.9
4	40	2414.5	2003.9	3014.5

4.2 TABULATION OF SHEAR

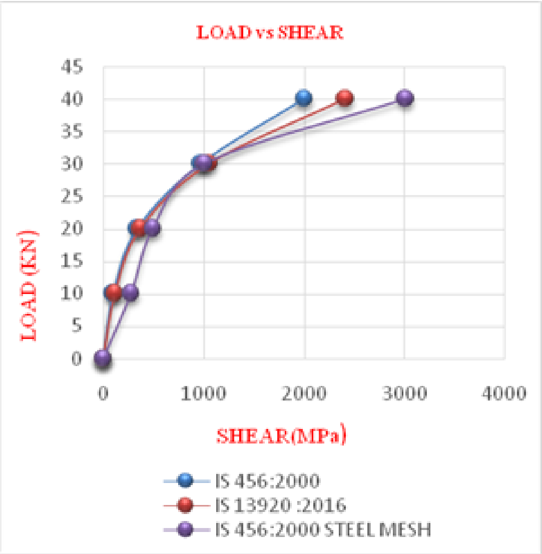


Fig 4.2 GRAPHICAL COMPARISON OF LOAD vs SHEAR

From the graph it has been observed that IS 456:2000 with steel mesh has higher shear capacity as compared with IS 13920:2016 and IS 456:2000

IV. DISCUSSION

A nonlinear finite element analysis model is developed.The results from the present nonlinear finite element analysis of deflection for exterior beam-column joint are presented in Table 4.1.Further studies were carried out to assess the effect of axial load on the load carrying capability of beam-column. Failure of beam-column joint is considered as beam plastic hinge failure or simply beam failure.This project introduces the steel mesh in the beam to resist the seismic force and resist shear failure.The load capacity of each specimen decreases as the displacement of beam tip increases.Steel mesh has a good tensile property. The load is taken first by the steel mesh As compared to IS 456:2000 the percentage difference for IS 13920:2016 is 3%and percentage difference for IS 456:2000 with steel mesh is 21%. The graph[4.1] shows the difference of IS 456:2000, IS 13920:2016 and IS 456:2000 with steel mesh. Shear strength will be more in the design of IS 456:2000 with steel mesh.For shear the percentage difference between IS 456:2000 and IS 13920:2016 is 20%. The percentage difference between IS 456:2000 with steel mesh and IS 456:2000 is 50%. From this we can observe that the shear capacity is increased when steel mesh in the beam as shown in table 4.2. The graph[4.2] shows the difference for the three designs IS 456:2000, IS 13920:2016 and IS 456:2000 with steel mesh.To reduce the failure in the beam column joint the material like steel mesh, chicken mesh material can be used. Steel mesh will be economical as compared to other and it will be more stiffer than other.

V. CONCLUSION

1. IS 456:2000 with steel mesh is more stiffer than IS 456:2000 without steel mesh.
2. IS 456:2000 with steel mesh is increasing shear capacity compared to IS 456:2000 and IS 13920:2016.
3. The portion of the joint with steel mesh is more rigid and stiffness is more. It will reduce the rotation in beam column joint and it will reduce the failure.

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