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Behaviour of Exterior and Interior RC Beam Column Joint Under Cyclic Loading

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ABSTRACT: The objective of the present study is to compare the behaviour of exterior and interior beam-column joint under different loading conditions. G+4, G+9, G+14 etc. structures in the zone III is analyzed. The earthquake analysis and design are carried out by IS 1893 and IS 13920. IS 456 and SP 34 are used for detailing and designing. Each load is applied to the three models viz. G+4, G+9, G+14 respective to exterior and interior joints.Present work involves a study of different types of beam column junction under different loading conditions using the software STAAD PRO.The test results indicate that the properties of exterior and interior joints show similar results in each loading condition. A comparative study with exterior and interior joint will be studied with different parameters like displacement, stiffness, storey drift and shear stress.

Keywords: Beam column joint, displacement, stiffness, storey drift, shear stress,

I. INTRODUCTION

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 speaking occur frequently, occasionally an rarely respectively. Design and construction of a building to resist the rare earthquake shaking that may come only once in 500 years or even once in 2000 years at a chosen project site even though life of the building itself may be only 50 to 100 years is too robust and also too expensive. 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. The pattern of forces acting on a joint depends upon the configuration of the joint and the type of loads acting on it. The joints should have adequate strength and stiffness to resist the internal forces induced by the framing members. The behaviour 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 frames, the joints are generally assumed as rigid.Present work involves a study of different types of beam column junction under different loading conditions using the software STAAD PRO.

II. OBJECTIVES AND SCOPE

The main objective of this study is to,

1) To study the concept of behaviour of beam column joint.
2) To study the joint behaviour and joint capacity of beam column joint.
3) To study the different loads and resulting forces acting on beam-column joint.
4) To study the influence of high strength concrete on the shear strength of cyclically loaded beam column joint
5) To study the influence of various key parameters
    - Displacement
    - Stiffness
    - Storey drift

- Shear stress

The main scopes of this study are,

1. Extensive Literature Review of roof- interior, exterior and corner seismic designs.
2. Analytical investigation of Irregular building's exterior, interior and corner beam-column joints with different loading conditions.
3. Comparison of exterior, interior and corner beam-column joints for Regular and Irregular building.

III. STRUCTURAL MODELLING AND ANALYSIS

This project mainly deals with the analysis of exterior and interior beam column joint under different loading conditions. For this study five storied, ten storied and fifteen storied structures and are designed for seismic forces in Zones III. Modelling was done using STAADPRO 2007, It includes generation of model, defining materials, defining sections, defining loads, and load combinations, assignment of defined properties and analysis of the model. And thus the process consists of structural modeling, material specification, and property specification, assigning restraints and loading. The structure geometry consists of joint members, their coordinates, member numbers, the member connectivity information, etc. At first we have to fix the position of beams and columns. Then the joint coordinates were fixed. Beam center lines were taken for fixing joint coordinates. Then the members were connected along the joint coordinates using the member incidence command. For creating model geometry center line of the beam layout was prepared in Auto CAD referring to the architectural plan. The model was then generated in STAAD, by editing grid dimensions from the center line layout from Auto CAD 2015. Then, assign cross sectional properties for beams and columns. From the load calculations and thumb rules preliminary dimension of beams and columns were fixed. The slab thickness and type is also obtained similarly. Thus the properties of the various frame member sections such as cross sectional dimensions of beams, columns, RC walls, slabs was defined and assigned. First consider the exterior beam column joint then apply loads 20kN, 30kN and 40kN. Each load is applied to three models, viz G+4, G+9, and G+14. Then find out the displacement, shear stress, stiffness and storey drift for each loading condition. Similarly the displacement, shear stress, stiffness and storey drift for interior joint are also find out. Compare the results.

IV. TYPES OF JOINTS

According to design configuration six types of joints are there. They are:

1. Interior joint
2. Exterior joint
3. Corner joint
4. Roof interior
5. Roof exterior
6. Roof corner

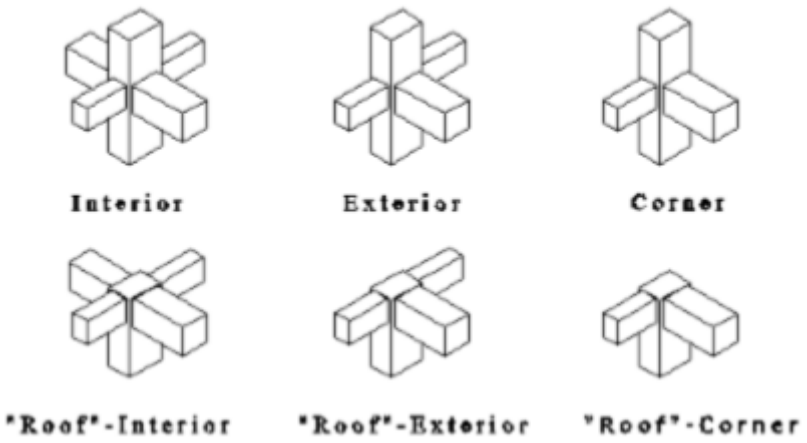

Fig: 1 Types of beam column joint

The other category of joints is type 1 and type 2 joints. Type 1 is a static loading and connects the joints of ordinary structures designed on the basis of strength, gravity and wind loads. In type I joint first

importance to strength and ductility is a secondary factor. Type 2 joint connect deformation at the inelastic range during earthquakes and occurrence of blast effects.

V. RESULTS AND DISCUSSIONS

EXTERIOR JOINT

1. In G+4 storied structure as load increases, displacement and stiffness decreases, drift shear stress increases.
2. In G+9 storied structure as load increases, stiffness decreases, displacement, drift, shear stress etc. increases.
3. In G+14 storied structure as load increases, displacement and stiffness decreases, drift and shear stress increases.

INTERIOR JOINT

1. In G+4 storied structure as load increases, displacement and stiffness decreases, drift shear stress increases.
2. In G+9 storied structure as load increases, stiffness decreases, displacement, drift, shear stress etc. increases.
3. In G+14 storied structure as load increases, displacement and stiffness decreases, drift and shear stress increases.

Table 1: comparative results of load vs all parameters in exterior and interior beam column joint

Load cycle	Load (kN)	Displacement (mm)	Stiffness (kN/mm)	Drift (mm)	Shear stress (kN/mm^2)
EXTERIOR JOINT					
a1	20	3.54919E-03	1.88	2.5	2043
a2	30	-9.82807E-03	1.63	2.8	3012
a3	40	-5.23264E-02	1.1	3.33	3424
b4	20	-7.62621E-02	2.68	3.82	3820
b5	30	6.22954E-02	2.1	4.23	4401
b6	40	8.30606E-02	1.8	4.66	4670
c7	20	-1.32442E-01	4.2	4.83	5120
c8	30	-1.98663E-01	3.6	5.1	5512
c9	40	-2.64885E-01	3.2	5.33	5723
INTERIOR JOINT					
a10	20	-2.55380E-01	1.88	2.5	2082
a11	30	-3.83069E-01	1.63	2.81	3124
a12	40	-5.10759E-01	1.1	3.23	3233
b13	20	-9.26514E-01	2.68	3.89	3732
b14	30	-7.68551E-02	2.11	4.24	4612
b15	40	-8.71024E-01	1.82	4.69	4870
c16	20	-2.40982E+00	4.20	4.88	5133
c17	30	-3.61474E+00	3.62	5.13	5734
c18	40	-4.81965E+00	3.213	5.24	5911

VI. CONCLUSIONS

From the analysis we can notice that, the results obtained from interior and exterior joints are similar. That is when fracture occurs, it affects both interior and exterior. 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 shear transfer capacity to beam column joints to increase the strength and ductility during earthquake. It will leads to reduce the larger cracks appear on a structure and helps to improving the seismic performance.

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