Behavioural Study of Beam Column Joint Strengthend with Cross Inclined Column Bars & FRP Fibres

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***Abstract* — One of the major reason for the disaster occurred to reinforced concrete building is due to weak beam column joint. Improper designing and detailing, avoidance of codal provisions, insufficient strengthening materials in the beam column joint etc. are the causes of weak beam column joint. In this paper a study of beam column joint and type of strengthening materials used to improve the strength of beam column joint. To increase the strength cross inclined bars are provided at the beam column joint. FRP fibres can also be used at the beam column joints.**

Keywords—Beam column joint; FRP fibres; cross inclined bars.

I. INTRODUCTION

Strengthening of existing reinforced concrete structures is very complicated and difficult job. Most of the disasters occurred in the reinforced concrete structures due to earthquakes, corrosion, fire, faulty construction methods, incorrect application of codal provisions etc. Placing of cross inclined column bars and also FRP fibres on the beam column joint protect the structure from destruction upto a certain limit and provides longer life than normal reinforcing techniques. The commonly used codes are IS 13920:1993value and IS 456:2000. Studies carried out according to experimental and analytical values. Analytical findings are done through software analysis ie by finite element method.

In this study the materials are collected from the theoretical as well as experimental observations. The cross inclined bars are provided according to the codal provisions and analysed through softwares. FRP fibres also provided in the beam column joint. The strengthening materials are designed using softwares such as STAAD PRO, ETABS, ANSYS, ABAQOUS, ATENA 3D. The study carried out under the following loads, ie static dynamic and reverse loading patterns. Commonly used FRP fibres are SIMCON laminates, carbon FRP, basalt FRP, glass FRP etc.

II. LITERATURE REVIEW

Different types of experiments and observations are conducted to improve the strength of beam column joint. Beam column joint provide less strength under seismic and reverse loading conditions. An important fact is to improve the strength of beam column joint by providing sufficient strengthening methods.

Literature review helps to know how to strengthen weak beam column joint. A number of papers published about the behavior of beam column joint. The research work mostly done on the behavior of exterior and corner beam column joint.

C. G. Konapure & S. S. Manekari- This paper investigates a study of R. C. C. beam column junction subjected to monotonic loading. The parameter used for the analysis is minimum principle stress, maximum principle stress, stiffness and deformation. Result gives the stiffness of the structure changes the displacement and load increases with respect to displacement and stiffness.

Shabana T S- This paper investigates the finite element analysis of beam column joint with GFRP under dynamic loading. Two codes are used for analysis. IS 13920:1993 and IS 456:2000. Four specimens are taken. Two are wrapped with GFRP and two are unwrapped. Wrapped ones possess strength and stability than unwrapped.

Suhasini M Kulkarni- This paper investigates the cyclic behavior of exterior reinforced beam-column joint with cross-inclined column bars. The parameters used for analysis are grade of concrete, tie ratio, joint aspect ratio, energy dissipation, yield ratio etc. The software used for analysis is ANSYS. The designing and detailing done according to IS 13920:1996 and IS 456:2000. The test results shows that greater the joint aspect ratio shear capacity will be minimum.

III. JOINT MECHANISMS

Functional requirement of a joint, which is the zone of intersection of beams and columns, is to enable the adjoining members to increase and sustain their ultimate capacity. The demand on this finite size element is always severe especially under seismic loading. The joints should have adequate strength and stiffness to resist the internal forces induced by the framing members.

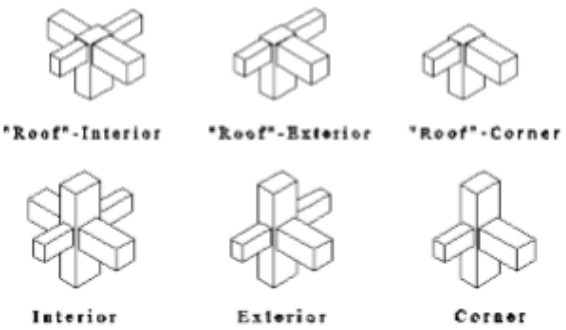

Fig 3.1 Types of joints

The number of forces acting on a joint depends upon the type of the joint and loads acting on it. The effects of loads on the three types of joints are interior, exterior and corner joint. The strong column-weak beam design, beam junction shows form plastic hinges at their ends and develop flexural over strength beyond the design strength. High internal forces are developed at plastic hinges and causes critical bond conditions in the longitudinal reinforcing bars which is passing through the joint. The bond performance of the bars anchored in a joint affects the shear resisting mechanism to a significant extent.

A. Exterior Joint

An Exterior joint has atleast two beams framing into opposite sides of the joint. It is to be classified as an exterior joint, the width of the beams on the two opposite faces of the joint should cover atleast ¾ the width of column, and depths of these two beams shouldn't be less than ¾ the total depth of deepest beam framing into the joint

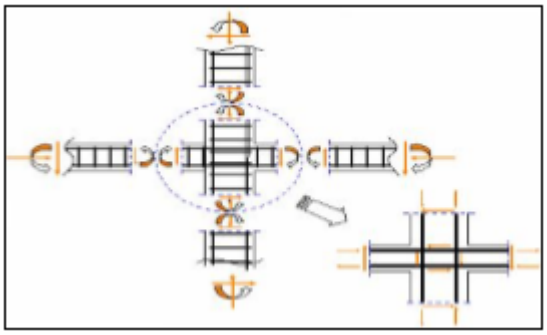

Fig 3.2 Exterior Joint

B. Corner Joint

The Corner joint has atleast one beam framing into the sides of joint. The widths of beam on the face of the joint should cover at least 3/4th the width of the column is termed as corner joint.

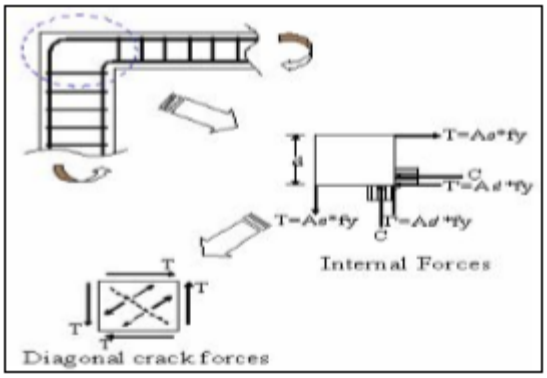

Fig 3.3 Corner joint

C. Framining of Basalt FRP on beam column joint

Basalt fibre is placed on the beam column joint as per experimental observations has been studied. Compression testing machine had been used for the experimental analysis.

Fig 3.4 Test specimen with basalt frp

D. Finite Element Analysis

The numerical and experimental observations had been done by finite element method. The modeling of the specimens were done by software. The experimental observations are studied.

E. Boundary conditions and loading

The studies shows that different types of loading conditions and boundary conditions such that at fixed support at the ends of column specimens of corner joint and 3 specimens of exterior joint were tested with the boundary condition of fixed support at the ends of the column.

IV. CONCLUSIONS

From the studies, the specimen having basalt FRP or any other strengthening materials such as cross inclined column bars are used at the joints possess high resistance to displacement and deformation under static and dynamic loading conditions. The beam column joint at exterior and corner joints with FRP shows more strength than without FRP. Studies shows that experimental and software results are almost similar in the case of cross inclined bars and FRP .

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REFERENCES

[1] N. Ganesan., P.V. Indira., and Ruby Abraham., Steel fibre reinforced high performance concrete Beam-column joints subjected to cyclic loading. ISET Journal of Earthquake Technology., Vol. 44, No. 3-4, Sept.-Dec. 2007, pp. 445–456.

[2] Mrs. S. M. Kulkarni, Dr. Y.D. Patil A State-of-art Review On Reinforced Concrete Beam-column Joints. Journal Of Information, Knowledge And Research In, ISSN: 0975 – 6744., Vol.2, Nov11-oct12, pp.94-98

[3] A.G. Kay Dora., and N.H. Abdul Hamid., (2012), Seismic Performance of SFRC Beam-Column Joint with Corbel under Reversible Lateral Cyclic Loading. IACSIT journal , Vol. 4, No. 1,76-80.

[4] S. S. Patil., S. S. Manekari., A study of R.C.C. Beam-column connection subjected to monotonic loading IJEIT journal, April 2013,Vol.2, 49-58

[5] T. Subramani et al., Finite Element Modelling On Behaviour Of Reinforced Concrete Beam Column Joints Retrofitted With CFRP Sheets Using ANSYS . Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 12(Part 5), December 2014, pp.69-76