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Experimental Behaviour of Beam Column-Joints with Hybrid Fibre Reinforced Concrete

Mr.R.Abhilash[1], Dr.K.Kartheek Babu[2], Mr.K.V.N.Mallikarjuna Rao[3]
[1]*Research Scholar, Rise KrishnaSai Prakasam Group of Institutions, Valluru, India*
[2]*Associate Professor, Rise KrishnaSai Prakasam Group of Institutions, Valluru, India*
[3]*Assistant Professor, Rise KrishnaSai Prakasam Group of Institutions, Valluru, India*

Abstract– The normal conventional concrete has less compressive and tensile strength so to enhance the performance of the Beam column joins Become the weak link to prevent this week. Link superior detailing techniques should be given in the joint region In these areas, high percentage of transfers hoops in the core of the joint is needed in order to Meet required strength toughness stiff And ductility under cyclic flexural loading. Play addition of fibres to seismic joints Without changing the joint design, he is noted to improve the resistance to earthquake loading. A mixture of steel fibre of 70% and 30% polypropylene fibres used in the rainforecement in our specimen. A control specimen of M60 concrete is made with hoop reinforcement. Hybrid fiber reinforced concrete in 0.25%,0.5%,0.75%,1% percentage is made without hoop reinforcement. All the specimen will be subjected under cyclic loading and their performance will be analyzed. Fibre reinforced concrete is a composite partially eliminate the need of confinement (transverse reinforcement) and the associated construction problems in the beam-column connections subjected to earthquake loading. Study of Beam-column joint under seismic excitation which is under horizontal and vertical forces. In that joint the reinforcement should be heavy then only it can withstand high strength. Hoop reinforcement should be given in that joint as per IS 13920-1993.But it is very difficult to execute in field. For that we are going to alternate hybrid fiber as reinforcement. Comparison of shear strength, ductility, Toughness and stiffness which is achieved in fiber reinforced beam and hoop reinforced beam. Under cyclic loading the performance will be noticed and comparison will be done

Index Terms— Seismic Excitation, Earthquake Loading, Reinforcement Techniques, Concrete Performance, Structural Resilience, Fiber-Reinforced Polymers (FRP), Composite Materials

I. INTRODUCTION

In the last few decades earthquakes have struck different parts of the world. Recent earthquakes have demonstrated that most of the reinforced concrete structures specially the beam-column joints are vulnerable during earthquakes. Most of the reinforced concrete structures will need major repairs in the near future to avoid partial or total collapse during earthquakes. Retrofitting of existing structures is one of the major challenges that civil engineers are facing these days. Up gradation to higher seismic zones of several cities and towns in the country has also necessitated in evolving new retrofitting strategies. Judicious detailing of reinforcement is of paramount importance to obtain a ductile response of reinforced concrete structures during earthquake. The detailing is to ensure that the full strength of reinforcing bars, serving either as principal flexural or transverse reinforcement, can be developed under the most adverse condition that an earthquake may impose.

1.2 Historical Perspective

The concept of using fibers as reinforcement is not new. Fibers have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and straw in mud bricks. In the early 1900s asbestos fibers were used in concrete, and in the 1950s the concept was one of the topics of interest. There was a need to find a replacement for the asbestos used in concrete and other building materials once the health risks associated with the substance were discovered. By the 1960s, steel, glass (GFRC), and synthetic fibers such as polypropylene fibers were used in concrete, and research into new fiber reinforced concretes continues today.

Fiber reinforced concrete is a type of concrete that includes fibrous substance that increases its structural strength and cohesion. Fiber reinforced concrete has small distinct fibers that are homogeneously dispersed and oriented haphazardly. Fibers are natural fibres and artificial fibres, namely steel fibers, synthetic fibers, glass fibers, and polyethylene fibers. The characteristics of fiber reinforced concrete are changed by the alteration of quantities of concretes, fiber substances, geometric configuration, dispersal, orientation and concentration of fibres.

1.3 Principle of Fibre Reinforcement High Strength Concrete

Apart from its excellent properties, concrete shows a rather low performance when subjected to tensile stress. Although in constructions pure tensile forces acting on concrete elements are rather scarce, this is not only an academic problem. Even a simple concrete beam under bending conditions has zones with high compressive as well as high tensile stresses.

The traditional solution to this problem is reinforced concrete, where reinforcing bars or pre stressed steel bars inside the concrete elements are capable of absorbing the appearing tensile stresses. Another rather recent development is steel fiber reinforced concrete (FRC). By adding steel fibers while mixing the concrete. This does increase the mechanical properties before failure, but governs the post failure behavior. Thus, plain concrete, which is a quasi brittle material, is turned to the pseudo ductile steel fiber reinforced concrete. After matrix crack initiation, the crakes are arrested by bridging fibers, and the bending moments are redistributed. The concrete element does not fail spontaneously when the matrix is cracked; the deformation energy is absorbed and the material becomes pseudo- ductile. Due to the random distribution of the fibers in FRC, this is a rather difficult task. In RCC buildings, a portion of columns that are common to beams at their intersections are called beam-column joints. Since their constituent materials have limited strengths, the joint have limited force carrying capacity. When forces larger than these are applied during earthquakes, joints are severely damaged. Repairing damaged joints is difficult, and so damage must be avoided. Thus, beam-column joints must be designed to resist earthquake effects.

II. BEHAVIOUR OF BEAM-COLUMN JOINT

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

The joint is defined as the portion of the column within the depth of the deepest beam that frame into the column1.in a moment resisting frame, three type of joints can be identified viz. interior joint, exterior and corner joint (Fig.1). When three beams frame into the vertical force of a column, the joint is called as exterior joint.

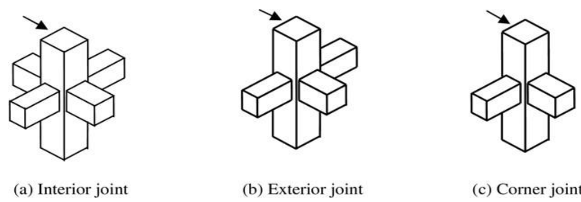

Fig: 1 Types of Joint in a Moment Resisting Frame

III. OBJECTIVES AND SCOPE OF THE INVESTIGATION

To study the behavior of exterior beam column joint designed and detailed as per SP-66 (ACI) with and without fibers. To investigate the load- deflection characteristics, stiffness and ductility under cyclic loads through experimental study. To compare the behavior of all the specimens with the effect of hybrid fibre in the beam-column joint under cyclic loads and also to compare the various parameter like stiffness, ductility and Load carrying capacity. The above said performance with hoop reinforcement and without hoop reinforcement with additional of hybrid fibers in some aspect ratio.

Fibres are usually in concrete to control plastic shrinkage cracking and drying shrinkage cracking. They also lower the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion and shatter resistance in concrete. Generally fibers do not increase the flexural strength of concrete, so it cannot replace moment resisting or structural steel reinforcement. The amount of fibres added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibres) termed volume fraction typically ranges from 0.5 to 1%.

Some recent research indicated that using fiber in concrete has limited effect on the impact resistance of concrete materials. This finding is very important since traditionally people think the ductility increases when concrete reinforced with fibers. The results also pointed out that the micro fibers is better in impact resistance compared with the longer fiber.

IV LITERATURE REVIEW

Eswari et al (2008). presents a study on the ductility performance of hybrid fibre reinforced concrete. The influence of fibre content on the ductility performance of hybrid fibre reinforced concrete specimens having different fibre volume fractions was investigated. The parameters of investigation included modulus of rupture, ultimate load, service load, ultimate and service load deflection, crack width, energy ductility and deflection ductility. The specimens incorporated 0.0 to 2.0% volume fraction of polyolefin and steel fibres in different proportions. The ductility performance of hybrid fibre reinforced concrete specimens was compared with that of plain concrete. The test results show that addition of 2.0% by volume of hybrid fibres improves the ductility performance appreciably. An adaptive Neuro- Fuzzy based model has been proposed to predict the ductility performance characteristics.

Ganesan. Indira el al (2005). have conducted to study the effect of steel fibre on the durability parameter of self-compacting concrete such as permeability water absorption, abrasion resistance, resistance to marine as well as sulphate attack. The variable considered were aspect ratio (0, 15, 25&35) and volume fraction (0, 0.25, 0.5and 0.75%) of steel fibre the water-cement retain of 0.36 by weight and trinity blend of cement, fly ash and silica fume were used. A total of 244 specimens were cast and tested for this study. It was observed that the coefficient of permeability and wear of SFRSC were lower the corresponding moderate strength concrete. Under the marine and sulphate attack.

Gustavo, Parra – Montestion(2005).an overview of recent application of tensile stain hardening, high performance fibre reinforced concrete composites in earthquake –resistance structure is presented. Applications discussed include member with shear-dominated response such as beam-column connection, low rise walls and coupling beams as flexural members subjected large displacement reversals. The result presented in this paper show that HPFCC material are effective in increase in shear strength, displace

V. PROPERTIES OF FIBRES ARE USED

Table1: Properties of Steel Fibers used

S.NO	Technical Data	Details
1.	Length	35mm
2.	Diameter	0.60mm
3.	Aspect ratio	58.33
4.	Modulus of elasticity	210000 Mpa
5.	Tensile strength	1100Mpa
6.	Specific gravity	7.8 g/cc

Table2: Properties of Polyolefin Fibers used

S.NO	Technical Data	Details
1.	Base Resin	Modified Olefin
2.	Length	54mm
3.	Tensile Strength	640 MPa
4.	Surface Texture	Continuously embossed
5.	No. fibres per kg	37,000
6.	Specific Gravity	0.90 - 0.92
7.	Young's Modulus	10 GPa
8.	Melting Point	159°C - 179°C
9.	Ignition Point	Greater than 450°C

VI. SPECIMEN DETAILS

The specimens has been casted on mix 2 which is having 9% silica fume replacement and 1.75% replacement of HRWR.
Six numbers of Beam-Column joint Specimen has been casted with a dimension of Beam

(800X200x150) column (1000x200X150) having 0.054 Cum volume.

The control specimen has been casted with Hoop reinforcement as per IS 13920 and without hoop reinforcement as per ACI 311and the other specimens has been casted without Hoop reinforcement.

The specimens without Hoop reinforcement has been casted with adding some percentage of steel fibre.

Table: 3 specimen description

Specimen Name	Description
ASCH	Control with Hoop reinforcement
ASC	Control without Hoop reinforcement
S1	Without Hoop reinforcement and with 1% volume of steel fibers
S2	Without Hoop reinforcement and with 0.75% volume of steel fibers
S3	Without Hoop reinforcement and with 0.5% volume of steel fibers
S4	Without Hoop reinforcement and with 0.25% volume of steel fibers

VII CASTING AND CURING

The model is arranged properly and placed over a smooth surface. The sides of the mould exposed to concrete were oiled well to prevent the side walls of the mould from absorbing water from concrete and to facilitate easy removal of the specimen. The reinforcement cages were placed in the mould and cover between cages and from provided was 20mm. M60 grade concrete mix designed 1:1.6:2.03 and water cement ratio 0.32 with HRWR. Cement mortar block pieces were used as cover blocks. Silica fume were 8.5% used for replacing of cement. HRWR were 1.25% used for replacing of water. The concrete contents such as cement, silica fume, sand, aggregate, steel fiber, water and HRWR were weighted accurately and mixed. The mixing was done till uniform mix was obtained. The concrete was placed into the mould immediately after mixing and well compacted. Control specimen and cylinder were prepared for all the mixing along with concreting. The test specimens were remolded at the end of 24hours of casting. They are curing in water for 28 days.

Fig.2 Mould Placed for concrete

VIII TESTING

8.1 Experimental Setup

Each specimen was tested under cyclic loading in the structural laboratory. The column of the test assembly was placed in a loading frame. The column was centered accurately using plumb bob to avoid eccentricity. The bottom end was placed in the frictionless surface. In top and bottom of column was hinged. It's used for applying axial load for column and also avoids the movement of column. Dial gauge are used to measure the upward displacements in the beam at a distance of 400 mm from the face of ground.

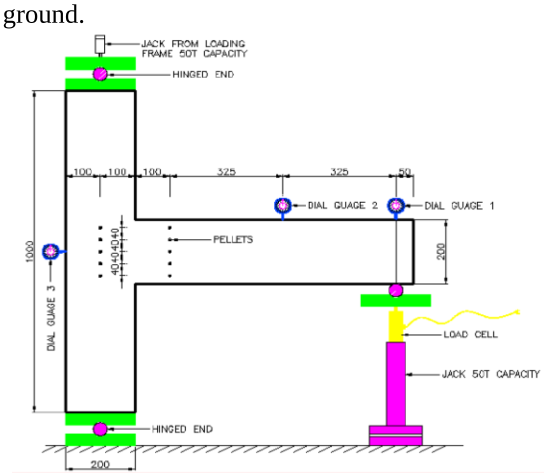

Fig.3 Specimen testing setup

8.3 Test Procedure

The specimen has set up for testing in the fig. 4.9. The Dial gauge 1 fixed at 50mm at free end of the beam for measuring the deflection of beam directly above the Load cell and jack. The Dial gauge 2 fixed center portion for beam between dial gauge 1. In the beam column joint 10 pellets fixed 200mm spacing from center of column for measuring the beam deflection and center with an interval of 40mm. The dial gauge 3 fixed at center point of column for measuring the buckling of column. The pellets dimension 200mm is fixed from center portion of column to 200mm of beam portion shown in fig.4.10 for measuring deflection by five demuc gauge. The deflections are taken by cyclic method. First cyclic starts from 0 to 5kN, second cyclic starts from 0 to 10 kN, third cyclic load starts from 0 to 15 kN and fourth cyclic load starts from 0 to 20 kN. The tabulation drawn for each cyclic load and specimen. The graph will drawn and compare for each specimen and with control specimen.

Fig .4 Testing Setup of specimen

8.4 Comparison of Load deflection of Beams

Fig.5. Comparison of Deflection

Table 4 Comparison of specimen

Specimen Name	Yield load (KN)	Ultimate (KN)	Deflection Ductility
ASC	13	37.26	2.866
ASCH	15	39.28	2.61
S4	14	37.54	2.68
S3	14	37.42	2.67
S2	15	39.32	2.62
S1	14	38.32	2.73

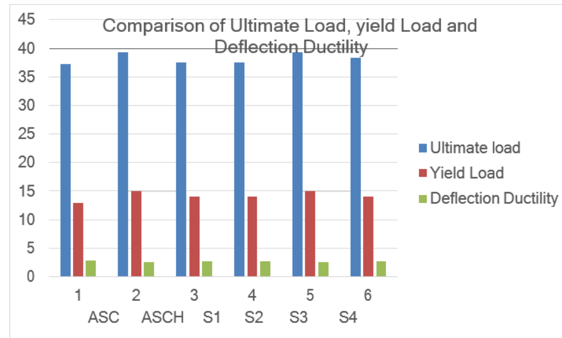

Fig 3.14 Comparison of Ultimate Load, Yield Load, and Deflection Ductility

VI. CONCLUSION

In this thesis, four number of Fiber reinforced high strength concrete specimens and two number of control specimen (with and without Hoop reinforcement) tested under cyclic loading and has concluded that the effective application of hybrid fibers in the beam column joint concrete mix results in partially improved joint behavior under seismic loading, in particular with an increased ductility and ultimate load than control specimen.

In general, it is concluded that the effect of adding hybrid fibres influence the behavior of beam column joint by increasing the ductility characteristics and initial ultimate load and load carrying capacity. The hybrid fibre volume fraction of 0.25%,0.5% with 70% - 30% steel polyolefin combine significantly improves the overall performance of high-strength reinforced concrete In the fraction of 0.75%and1% the strength slightly decreased,

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AUTHOR PROFILE

R.Abhilash, Civil Engineering Department, Rise Krishna Sai Prakasam Group of Institutions, Ongole. Pin Code: 523001

Dr.k.kartheekbabu M.Tech, Professor, Civil Engineering Department, Rise Krishna Sai Prakasam Group of Institutions, Ongole. Pin Code: 523001

Mr.K.V.N.Mallikarjuna Rao, Assistant professor, Civil Engineering Department, Rise Krishna Sai Prakasam Group of Institutions, Ongole. Pin Code: 523001