STRENGTHENING OF THE BEAM COULMN JOINT USING MIXED FIBERS LITERATURE REVIEW

Ms K.Prassana Karunya Devi[1], P.Vetri Selvi[2], Dr.M.Rama[3]

[1]II Year, M.E(Structural), RVS Technical Campus, Coimbatore, Tamil Nadu
[2]Assistant Professor, Department of Civil Engineering, RVS Technical Campus, Coimbatore, Tamil Nadu
[3]Assistant Professor, Department of Civil Engineering, Government College of Technology, Coimbatore, Tamil Nadu

---

Abstract:- It's critical to ensure the structure's ductility in earthquake- resistant design, which means it should be able to deform elastically and disperse energy without collapsing. During an earthquake, the external joint of a beam-column junction reacts more critically than the interior joint. According to the literature, polypropylene and steel fibers have improved many desired qualities of concrete. As a result, these fiber materials can be used in these joints to improve joint performance. Polypropylene is a polymeric polymer, and steel fibers are made from prime grade hard-drawn steel wire to ensure high tensile strength and close tolerances. A review of the literature on these mixed fibers reveals no notable work on beam-column joints employing these mixed fibers, particularly under cyclic loads. As a result, in the current study, these mixed fibers materials were employed for beam column joints to see how the strength, stiffness, ductility, and energy dissipation capacity of the joints changed or improved. Three one-third (1/3rd) scaled beam column joints were cast with plain RC and RC fibers in this study. IS: 13920, which includes similitude requirements, has been used to detail all of the specimens. The specimens were subjected to cyclic load testing. The experiments were carried out with a 100kN capacity servo hydraulic actuator (manufactured by MTS).

***Key Words*: Concrete, Fiber reinforced Concrete, Polypropylene fiber.**

1. INTRODUCTION

1.1 General

Concrete is the most commonly utilized building material. Concrete is made up of aggregates and paste (rocks). The fine (small) and coarse (bigger) aggregates are coated with a paste made primarily of Portland cement and water. The paste solidifies and increases strength through a series of chemical reactions known as hydration, resulting in the rock-like mass known as concrete. Concrete has a high compressive strength and has less corrosive or weathering impacts. Green or freshly mixed concrete can be easily handled and moulded into practically any shape or size as needed.

1.2 Significance of Concrete

Concrete is one of the most long-lasting construction materials. When opposed to timber construction, it is more fire resistant and gains strength over time. Concrete structures can have a lengthy service life. Concrete is the most widely utilized man-made substance on the planet. Although concrete has a great compressive strength, it has a poor tensile strength. Steel bars or short randomly distributed fibers are used to reinforce concrete in instances where tensile stresses emerge, resulting in Reinforced cement concrete (RCC) or fiber reinforced concrete. Concrete possesses flexural and splitting tensile strengths in addition to its compressive strength. Concrete is a non-combustible substance that is both fire-resistant and temperature- resistant.

Plain concrete has a low tensile strength, minimal flexibility, and low crack resistance. Internal micro fractures are a natural feature of concrete, as is its low tensile strength.

1.3 Fiber Reinforced Concrete

Fiber reinforced concrete is a type of concrete that contains fibrous material to improve structural strength. It is made up of short discrete fibers that are uniformly dispersed and orientated randomly. Steel fibers, glass fibers, synthetic fibers, and natural fibers are all types of fibers that give concrete different qualities. In addition, different concretes, fiber types, geometries, distribution, orientation, and densities modify the nature of fiber-reinforced concrete. Fiber is a small bit of reinforcing material with a unique set of properties. They come in a variety of shapes and sizes, including circular and flat. A useful measure termed "aspect ratio" is frequently used to define the fiber. The length-to-diameter ratio of a fiber is known as its aspect ratio. Aspect ratios often range from 30 to 150.

1.4 Polypropylene Fiber

It's utilized as a continuous mat for manufacturing thin sheet components or as a short discontinuous fibrillated material for making fiber reinforced concrete. Since then, the utilization of these fibers in the construction of structures has skyrocketed since adding fibers to concrete improves its toughness, flexural strength, tensile strength, impact strength, and failure mode.

2. LITERATURE REVIEW

A building's beam-column joint is one of its most important components. Several scholars looked at the methods for strengthening the beam-column joint. To boost the strength, one technique is to add fibers. The general review of journals connected to Fiber reinforced concrete, beam column joint, steel fiber reinforced beam column joint, and hybrid fiber reinforced beam column joint was presented in this chapter, and they are mentioned in the references section at the end of the report.

2.1 REVIEW OF LIERATURE

Bindhu K.R et al (2009) compared the behaviour of exterior beam-column joint sub assemblages with transverse reinforcements detailed as per IS 456 and IS 13920.One of the outside beam-column joints at an intermediate storey is intended for a six-story RC structure in Zone III. The columns were 3 meters long and had a cross section of 450300 mm, while the beams had a cross section of 300450 mm. The analysis was carried out with a live load of 3 kN/m2 and a floor finish of 1 kN/m2. The thicknesses of the external and internal walls were 250 and 150 mm, respectively. He came to the conclusion that all of the specimens failed due to the formation of tensile cracks at the beam-column interface, ensuring that the strong-column weak-beam requirements were met. With the exception of a few hairline cracks in the joint region, the joints were in good condition.

IRJET sample template format, Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable

Isler.O (2008) investigated the damage caused by earthquakes in Turkey and devised techniques to reduce earthquake damage. The last and most severe earthquake in Turkey happened on May 1, 2003, in Bingol. The earthquake had a magnitude of 6.4 at its epicenter. Many structures were severely damaged, and others completely collapsed, as a result of the earthquake. Encouragement of the use of appropriate materials and ready-mix concrete will ensure that damage is minimized in the event of future earthquakes. In addition, the widespread usage of shear walls, especially in low-rise buildings, could be an alternate method of preventing earthquake damage. Finally, instead of considering the biaxial earthquake impact, an analysis of a structural system under seismic stresses should incorporate the three-dimensional earthquake effect.

Muthuswamy K.R and Thirugnanam G.S et al (2014) identify the potential of hybrid fibre reinforced concrete (HFRC) as a ductile material which can be used for the construction of beam-column joints. The test specimen for this experimental investigation was a fifth-scale model of an exterior beam-column joint made of conventional concrete and fibre reinforced concrete. Cyclic loading was used on the specimens. The load-bearing capacity, load-deflection behavior, ductility, energy absorption, stiffness, and failure patterns of joints have all been investigated. When hybrid fibre is used in the RCC beam-column joint, the first crack load is increased by 61% and the ultimate load is increased by 33%. When compared to the traditional RCC beam- column joint, the cumulative ductility of the HFRC beam- column joint has been enhanced by 1.5 times. The HFRC beam-column joint's cumulative energy absorption capability was 1.8 times that of a traditional RCC beam- column joint.

Kaliluthin. A. KandKothandaraman. Setal (2014) investigate the seismic performance of RC beam column joint designed a per IS 456 as reference joint, IS 13920 as ductile joint and cor reinforcement as core joints.The column had a cross section 200mm by 150mm and a length of 800mm. The bea measured 150mm x 200mm (depth) and 6000mm in lengt from the face of the column. The basic conclusion is that the proposed core joint outperformed the other two types of joint investigated. The core joint's initial fracture load was 15.2 percent higher than the reference and ductile joints. Fo reference and ductile joints, however, the load at first crac remained constant. The ultimate load carrying capability of th core joint was found to be 25.5 percent higher than that of th reference joint and 6% higher than that of the ductile joint. Th load deflection behavior of the reference joint and core join was found to be similar, with the ultimate deflection in th reference joint being 19mm, 18mm in the ductile joint, an 16mm in the core joint. When compared to the Reference join the stiffness factor of the core joint increased by 38 percen and by 17 percent when compared to the ductile joint. Th ductility factor of the core joint was 50% higher than th reference joint and 25% higher than the ductile joint

Mustafa Gencoglu and Ilhan Eren (2002) evaluated th behavior of a Steel Fiber Reinforced Concrete beam-colum joint (SFRC). Under displacement controlled stress, fou specimens exhibiting an exterior beam column joint exposed t reverse cyclic loading were examined in this investigation. Th application of SFRC in crucial parts of beam-column joint increased the strength capacity for bending moment and shea forces, according to the experiments. Steel fibers prevent cros bending or shear cracks and reduce crack breadth by bridgin between two sides of cracks; also, SFRC raises the concret section's shear capability. It is suggested that SFRC be used i conjunction with regularly spaced stirrups in order to preven shear cracks in beam-column joints under reverse cycle stres The use of SFRC in beam-column joint specimens subjected t reversed cyclic loads can raise the total energy quantities in th specimens.

Priti. A. Patel et al. (2012) using polyester fiber studied the performance characteristics of non-ductile reinforced concrete (RC) beam-column connections. 1 percent, 1.5 percent, and 2 percent by volume fiber doses were employed. The load-deflection behavior, energy dissipation, stiffness, and specific damping capacity of non-ductile PFRC beam-column connections were all evaluated as part of the test program. It was found that when the fibre volume percentage grew, the ultimate strength capability of the beam-column connection increased. In comparison to the non-ductile control specimen, the PFRC beam-column connections experience a considerable displacement (50 mm) (35mm). The PFRC specimens did not develop broader cracks, indicating that polyester fibers give the beam-column connection ductility. The stiffness degradation rate of PFRC specimens is reduced when polyester fibre is added, compared to the control specimen ND. The energy dissipation of control specimen ND was poor, whereas all PFRC specimens dissipated energy better than ND. This also suggests that polyester fiber has a positive impact.

Murugesan.A et al. (2015) compared the strength of a traditional beam column joint with a beam column joint made of steel fibers. Using STAADPro, a two-bay five- story reinforced cement concrete moment resisting frame for a general building was evaluated and developed in accordance with IS 1893-2002 code processes and detailed in accordance with IS 13920-1993 recommendations for a general building. A 1/5th scale model of an exterior beam column joint was created, and the specimen was subjected to cyclic stress to evaluate its behavior during earthquake loading. The beam dimension of the specimen was 305 mm X 460 mm, including the slab thickness, and the column dimension was 305 mm X 460 mm. The beam and column have set dimensions of 120 mm x 170 mm and 120 mm x 230 mm, respectively. The beam's length and the height of the test specimen's column are 1130 mm and 620 mm, respectively.

The beam's length and the height of the test specimen's column are 1130 mm and 620 mm, respectively. The addition of steel fibers at the junction raised the ultimate load carrying capacity of the beam column joint by 11%. SFRC's cumulative ductility factor increased by 70% higher than RC's. The cumulative energy absorption capability of the SFRC beam column joint has increased by approximately 10%. The addition of steel fibres increases the initial stiffness of the test specimen by 93%. In both SFRC and RC, the crack pattern is nearly identical, and the cracks are located away from the junction in both specimens.

Ganesan, N. et al. (2007) studied ten steel fiber specimens of external beam-column joints under cyclic load in an experiment. The concrete utilized was of the M60 grade. The volume fraction of the fibres used in this investigation ranged from 0% to 1%, with 0.25 percent increments. Positive cyclic loading was used to test joints, and the results were analyzed for strength, ductility, and stiffness. As fibres were added to beam-column joints, the rate of stiffness deterioration was significantly reduced when compared to joints without fibres. As a result, the technique of incorporating steel fibres into beam column joints looks to be a viable option for joints that are subjected to cyclic or recurrent loading. During testing, it was discovered that adding fibers to the joints could increase their dimensional stability and integrity. By replacing the steel reinforcement in the beam-column joints, it is also possible to lessen the congestion of steel reinforcement.

Tamil Selvi.M and Thandavamoorthy T.S,(2013) studied the compressive strength, split tensile strength of steel, polypropylene fibre and hybrid polypropylene and steel (crimped) fibre reinforced concrete. Casting is used to make cubes and cylinders. Tensile strength tests are performed, both compressive and split. When compared to ordinary concrete of M30 grade, SFRC (Steel Fibre Reinforced Concrete) cubes exhibit a 41 percent increase in compressive strength after 7 days, with 14th and 21st days equal strengths and 14 percent increase at 28 days. 2. When comparing PPFRC (Polypropylene Fibre Reinforced Concrete) to conventional concrete for M30 grade, the compressive strength of PPFRC (Polypropylene Fibre Reinforced Concrete) increases by percentages of 11, 10,

18 and 11, respectively, at 7, 14, 21, and 28 days. 3. Compressive strength data for Hybrid Polypropylene and Steel (crimped) Fibres 7, 14, 21, and 28 days demonstrate a decrease in compressive strength for percentages of 22,

10, 3, and 9 when compared to conventional concrete for M30 grade. PPFRC split tensile strength measurements for 30 grade concrete indicate increases of 21, 10, 27, and 25% at 7, 14, 21, and 28 days, respectively, when compared to conventional concrete. Split tensile strength data for concrete reinforced with Hybrid Polypropylene and steel (crimped) fibres show a 7% increase in 7 days, a 15% decrease in 14 days, equal strength in 21 days, and a 5% rise in 28 days when compared to conventional concrete for M30 grade.

Romanbabu M. Oinam et al. (2013) used steel and polypropylene fibers to investigate the exterior beam column junction. With ordinary RC and RC fibres, three one-third (1/3 rd) scaled beam-column joints were created.

All of the specimens have been specified according to IS: 13920, which include similitude requirements. The first example, which was made of RC, served as a control. A percent of polypropylene fibre was added to the second specimen, and a percent of steel fibre was added to the third specimen. To create a comparison study, all specimens were evaluated under cyclic loading. The specimens were put through a cyclic load test. The testing were carried out with a 100kN servo hydraulic actuator (manufactured by MTS). The comparison was made in various plots such as the envelope curve, stiffness, energy dissipation, and ductility. The following significant conclusions are formed based on the interpretation of the results.

Perumal.P and Thanukumari.B investigated the behaviour of beam column joint with steel and polypropylene fibres Using M20 concrete, the seismic performance of seven one-fourth scale exterior beam- column junctions was investigated. The first and second examples were planned and detailed without and with seismic loads, respectively, and were cast with no fibers. The other five specimens were comparable to the first, but with different mixtures of cocktail fibre concrete in the joint area. Cocktail fibre is made up of a consistent percentage of steel fiber (1.5%) and 0 to 0.6 percent polypropylene fibres. Ultimate strength, ductility, energy dissipation capacity, and joint stiffness were all measured and compared. Four of the five fibre specimens were cast using this method (constant 1.5 percent of steel fibre and 0 to 0.6 percent polypropylene fibres).

Jose' I Restrepo and Cheng-Ming L in developed a behavioral model to figure out what factors affect the behavior and strength of inner beam-column junctions in earthquake-resistant reinforced concrete frames. In addition, the research studies a database and presents equations for horizontal joint reinforcement design. The analytical model proposed in this study is based on the lower bound theorem of plasticity and evaluates the internal force flow within a joint panel using strut and tie models. To determine their relative relevance, several variables that are likely to affect the shear strength of the joints were explored. Some assumptions are made and analytical studies were done.

Geethanjali.C et al Under cyclic loads, examined the behavior of Hybrid Fibre Reinforced Concrete in Exterior Beam-Column Joints. M40 concrete mix has been designed according to IS10262-2009 with a water cement ratio of 0.4. Six exterior beam column joints were cast and tested using a fibre combination of steel and Polypropylene with a volume fraction of 0.5 percent. The column is 200 mm x 150 mm in cross section, with an overall length of 1000 mm, and the beam is 150 mm x 200 mm in cross section, with a cantilever part of 1000 mm. When compared to beam column joint specimens with SFRC, cracking load increased in hybrid fibre reinforced beam column joint specimens with fibre content of S0.5P0.5 and S0.75P0.25 correspondingly. The addition of fibres was discovered to bridge the cracking effects and delay the emergence of the initial crack.

Prof. Meher Prasad.A and Uma.S,R explain the seismic effects on various types of joints and highlight the essential elements that influence joint performance, with a focus on bond and shear transfer. The overall behavior of various types of joints in reinforced concrete moment resisting frames is examined in this work. The mechanisms underlying joint performance in terms of bond and shear transfer are thoroughly examined and explained. The level of axial stress and the number of transverse reinforcements in the joints appear to be important factors affecting bond transmission within the joint. The parameters that affect the shear demand and shear strength of the joint are explained. The design of shear reinforcement within the joint and its detailing aspects are also discussed. A significant amount of ductility can be developed in a structure with well-designed beam-column joints wherein the structural with properly engineered beam-column joints, a large amount of ductility can be created in a structure.

Surinder Pal Singh (2012) looked into the flexural fatigue strength of Hybrid Fibre Reinforced Concrete (HyFRC) using various proportions of steel and polypropylene fibers. Approximately 115 flexural fatigue tests were done as part of an experimental program to determine the fatigue lifetimes of HyFRC specimens at various stress levels. Different amounts of steel and polypropylene fibres were used in the specimens, i.e. 75-25 percent, 50-50 percent, and 25-75 percent. The total volume fraction of fibres was kept at 0.5%. Experiments have been conducted to obtain the flexural fatigue lives of HYFRC with 0.5% fibre volume fraction incorporating different combinations of steel and polypropylene fibres. The test data has been used to develop S-N-Pf curves for HYFRC and a relationship between stress level, fatigue life and survival probability has been determined.

The material coefficients of the fatigue equation **representing** family of S-N-Pf curves have been obtained for HYFRC containing different proportions of steel and polypropylene fibres. The equation can be used to predict the flexural fatigue strength of HYFRC using the coefficients obtained in this investigation. However, the results obtained are applicable to the type and size of the fibres used and additional research work is required to develop equations for other type and size of the fibres.

2.2 Observation from literature Review

This chapter dealt with the journals related to the Fiber reinforced concrete, beam column joint, steel fiber reinforced beam column joint, Hybrid fiber reinforced beam column joint.

3. MATERIAL USED

3.1 Cement

The Ordinary Portland Cement of 43 Grade conforming to IS 12269 – 1987 was used in this study. The specificgravityand initial setting of OPC 43 grade were 3.15 and 35 minutes respectively.

3.2 Fine Aggregate:

Locally available river sand conforming to grading zone II of IS 383 – 1970. Sand passing through IS 4.75mm Sieve will be used with the specific gravity of2.65.

3.3 Coarse Aggregate

Machinecrushedangulargranitemetalof 20mmnominalsize from the local source was used as coarse aggregate. The specific gravity and water absorption of coarse aggregate were investigated as 2.68 and 1.17%. The impact value and abrasionfactorofcoarseaggregatewere 14.13%and24.6%.

3.4 Water

Water used for mixing and curing must be free of oils, acids, alkalis, salt, sugar, organic, and other substances that could harm concrete. For mixing and curing, potable water is generally regarded as adequate.

3.5 Steel Fiber

The material length of 50 mm and its diameter of 0.75 mm with the aspect ratio of 67.

3.6 Polypropylene fiber

The properties of polypropylene fibers are fibrillated and its length of 12mm and melting point of 162^{0} C and specific gravity 0.91 with the diameters of 14 microns suspected aspect ratio to be 12mm

4. CONCLUSION

Detailed literature survey gives us a theoretical knowledge about the Strengthening of beam column joints using the mixed fibers in a conventional concrete. From these literatures it is understood that partial replacement of mixed fibers upto 20% shows good physical and mechanical properties in concrete and cohesiveness of concrete increased The material testing carried out shows that the materials that are to be used for the concrete are of the required quality and strength.

REFERNCES

1) **Anbuvelan.K and Subramanian.K(2014)** “A comparative study of Strength Properties of Exterior Beam- Column joint” Journal of Applied Sciences Research 2014 May; 10(5).

2) **Anbuvelan.K and Subramanian.K(2014)** Behaviour of High Performance Steel Fiber Reinforced Concrete in Exterior Beam- Column joint – A General review Australian Journal of Basic and Applied Sciences, 8(7) May 2014

3) **Arabi Nawwaf Saoud AL Qadi, Kamal Nasharuddin Bin Mustapha, Sivakumar Naganathan, Qahir N. S. AL-Kadi (2011)** “Effect of

4) Polypropylene Fibres on Fresh and Hardened Properties of Self-Compacting Concrete at elevated temperatures” Australian Journal of Basic and Applied Sciences, 5(10): 378-384, 2011 ISSN 1991-8178

5) **Bindhu K.R, Sukumar P.M. and Jaya. K.P. (2009)** “Performance of Exterior beam-column joints under seismic type loading” ISET Journal of Earthquake Technology, Paper No. 503, Vol. 46, No. 2, June 2009, pp. 47–64

6) **Durai S, Boobalan SC, Muthupriya P, Venkatasubramani R (2013)** “Behaviour of high performance concrete in exterior beam column joint- A General Review” Indian Journal of Engineering , Volume 3, Number 6, April 2013.

7) **Ganesan.N, Indira P.V. and Ruby Abraham(2007)** "Steel Fibre Reinforced High Performance Concrete Beam-Column Joints Subjected to Cyclic Loading" ISET Journal of Earthquake Technology, Technical Note, Vol. 44, No. 3-4, Sept.-Dec. 2007, pp. 445–456

8) **Geethajali.C, MuthuPriya.P,.Venkatasubramani.R (2014) "Behaviour of HFRC Exterior Beam Column Joints under Cyclic loading" International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 5, May 2014 1568.**

9) **Isler.O (2008)** "Seismic performances and typical damages of beam- columnJoints in the RC buildings" The 14thWorld Conference on Earthquake Engineering-2008, Beijing, China.

10) **Kaliluthin.A.K, Kothandaraman.S (2014)** "Experimental investigation on behaviour of reinforced concrete beam column joint" International Journal Civil and Structural Engineering, Volume 4, No 3, 2014.

11) **Murugesan.A, Shankar.D, Venkatesan.M, Thirugnanam.G.S (2015)** "Seismic response of RC and SFRC beam column joints" Integrated Journal of Engineering Research and Technology ISSN NO. 2348 – 6821

12) **Mustafa Gencoglu, Ilhan Eren (2002)** "An Experimental Study on the Effect of Steel Fiber Reinforced Concrete on the Behaviour of the Exterior Beam-Column Joints Subjected to Reversal Cyclic Loading" Turkish J. Eng. Env . Sci.26 (2002), 493-502..

13) **Nassim Ghosni, Bijan Samali, Hamid Valipour** "Evaluation of Mechanical Properties of Steel and Polypropylene Fibre Reinforced Concrete Used in Beam Column Joints".

14) **Perumal.P, Thanukumari.B(2010)** "Seismic performance of hybrid fibre reinforced Beam - Column joint" International Journal of Civil and Structural Engineering Volume 1, No 4, 2010

15) **Uma.S.R, Meher Prasad.A** "Seismic behaviour of beam column joints in moment resisting frames" Document No. : IITK-GSDMA-EQ31-V1.0 Final Report :: A - Earthquake Codes IITK-GSDMA Project on Building Codes

16) **Tamil Selvi.M, Thandavamoorthy T.S, FIE(2013)** "Studies on the Properties of Steel and Polypropylene Fibre Reinforced Concrete without any Admixture" International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 1, July 2013.

17) **Shende.A.M., Pande.A.M, Gulfam Pathan.M (2012)** "Experimental Study on Steel Fiber Reinforced Concrete for M-40 Grade" International Refereed Journal of Engineering and Science (IRJES) ISSN (Online) 2319-183X, (Print) 2319-1821 Volume 1, Issue 1 (September 2012), PP. 043-048.

18) **Surinder Pal Singh (2011)** "Fatigue Strength of Hybrid Steel-Polypropylene Fibrous Concrete Beams in Flexure" The Twelfth East Asia-Pacific Conference on Structural Engineering and Construction