COMPARATIVE STUDY ON BEAM COLUMN JOINT IN DIFFERENT FIBERS USING NDT

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ABSTRACT

In this paper an attempt was made to establish Non Destructive testing technique for the estimate of compressive strength of M25 grade of concrete using different types of fibers (Steel and Glass fibers). Beam-column joint connections are crucial in framed structures because they play a crucial role in the load-carrying moments of reinforced concrete structures.This paper presents two NDTs - Ultrasonic Pulse Velocity tool (PUNDIT) and Schmidt rebound hammer test done on beam column joints connections, in this paper is about evaluating the beam column joint connections in different fibers using NDT. Laboratory experiments and other test data from the literature were used to gather the data that was used to determine the values and test the model. To increase the joints' ability to resist forces, numerous researchers have studied joints utilizing various methodologies, materials, and healing approaches.According to the literature, steel and polypropylene fibers have improved a number of concrete's desired qualities. In our research paper a comparison study was made on polyprolene and steel fibers using Non destructive method.

Key words: Non-Destructive Evaluation, pulse velocity, Rebound Number, Steel fiber and Glass fibre, loading Frame, Deflection

1. INTRODUCTION

Beam-column joints are the areas of columns that are shared by beams at their junctions in RC constructions. As the lateral and vertical load-bearing components in RC structures, beam-column junctions are particularly prone to failure during earthquakes; therefore, their confinement is essential to an effective seismic strengthening approach.One of the primary reasons for the collapse of many moment-resistant reinforced concrete (RC) frame buildings in recent earthquakes is shear failure of the beam-column joints. Recent earthquake evidence shows that weak beam-column couplings can compromise the structural integrity of the entire building.The total ductility of structures is also greatly reduced by the brittle joint shear failure, leading to risky failure modes. Beam-column junctions made of reinforced concrete (RC) that break too soon risk experiencing significant lateral deformations and ultimately collapsing.The soft-story columns may be a result of inadequate detailing of the beam-column joints, which may lead to bursting failures, shear failures, and anchorage failures. Beam-column joints, a crucial component of structural design, are essential for preventing earthquake loading.

Fig1:BeamandColumnjoint

1.2. OBJECTIVE

- To investigate the behavior of the beam-column joint at theexterior
- To find the ultimate moment capacity of beam-column jointusing steel and Polypropylene fiber.
- To identify the performance of a concrete using NDT
- Toanalysisthecrackpattern atthejoint

1.3.SCOPE

- To find themaximum load bearing capacity of beam columnjoint
- Thescopeoftheproject studyistostudytheincreaseloadcarryingcapacityofbeamcolumn jointconnection
- Comparison between normal beam-column joint connection with steel fibres and Polypropylene fiber.

2. EXPERIMENTAL METHOD

2.1. BEAM-COLUMNJOINT-(IS 456:2000)

A.BEAMDESIGN

Givendata:

Breadth=100mm

Depth=200mm

Length =700mm

Characteristic strength of concrete =20 [N/mm^2]

Grade of steel =415[N/mm^2]

Clearcover=25mm
Effectivecover=20+5
25mmOveralldepth-effectivecover=
200–25=175[mm]

STEP1:ULTIMATEMOMENT OFRESISTANCE

Mulimit=0.138×fck×b×d^2

=0.138×20×100×175^2=8452[KNm]

STEP2:BALANCESECTION[0.48d]

AccordingtocodeIS456:2000,Clause38.1[xu/d](limit)=0.48forfe415
According to code IS 456:2000, ANNEX- G 1.1
(a)[xu/d]=[0.87×fy×Ast[req]]/[0.36×fck×b×d
0.48=[0.87×415×Ast[req]] /[0.36×25×100×175]
Ast[req]=209.38[mm]

STEP3:TENSIONREINFORCEMENT

AccordingtocodeIS456:2000,Clause26.5.1.1(a)
Theminimumtensionreinforcementshouldnotbelessthanthefollowing
As=0.85bd/fy
As = 0.85×100×175/415As=35.84[mm$^{2]}$
AccordingtocodeIS456:2000,Clause26.5.1.1(b)
Themaximumareaoftensionreinforcementshallnotexceed0.04bD=0.
04bD=0.04×100×200=800[mm$^{2]}$
Provide2no'sof10 mmdiameterbar(Ast=157.08[mm2]
Ast[provided]=2×0.77×102=157.08[mm^{2}$_{]}$

According to code IS 456:2000, ANNEX- G-1.1

(a)[xu/d]=[0.87×fy×Ast[provided]]/[0.36×fck×b×d]=[0.87×415×15
7.08]/[0.36×25×100×175][xu/d]=0.47
0.47<0.48
HencedesignasunderreinforcedsectionAccording to code
IS 456:2000, ANNEX- G-1.1(b)
Mu=0.87×fy×Ast×d[1-(Ast×fy)/(b×d×fck)]
=0.87×415×157.08×175[1-(157.08×415)/(100×175×25)]
=8.43[KNm]<10.56[KNm]
Thereforebeamisunderreinforcedsection

STEP:4 COMPRESSIONREINFORCEMENT

AccordingtocodeIS456:2000,Clause26.5.1.2

The maximum area of compression reinforcement shall not

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exceed0.04bD

=0.04bD

=0.04×100×200

=800[mm^2]

Provide2no'sof10mmdiameterbar(Ast=100.53mm^2)

STEP:5DESIGNFORSHEARREINFORCEMENT

Mu = W×8.43×106=W×500

W=17.8KNTakeVu=W=17.8[KN]

Nominalshearstress

The following equation shall be used to determine the nominal shear stress in beams of uniform depth.

Shearstress[-v]= Vu/b*d

=17.8×103/[100×175]

=0.1[N/mm2]

Where,

Vu=Shearforceduetodesignloads;b=breathofthemember

d=effectivedepth

Percentageofsteel

[Pt]=100×Ast/[b×d]

=100×157.08/[100×175]

=0.89

AccordingtocodeIS456:2000,Table193.90>0.612

Therefore, shear reinforcement shall be

providedAccordingtocode**IS456:2000clause26.5.1.5**.

The maximum spacing of shear reinforcement measured along

theaxisof=1.79

i.e.,0.8>1.79 <6,

Hencewithinthelimit

STEP:2LATERALTIES

For vertical stirrups and inclined stirrups at 45°, the member's maximum depth shall not be greater than 0.75d, where d is the effective depth of the section under consideration. The distance can never be greater than 300 mm.

Accordingtocode**IS456:2000,Clause26.5.3.2(c)**

The polygonal links' or lateral ties' diameter must not be less than one-fourth of the greatest longitudinal bar's diameter and in no instance less than 8 mm. As a result, use 8 mm diameter bar for lateral ties that are bigger than one fourth the diameter of 10 mm diameter bar's longitudinal bar.

Provide 8mm diameter bars for lateral ties.

SPACING OFLATERALTIES

AccordingtocodeI**S456:2000,Clause26.5.3.2(c)**

The spacingoftransverse reinforcement

=0.75d

=0.75×175

=131.25 mm

Provide100mmspacingof stirrups

AccordingtocodeIS456:2000,Clause26.5.1.6

Stirrups must be used as the very minimum shear reinforcement to ensure

Provide two-legged stirrups with an 8 mm bar at 100 mm center-to-center.($ASV=56.54mm^2$)

B.COLUMNDESIGN

STEP:1LONGITUDINALREINFORCEMENT

Accordingtocode**IS456:2000,Clause26.5.3.1(a)**

The longitudinal reinforcement's cross-sectional area must not be less than 0.8 percent nor greater than 6 percent of the column's total cross-sectional area.

Provide4 no'sof10mmdiameterbars

$$Ast = 4\times\pi/4\times10^2$$

$$=314.16mm2$$

$$Percentageofsteel[Pt]=100\times Ast/(b\times d)$$

$$=100\times314.16/(100\times175)$$

$$= 1.79$$

i.e.,0.8 > 1.79 < 6, Hence within the limit

STEP : 2 LATERAL TIES

According to code **IS 456:2000, Clause 26.5.3.2 (c)**

The polygonal links' or lateral ties' diameter must not be less than one-fourth of the greatest longitudinal bar's diameter and in no instance less than 8 mm.

Adopt 8 mm diameter bar instead, which is bigger than one-fourth the diameter of the longitudinal 10 mm diameter bar, for the lateral ties.

Provide 8mm diameter bars for lateral ties.

STEP : 3 SPACING OF LATERAL TIES

According to code IS 456:2000, Clause 26.5.3.2 (c)

Transverse reinforcement z must be spaced no further apart than the shortest of the following distances:

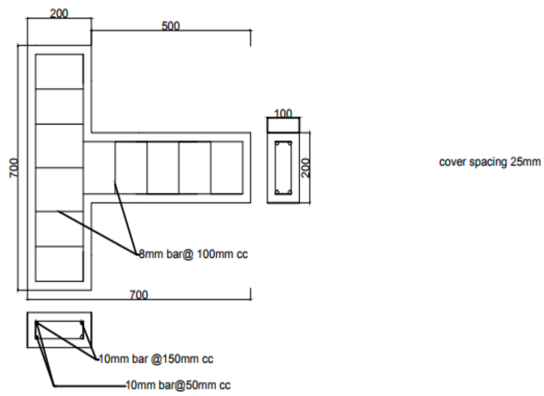
1. The compression members' smallest lateral dimension is 100 mm.

2. 2. The longitudinal reinforcing bar that needs to be tied must be sixteen times its lowest diameter (16 x 10 = 160 mm).300 mm.
3. The least of the above three dimensions is100 mm. Therefore the spacing should be less than or equal to 100

Provide 8mm diameter @100mm centre to centre lateral tires

2.2. DETAIL DRAWING OF REINFORCEMENT

a) Re inforcement detail of beam-column joint



2.3. Characteristics of the concrete mixtures

S.no	Materials	unit	Plain Concrete	Steel fibre reinforced concrete	Polyester fibre reinforced concrete
1	Cement	kg/m^3	430	430	430
2	Aggregate (12mm)	kg/m^3	910	910	910
3	Sand	kg/m^3	445	445	445
4	Water	kg/m^3	180.6	180.6	180.6
5	Fibre	kg/m^3	-	0.5% - 12 1.0% - 24 1.5% - 36	0.5% - 12 1.0% - 24 1.5% - 36

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Fig 2: Steel Fibres

Fig 3: Polypropylene Fibers

3. EXPERIMENTAL SETUP AND TESTING

As shown in Figure 3.1, the self-straining load frame, hydraulic loading jack, and load cell are set up to deliver a concentrated force. Linear Variable Differential Transformers (LVDT) are attached where the specimen's requisite deflections are needed.The specimens for the beam-column joint with the control specimens were connected by a bracket at the joint to record the ultimate load and deflection on the specimens, as illustrated below.

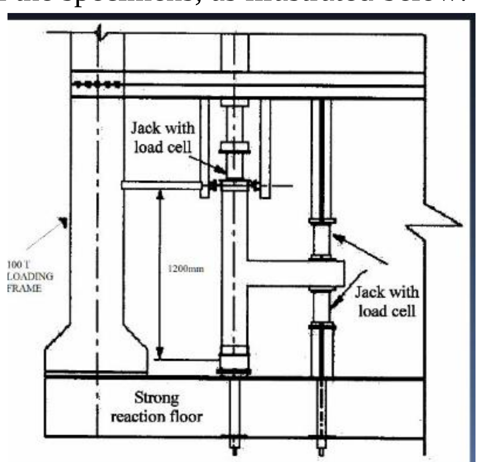

Fig 3.1 Testing of Beam-Column Specimens in Loading Frame

Table 1-Size of Model

Model	Size (mm)
Column Length	700
Beam Length	500
Beam column joint cross joint	200x100

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Preparation of specimen

Preparation of specimens include different stages like

(i) Mould Preparation

(ii) Steel cage fabrication

(ii) Steel Placing

(iii) Concreting

(iv) Curing

. This is clearly explained in the following section.

Figure 3.2 –Preparation of mould with reinforcement.

Figure3. 3 – Concreting of the specimens

Testing of specimen

Fig 3.4 Rebound Hammer

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Fig 3.5 Testing of concrete by Rebound Hammer

NON-DESTRUCTIVE TESTS

Rebound Hammer Test.

The following non-destructive tests are performed on the beam-column joint specimen as indicated in fig. 3.6 to assess the quality and integrity of concrete, and the corresponding results Are listed in table 3.

Designation	Specimen
CM	Control mix
PFCC	Polypropylene Fibre Cement C oncrete
SFCC	Steel Fibre Cement Concrete

Fig 3.6- Testing of Beam column joint by Rebound Hammer

Fig 3.7- Specimen Placed On Loading Frame for Testing

4. RESULTS AND DISCUSSIONSULTIMATELOADTEST

4.1 In general, the goal of the current inquiry was to compare the performance of various fibre kinds at beam-column joints by looking at their breaking load capacities. Additionally, NDT evaluations were performed on these specimens.

Table 2-Evaluating the crack and deflection

First crack is the load that corresponds to the first crack that is evident. Table 3 provides the ultimate load and first crack load determined for each specimen. In the table below, the specimen designations are provided.

Table 3-NDT

Designation	Specimen	Rebound Hammer Number (N/mm^2)
CM	Control mix	27
PFCC	Polypropylene Fibre Cement Concrete	28
SFCC	Steel Fibre Cement Concrete	28.5

Table 4-Comparision of Specimens using loading frame

Fig 3.8- Beam-Column Joint –Cracks

Table 4-Comparision of First crack and Final Load

Specimen	Initial crack Load(KN)	Final Load (KN)	% Increase in Ultimate load
CM	15	22	-
SFCC	22	32	45.45 %
PFCC	12	25	13.63%

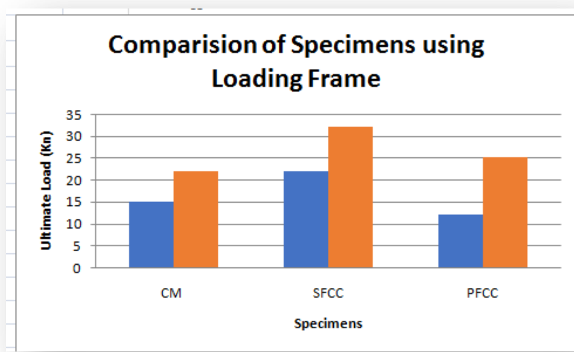

Fig. 4.1: Graphical Representation of Initial Crack and Final Load

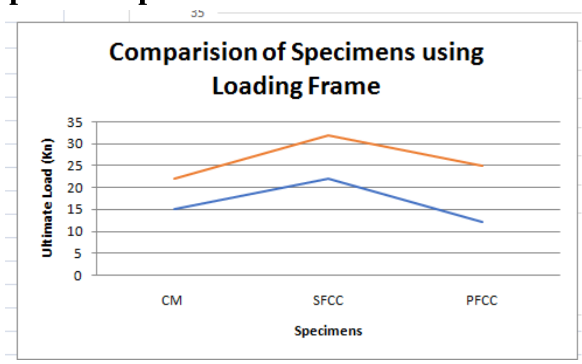

Fig. 4.2: Graphical Representation of Initial Crack and Final Load

CONCLUSIONS

From the Table 4 makes it evident that, when compared to the control specimen, the fibre modified specimen exhibits notable increases in first crack load and Final load. The findings indicate that using SF increased the ultimate load by roughly 32%.The BCJ with fibres is stronger than the conventional joint. Steel fibre reinforced concrete, which is one of the fibres used, inhibits high strength at first crack and Final load. Polypropylene and fibre reinforced concrete, however, exhibit a slight improvement in resistance at first crack. The result of the rebound hammer test is obtained from the table 3 shows the quality concrete.

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