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Experimental Investigation on Torsional Behaviour of Beam-Column Joint Wrapped with Aramid fibre

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Abstract— In this work the experimental investigation of Beam-Column Joint subjected to Torsional loading has been found weak due to adequate Torsional Design provisions, design capacity considerations and for ductile detailing behavior. Experimental tests showed that heavy damage to beam-column joint in particular outer that is corner joint which is lead to the collapse of structure. Now a day inspection of Civil Engineering structures has most of them will need major repairs in the upcoming day and up gradation to heavy seismic zones of some countries and towns has also necessity involving new strengthening method. one of the important methods of strengthening to RC beam-column joint structural members with wrapping of fiber on surface of concrete. Beams-column joint externally wrapped with Aramid fiber was test to failure using an arrangement which transfer Torsional moment to the joint of the Beam-Column through two opposite cantilever moment arms. Each arm is subjected to equal constant loading during the experiment. Total 9 beam-column connection specimen were cast and tested for the experimental study. Out of 9 beam-column joint specimen, 3 specimens are control beam-column joint. 3 specimens are control beam-column joint with extra reinforcement for torsion and 3 beam-column connection specimens full wrapped with Aramid fiber. Experimental observation on ultimate load & first crack loads and failure pattern of every Beam-column joint specimen is obtained.

Keywords- Aramid Fiber, Torsion, Beam-Column joint, Strengthening.

I. INTRODUCTION

In RC structure the part of column that is common to the beams at intersection of beam-column joint. This beam-column joint material having limited strength and forces carrying capacity environmental condition, old code provision, when the forces are more than these occur during earthquake this beam-column joint damaged in that case retrofitting of damage beam-column joint is difficult due to this damage of beam-column joint avoid hence beam-column joint must be designed to resist earthquake. Fiber reinforced polymers have been used many times in automotives and aerospace industries. Most of the structure are constructed as per the old design code in the world this are unsafe according to new design code since replacement of such structure take much money and time hence it is necessary to find repairing techniques suitable in terms of low cost and fast work process. In the world most of the structure constructed with help of concrete as the time passes detoriation and change of requirement facilities need for new structure. Externally wrapping of FRP fabric sheet can be used to increase the Torsional capacity of beam-column joint. The FRP material such as Aramid fiber having high strength tough and highly organic fiber derived from polyamide is useful for strengthening beam-column joint. The aim of this paper to examine the Torsional behavior of beam-column joint and the performance of Aramid fiber in rehabilitation of damaged beam-column joint. And experimental result and the Torsional capacity of controlled beam-column joint, design for torsion beam-column joint and fully wrapped with Aramid fiber beam-column joint obtained.

Aramid Fiber

aramid fiber having highest weight to strength ratio of any commercially available reinforcement fiber in 1970s. Aramid fiber is also high tensile strength, tough and highly oriented organic fiber

manufactured from polyamide. Aramid fiber is used in bullets resistance jacket. This fiber had good abrasive resistance and under cyclic loading, they can abrade against each other by weakening the sheets. Aramid fiber is a formed from synthetic products characterized by strength some five times stronger than steel on an equal weight basis and heat-resistance and high tensile strength. Physical properties of Aramid fiber are given in Table 1

Table No.1 properties of Aramid fiber

	Description	**Specification**
Property	Weave style plain	Plain
	Areal Weight of Fabric	300
	Standard width (mm)	1000
	Dry Fabric Thickness(mm)	0.25
Mechanical Properties of Fiber	Tensile Strength (Mpa)	2400 to 3600
	Tensile Modulus (Gpa)	60 to 120
	Elongation Percentage (%)	2.2 to 4.4

II. EXPERIMENTAL WORK

The experimental work consist of casting RC Beam-Column Joint in that 3 of specimen controlled Beam-Column Joint, 3 specimen of Design for torsion Beam-Column Joint, and 3 specimen of fully wrapped with Aramid fiber Beam-Column Joint and curing this specimen for 28 days and testing this test specimen under "Universal testing machine".

A) Details of Beam-Column Joint specimen

SET-I: 3 Controlled Beams-Column Joint Specimens
SET-II: 3 Beams-Column Joint Specimens Design for Torsion
SET-III: 3 Beams-Columns Joint Specimens Continuously Fully Wrapped.
SET-I and SET-III- the Dimension of all the Beams-Column Joint specimens is same. The cross sectional dimension of the both the set of Beam is 200 mm x 100 mm and length is 1000 mm and column 200mm x 100mm and length 600 mm, in Beam 2nos, 8mm bar at Top and 3,8mm bars at Bottom, for column 3nos ,8mm both Top and Bottom.
SET-II- Beam and Column 2nos, 8 mm diameter bar as provided at bottom and 2nos, 8 mm diameter bar provided at mid depth of beam and 2nos, 8 mm diameter bar provided at top. 6 mm diameter bars used as stirrups at a spacing of 100 mm centre to centre throughout the span. The casting of beam-column joint as per the IS code 456-2000 specification using M_{30} grade of concrete with 20 mm size of coarse aggregate.

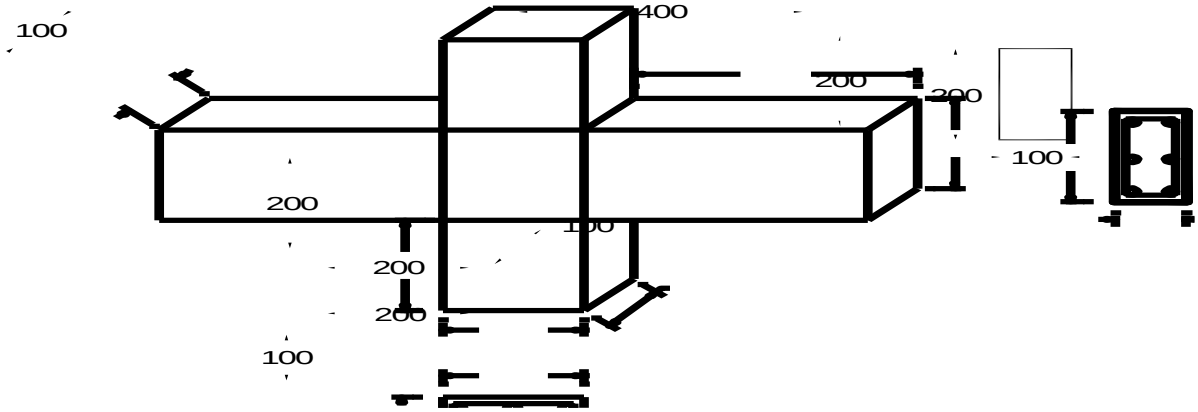


Fig.1 Specimen Design For Torsion

B) Test specimen preparation

As per the experimental work the description of beam-column joint specimen given in the table No.2The outer surfaces of the beam-column joint were cleaned using polish paper to ensure the bond between Aramid fiber and concrete surface. The 3 beam-column joint test specimen externally wrapped with Aramid fiber and epoxy at the outer face of beam-column joint as per the procedure given by the manufacturer.

Table No.2 Description of Test Specimen

Set No	Type of Beams-Column Joint	Beams-Column Joint Designation
I	Controlled specimen	C1
		C2
		C3
II	Design for Torsion	T1
		T2
		T3
III	Fully wrapped Beams-Column Joint	W1
		W2
		W3

Fig.2 Casting Beam-Column Joint Specimen

Fig.3 Fixing Aramid Sheet on Beam-Column Joint Beam-Column Joint

C) Test setup

The test specimens of beam-column joint were fixed on universal testing machine such that the both end of column were fixed by universal testing machine. the projection of beam on either side of column fixed by cantilever arm with hydraulic jack at distance of 0.30 m from support of beam. The test setup of beam-column joint as shown in fig. below

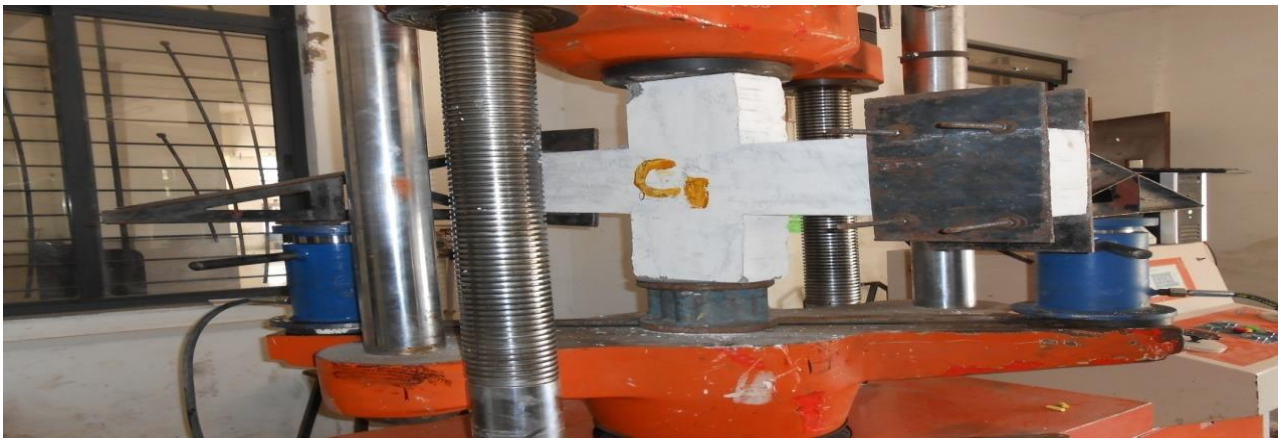


Fig.4 Experimental setup for controlled Beam-Column Joint specimen

Fig.5 Experimental for Beam-Column Joint Design For Torsion No.T1

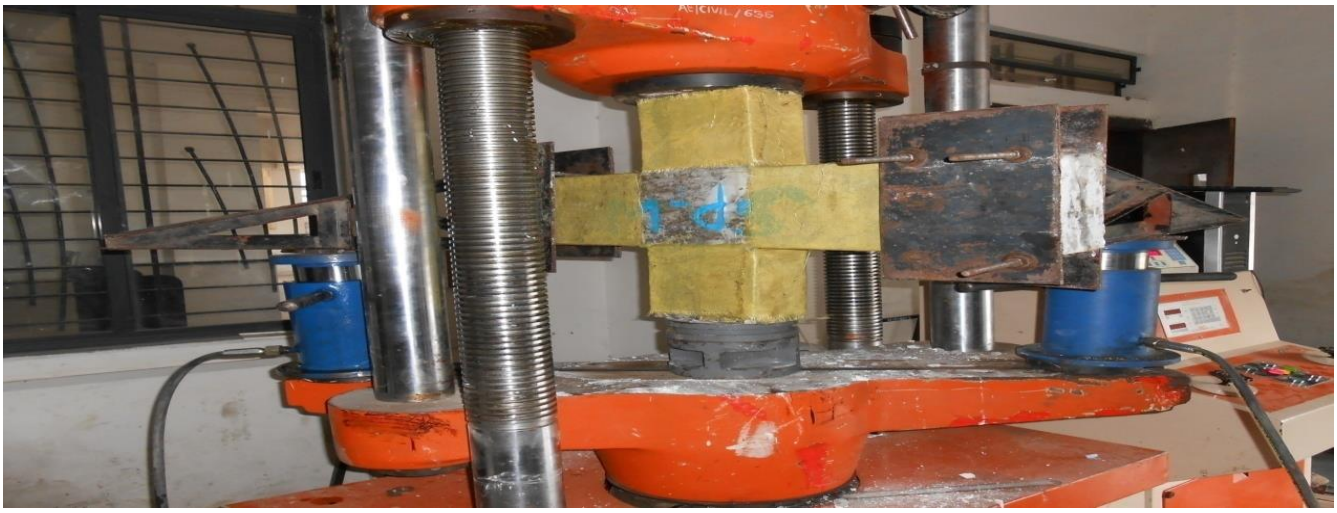


Fig.6 Experimental setup for Beam-Column Joint No.W1

D) Cracking pattern

At the time of testing following crack pattern observed.

Fig.7 Controlled Beam-Column Joint No.C1 after cracking

Fig.8 Beam-Column Joint No.T1 after cracking

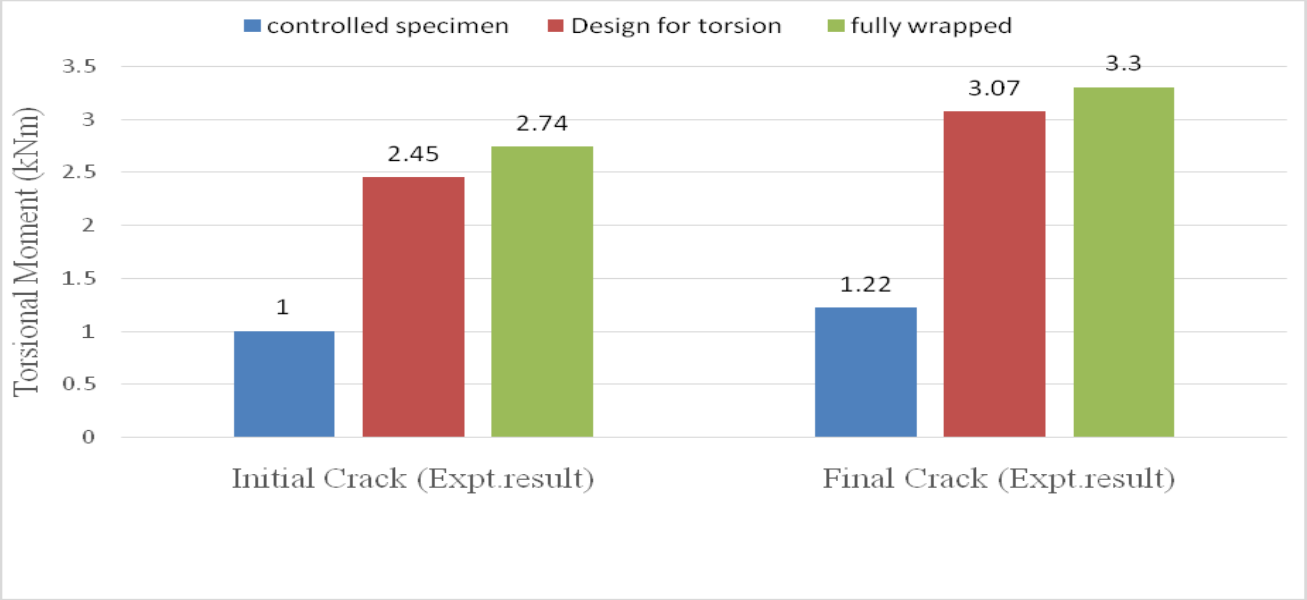
Fig.9 Twisted shape of the Beam-Column Joint No.W1

III. TEST RESULT AND GRAPH

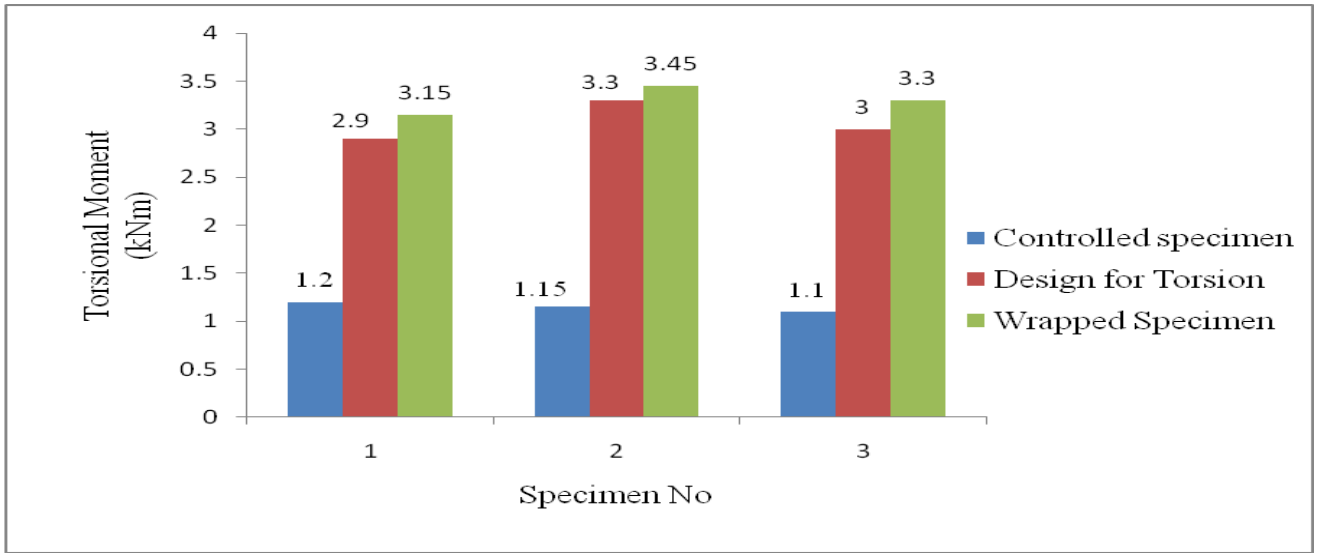
after testing the Torsional capacity of the entire Beam-Column Joint specimen workout. Following are the experimental test result of all Beam-Column Joint at initial and final crack.

Table No. 3 Initial and final crack load capacity of Beams-Column Joint

Set No	Type Of Beams-Column Joint	Designation	Torsional Moment (kN-m)	
			Initial crack	Final crack
I	Controlled Beams-Column Joint	C1	0.98	1.2
		C2	1.15	1.35
		C3	0.88	1.1
			1.0	**1.22**
II	Design for Torsion	T1	2.37	2.9
		T2	2.43	3.3
		T3	2.54	3.0
			2.45	**3.07**
III	Fully wrapped Beams-Column Joint	W1	2.52	3.15
		W2	2.93	3.45
		W3	2.78	3.3
			2.74	**3.3**



Graph No.1 Experimental result of initial, final crack of controlled, design for torsion and fully wrapped Beam-column joint



Graph 4.2 Experimental Result of Controlled, Design for Torsion and fully wrapped Beam-column joint

IV. CONCLUSIONS

- After the experimental result it is found that the Torsional capacity of controlled Beam-Column Joint as compare to Design for Torsion and fully wrapped Beam-Column Joint Increased.
- As compare to Controlled Beam-Column Joint specimen the Torsional capacity of torsionally design Beam-Column Joint enhanced by 60%.
- As compare to controlled Beam-Column Joint specimen the Torsional capacity of wrapped Beam-Column Joint enhanced by 62%.
- The crack in controlled Beam-Column Joint Specimen is 45° and this angle increased with horizontal in wrapped specimen.
- Ductility of wrapped Beam-Column Joint enhanced as compare to controlled Beam-Column Joint Specimen.

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