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EXPERIMENTAL STUDY ON SHEAR STRENGTHENING OF RC T-BEAMS WITH WEB OPENINGS USING FRP COMPOSITES

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ABSTRACT
Sudden fall of reinforced concrete is may be knows as catastrophic and as the name suggest it is catastrophic, that simply means that it is sudden in nature. No any intimation or no cracks are seen in reinforced concrete. On many old constructions it is found that there is significant damage has been occurred and they need a rework for strengthening. Conventional strengthening methods used for strengthening of shear e.g. post tensioning, enlargement of member along with internal transverse steel, and bonded[1] steel plates are very much cost. Moreover this method requires an extensive manpower, modern equipment, significant time and involvement of much labor. This study was carried out keeping in mind the shear performance and different catastrophic failure modes of RC- T beams modified with bonded GFRP sheets.
Keywords: RC T-Beams, FRP Composites

I. INTRODUCTION

In the past decade it is seen that natural disasters are increasing day by day, it if giving an toughest challenge to civil engineers to keep the buildings safe even in case of natural disaster. When it comes to natural disaster, the most dangerous one is earth quake. Because an earth quake is the most dangerous one and cause many lives as compared other natural disaster. Advancement in technology has given more accurate measurement about earth quake and study are been more accurate now [2]. As the earth quake frequency may increase in coming days as per prediction of researchers, to keep the building safe the seismic demands calculated for making structures of building need to be revised and follow strictly. The designs of constructions are changing day by day, with rich research in the area of seismic engineering. The building designs with old structures may or may not follow norms practice today. The complete demolish and re-construction is not possible, because it will incur a heavy loss. So existing solution is retrofitting, it will not incur much cost and it can improve beams load carrying capacity. Another advantage of retrofitting is also increased the service lives. Retrofitting is done in order to improve seismic level withstand capacity of the building [3]. Retrofitting also has many other advantages of not falling in natural disaster like flood, earth quake, and other unwanted hazards.

FIBRE REINFORCED POLYMER (FRP)

Composition comprises of fibers of high tensile strength with a polymer matrix and other material line vinyl ester or may be an epoxy is called fiber reinforced polymer (FRP). Many innovations in technology have gained an importance after the Second World War. Usage of FRP has became an very important in many engineering application such as manufacturing of helicopter, aircraft, submarines, satellites, chemical processing equipment and various civil engineering marvels [4]. The major role of FRP material is to strengthen the existing infrastructure. Another biggest advantage of FRP material it increases the speed of construction and possibility of applying it without altering an current construction infrastructure. The use of FRP material is mainly to strengthen existing RCC structure to withstand normal and seismic loads.

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II. EXPERIMENTAL WORK

Structure of a 11 RCC T-beams having span of 1300mm, 150mm width, 125mm deep web, 350mm wide flange, and having an effective depth of 125mm. Two groups are made for measurement for carrying out this experiment. Group 1 consists of 2 nos of 20mm dia and 1 number of 10mm dia, high yielding strength deformed bars (HYSD) for reinforcement of tension. Another provision of four bars of 8mm dia is used as a hang up bars and without use shear reinforcement.

Group 2 consists of 2 nos of 20mm dia and 1 no of 10mm dia high yielding strength deformed bars are used for reinforcement of tension. As in earlier case four bars of 8mm dia are used an s hang up bars and without use of shear reinforcement at spacing of around 200mm.

a. MATERIAL PROPERTIES: CONCRETE

Experiment is conducted with the following properties of concrete, it is specified in table no. 1, and also it is as IS: 456:2000. Another important aspect is water to cement ratio is fixed at 0.55. The mixing of water and concrete is done by using machine (concrete mixer) for better blend. The curing period of bars had been 28 days [5]. For each beam six samples of 150 x 150 x 150 mm concrete cube speciments and six samples of 150mm x 300mm cylindrical moulding structure is were made and it also kept for curing at the time of casting. Determination of compressive strength is taken on 7th and 28th days and are presented in table no. 2.

Table 1: Concrete ingredients as per IS: 456:2000

Description	Cement	Sand (Fine Aggregate)	Coarse Aggregate	Water
Mix Proportion (by weight)	1	1.67	3.33	0.6
Quantities of materials for one specimen beam (kg)	44.4	74.11	147.85	22.5

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Table 2: Test results after 28 days

Specimen Name		Size of Cube Specimen	Size of Cylinder Specimen	Average Cube Compressive Strength (Map)	Average Cylinder Compressive Strength (Map)
Group-A	Solid beam	150x150x150	150φ x300	35.23	25.15
	CBA	150x150x150	150φ x300	35.88	20.93
	SBA2-1	150x150x150	150φ x300	36.5	21.86
	SBA2-2	150x150x150	150φ x300	34.87	23.72
	SBA2-3	150x150x150	150φ x300	36.47	20.46
	SBA4-1	150x150x150	150φ x300	37.86	26.82
Group-B	Solid beam	150x150x150	150φ x300	30.83	21.08
	CBB	150x150x150	150φ x300	32.56	22.75
	SBB2-1	150x150x150	150φ x300	31.89	20.74
	SBB2-2	150x150x150	150φ x300	35.4	23.5
	SBB2-3	150x150x150	150φ x300	36.77	24.87

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b. CEMENT

Cement is one material without it civil engineering would not exist and as on today it is readily available. Cement comes in a form of fine powder. By addition of water to cement the paste can me make and when it is applied and kept to dry it will become a solid mass. Another many adhesives are added to cement powder. Another many organic compounds are added, for an adhering or fastening materials are called as cement material. But these materials are termed as adhesives. The Portland cement is most widely used material. Portland cement (PSC) of knar made was used for performing this instrument. The Portland cement used here having a specific gravity of 2.96.

c. FINE AGGREGATE

Sand or fine aggregate can be termed as accumulation of grains of mineral matter, all matter are derived from the disintegration of stones and rocks [6]. Distinguish between gravel and fine aggregate can be judge only by size. Sand is basically used for mortal and concrete, also it is use for polishing and sandblasting. Sand that contains little even smaller amount of clay is generally made for making molds in foundries. In general sands are used for filtration of water. The aggregate/sand having specific gravity 2.64. The grading zone of fine aggregate is of zone 3 as per IS: 383- 1970.

d. COARSE AGGREGATE

This material is very important for making an concrete and also to give an strength to concrete. The big stone is passed through a process of pulverization i.e. quarried, graded and crushed. Much of the crushed stone used is granite, trap rock and lime stone. The two types of coarse aggregates are used for performing this experiment.

The minimum size of coarse aggregate are of 10mm and maximum size of 20mm size sieve. The coarse aggregate used here are of specific gravity 2.88 confirming to IS: 383:1970.

e. REINFORCING STEEL

HYSD (high yielding strengthen deformed (HYSD) bars confirming to Indian standards IS 1786:1985. The two sizes of the bar used in this experiment are 20mm and 10mm diameter. Most important part of the structure i.e. stirrups are made of 8mm dia.

TABLES AND FIGURES: The observation of 11 nos of RC-T beams for the experimental program is shown below. Their analysis throughout the test is described with respect to initial crack load and ultimate load carrying capacities are observed in great detail.

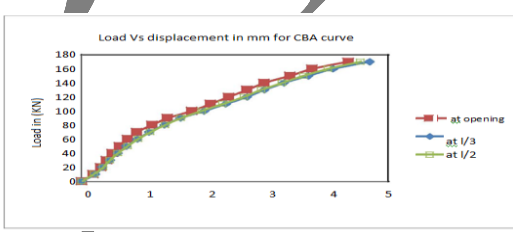

Figure 1 : Load Vs displacement for CBA curve

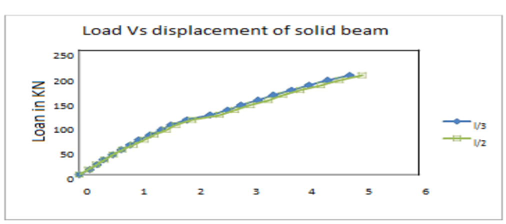

Figure 2 Load vs. displacement for solid beam

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Table 3: Comparisons of experimental and ACI predicted shear strength results

Speci-men	Experimental Results						Theoretical results predicted by ACI 440.2R-02 Design approach			
	Load at failure	*Vn,test (kN)*	*Vc,test (kN)*	*Vs,test (kN)*	*Vf,test (kN)*	*Vf,test/Vn,test)*100 (%)*	*Vf,theor (kN)*	*Vc,theor (kN)*	*Vs,theor (kN)*	*ϕVn,theor (kN)*
Solid beam	208	104	104	-	-	-	-	17.55	0	14.91
CBA	172	86	86	0	-	-	-	16.01	0	13.6
SBA2-1	180	90	86	0	4	4.44	11.2	16.36	0	21.74
SBA2-2	220	110	86	0	24	21.81	11.2	17.05	0	22.33
SBA2-3	210	105	86	0	19	18.09	11.2	15.83	0	21.29
SBA4-1	230	115	86	0	29	25.21	17.89	18.12	0	27.92
Solid beam	240	136	106.8	29.2	-	-	-	16.06	29.21	38.48
CBB	140	70	48.8	29.2	-	-	-	16.69	29.21	14.18
SBB2-1	198	99	48.8	29.2	21	21.21	11.2	15.94	29.21	46.21
SBB2-2	184	92	48.8	29.2	14	15.21	11.2	16.96	29.21	47.08
SBB2-3	214	107	48.8	29.2	29	27.1	11.2	17.45	29.21	47.5

From the above table it is seen that the prediction done in ACI gives satisfactory and good results as compared to experimental results for all RS-T beams.

III. CONCLUSIONS

The conclusion drawn here is purely on the basis of experimental findings. RS-T beams strengthened by GFRP sheets are studied in a great detail to observe performance of various types of loads.

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1. By the application of FRP system to the existing system, the shear capacity of RC-T beams can be increased.
2. The experiment performed also verifies the falange anchorage effectiveness increase in the shear capacity of RC beams.
3. The combination of GFRP reinforment to increase shear capacity results shear span to depts ratio (a/d).

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IV. REFERENCES

[1] ACI 440.2R-02, "*Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures"*, Reported by ACI Committee 440.

[2] Al-Amery R., and Al-Mahaidi R. (2006), *"Coupled flexural-shear retrofitting of RC Beams using CFRP straps",* Construction and Building Materials, 21, 1997-2006.

[3] Alex L., Assih J., and Delmas Y. (2001), *"Shear Strengthening of RC Beams with externally bonded CFRP sheets"*, Journal of Structural Engineering, Vol. 127, No. 4, Paper No. 20516.

[4] Balamuralikrishnan R., and Jeyasehar C. A. (2009), "*Flexural behaviour of RC beams strengthened with Carbon Fiber Reinforced Polymer (CFRP) fabrics"*, The Open Civil Engineering Journal, 3, 102-109.

[5] Bousselham A., and Chaallal O. (2006), *"Behavior of Reinforced Concrete T-beams strengthened in shear with carbon fiber-reinforced polymer –An Experimental Study"*, ACI Structural Journal, Vol. 103, No. 3, pp. 339-347.

[6] Ceroni F. (2010), *"Experimental performances of RC beams strengthened with FRP materials",* Construction and Building materials, 24, 1547-1559.

[7] Chen J. F., and Teng J. G. (2003), "*Shear capacity of FRP-strengthened RC beams: FRP debonding"*, Construction and Building Materials, 17, 27-41.

[8] Khalifa A., and Nanni A. (2000), *"Improving shear capacity of existing RC T-section beams using CFRP composites",* Cement & Concrete Composites, 22, 165-174