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EXPERIMENTAL STUDY ON BEAMS USING POLYPROPYLENE SHEETS BY RETROFITTING METHOD

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Abstract: Retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion etc. Many of the existing reinforced concrete structures throughout the world are in urgent need of rehabilitation, repair or reconstruction because of deterioration due to various factors like corrosion, failure of bonding between beam-column joints etc. Polypropylene Fibre Reinforced Polymer (PFRP) composite has been accepted in the construction industry as a promising substitute for repairing and in incrementing the strength of RCC structures. This work presents the experimental study on strengthening of RC beam with Polypropylene Fibre Reinforced Polymer (PFRP). Totally 12 RC beam specimens were casted & tested in this work. The beam dimensions considered for this study are 700 x 150 x 150 mm & 700 x 150 x 300. Fe500 grade steel and M30 grade concrete has been used for the casting beams. Beams are tested at a interval of 7,14,28 days of curing. The reinforced beams were retrofitted with single layer of U- shape & FULLY wrapped by PFRP sheets on full length of the beam. The beam specimens were tested under two point loading and the load-deflection behavior was observed up to failure. Also the maximum load, the stress strain behavior and the complete crack patterns were recorded and presented.

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I. INTRODUCTION

In the earlier it was thought that concrete will be a maintenance free Structure. Later on, this myth has proved wrong. Due to majority of Civil Engineering structures being RCC and on account of its requirement of maintenance, quantum of such rehabilitation/strengthening work has also increased tremendously. Constant maintenance and repairing is needed to enhance the life cycle of those structures which are deteriorated. Retrofitting of reinforced concrete element is traditionally accomplished by externally bonding steel plates to concrete. Although this technique has proved to be effective in increasing strength and stiffness of reinforced concrete elements, it has the disadvantages of being susceptible to corrosion and difficult to install. In the last decade, the development of strong epoxy glue has led to a technique which has great potential in the field of upgrading structures. Basically the technique involves gluing steel plates or fibre reinforced polymer (FRP) sheets to the surface of the concrete. The sheets then act compositely with the concrete and help to carry the loads. Also recent development in the field of composite materials, together with their inherent properties, which include high specific tensile strength good fatigue and corrosion resistance and ease of use, make them an attractive alternative to any other retrofitting technique in the field of repair and strengthening of concrete elements.

II. SCOPE OF WORK

- To increase flexural strength of the beam.
- To increase lifetime of the structure.
- To repair without dismantling.
- Reducing the cost of construction from whole to part.
- To study about structural behavior of beam.

III. METHODOLOGY

- Testing of Materials
- Casting of beams
- Testing of Beams
- Retrofitting of Beams
- Comparisons of Results

A. MATERIAL PROPERTIES

- Cement
- Fine aggregate
- Coarse aggregate
- Water

B. MIX DESIGN

It is defined as the process of selecting ingredients of concrete and determining of concrete their relative proportions with object of producing concrete of certain minimum strength and durability as economical as possible. The purpose of designing as can be seen from definition of two folds. The first objective is to achieve the stipulate minimum strength and durability. The second objective is to make the concrete in most economical manner. Cost wise all concrete depends preliminary on two factors, namely cost of materials and labor.

C. CONCEPT OF MIX DESIGN

The relationship between aggregate and paste which is the two essential ingredients of concrete. Workability of mass is provided by the lubricating effect of the paste and is influenced by the amount and dilution of paste, since mineral aggregate with rare exceptions. Since the proportion of concrete are governed to a considerable extend by the quality

of paste, it is helpful to consider more closely the structure of the paste. The fresh paste is a suspension, not a solution of cement in water. The more dilute the paste, the greater spacing between cement particles and thus the water will be the ultimate paste structure. The strength of concrete varies as an inverse function of W/C ratio. Since the quality of water required also depends upon the amount of paste, it is important that as little paste as possible should be used. There is no standard method of designing concrete mixes incorporating hypo-sludge. Hence the method of mix design proposed by IS 10262-1982 was employed to design the natural aggregate concrete and partial replacement aggregate to obtain the mixes. The purpose of mix propositioning is to reduce properties in both plastic and hardened concrete.

IV. RESULTS AND DISCUSSION

The test results of experiments conducted on twelve RC beam specimens with and without PFRP wrapping has been presented. The beams were tested in UTM machine under two point loading till the first crack occurs. Then the beams were retrofitted using single layer U-wrapping & FULLY-wrapping of PFRP composites. Stress strain curves are also presented in this experiment.

Load differences between NORMAL and U- WRAPPED beams

CURING PERIODS	BEAM TYPE	LOAD AT FIRST CRACK(KN)	LOAD AFTER RETROFITTED(KN)
7 DAYS	SQUARE	170.3	191.8
	RECTANGLE	330.1	399.4
14 DAYS	SQUARE	200.9	181
	RECTANGLE	359.2	392.8
28 DAYS	SQUARE	192.9	224
	RECTANGLE	396	578.2

Load differences between NORMAL and FULLY- WRAPPED beams

CURING PERIODS	BEAM TYPE	LOAD AT FIRST CRACK(KN)	LOAD AFTER RETROFITTED(KN)
7 DAYS	SQUARE	183.4	201.9
	RECTANGLE	378	411.6
14 DAYS	SQUARE	184.2	211.2
	RECTANGLE	399	448.2
28 DAYS	SQUARE	233	272.9
	RECTANGLE	335.8	526

Deflection between NORMAL and U- WRAPPED beams

CURING PERIODS	BEAM TYPE	LOAD(KN) NOR	LOAD(KN) RET	DEFLECTION(mm) NOR	DEFLECTION(mm) RET
7 DAYS	SQUARE	170.3	191.8	0.09	0.103
	RECTANGLE	330	399	0.023	0.028
14 DAYS	SQUARE	200.9	181.9	0.108	0.09
	RECTANGLE	359.2	392.8	0.025	0.028
28 DAYS	SQUARE	192.9	224	0.10	0.12
	RECTANGLE	396	578.2	0.028	0.0413

Deflection between NORMAL and FULLY- WRAPPED beams

CURING PERIODS	BEAM TYPE	LOAD(KN) NOR	LOAD(KN) RET	DEFLECTION(mm) NOR	DEFLECTION(mm) RET
7 DAYS	SQUARE	183.4	201.9	0.098	0.108
	RECTANGLE	378	411.6	0.027	0.029
14 DAYS	SQUARE	184.2	211.2	0.099	0.113
	RECTANGLE	399	448.2	0.027	0.032
28 DAYS	SQUARE	233	272.9	0.125	0.146
	RECTANGLE	335.8	526	0.023	0.037

Stress and strain between NORMAL and FULLY-WRAPPED beams

CURING PERIODS	BEAM TYPE	STRESS(N/mm2) NOR	STRESS(N/mm2) RET	STRAIN(mm) NOR	STRAIN(mm) RET
7 DAYS	SQUARE	7.5	8.5	0.99	0.99
	RECTANGLE	7.3	8.8	0.99	0.99
14 DAYS	SQUARE	8.9	8.04	0.99	0.99
	RECTANGLE	7.9	8.7	0.99	0.99
28 DAYS	SQUARE	8.5	9.9	0.99	0.99
	RECTANGLE	8.8	12.44	0.99	0.99

Stress and strain between NORMAL and FULLY-WRAPPED beams

CURING PERIODS	BEAM TYPE	STRESS(N/mm2) NOR	STRESS(N/mm2) RET	STRAIN(mm) NOR	STRAIN(mm) RET
7 DAYS	SQUARE	8.15	8.9	0.99	0.99
	RECTANGLE	8.4	9.14	0.99	0.99
14 DAYS	SQUARE	8.1	9.3	0.99	0.99
	RECTANGLE	8.8	9.96	0.99	0.99
28 DAYS	SQUARE	10.3	12.2	0.99	0.99
	RECTANGLE	7.4	11.6	0.99	0.99

V. CONCLUSION

- U-wrapping shows increase in strength upto 60%, and Full wrapping showing increase in strength upto 70%.
- The ultimate load carrying capacity of all the retrofitted beams is higher when compared to the normal beams.
- The stress vs strain graphs are plotted compared to normal and retrofitted beams, the retrofitted beams shows maximum values.
- After retrofitting all the specimens showed reduced crack, deflection at the ultimate load.
- The deflections of the beams are minimized due to full wrapping technique around all the four sides of the beam.
- Retrofitting using PFRP sheets prove to be economical since its cost is only Rs.150/m2.

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