Experimental Investigation on Strengthening of RC Beam Both Internally and Externally by using GFRP and GFRP Wraps

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***Abstract* - To prove the strength for, reinforced cement concrete < reinforced cement concrete with GFRP wraps < reinforced cement concrete with 1% GFRP & GFRP wraps < reinforced cement concrete with 1.5% GFRP & GFRP wraps < reinforced cement concrete with 3% GFRP & GFRP wraps. So the increasing the GFRP percentage and using GFRP wraps to increasing the beam flexural strength and load carrying capacity. The main aim of this study is to investigate the beam internal strength GFRP and external strength GFRP wraps.**

Keywords* - *Both internally and externally strength of beam, GFRP, GFRP wraps.

1. INTRODUCTION

Generally ordinary structural concrete possesses many disadvantages as a building material though it has great popularity in civil construction industry. On the material phase, concrete has low tensile strength, little ductile strength, and little resistance to cracking. For over fifty years there have been many attempts to overcome the drawbacks of concrete. All of your focus has been to replace fine aggregate and coarse aggregate of concrete. But we used GFRP as a additional materials to aggregate and GFRP wraps to provide strength both internally and externally respectively. The strengthening of concrete structures with externally bonded reinforcement is generally done by using GFRP laminates. The plate bonding technique is now established as a simple and convenient repair method of enhancing the flexural , shear and compressive performance of concrete structures.

A. Need

Need for this GFRP wraps for, Increasing flexural strength, Increasing bonding strength, Resistant to environmental affect, Light weight reinforcing for GFRP wrapping, Resistant to corrosion, High strength, Resistant to chemicals, High stiffness scope of this GFRP wraps are, Low coefficient of thermal expansion, High strength to weight ratio as well as being light weight, Equally fibre alignment, High structural efficiency, Reduced periodic maintenance, Longer life spans and, Reduced labor costs,

B. Objective

The main objective of this project is experimental investigation on strengthening of RC beam both internally and externally by using GFRP and GFRP wraps.

C. Advantages of GFRP wraps

High strength, less weight, Load carrying capacity very high, Increasing tensile strength , Resists the salt water, chemicals, and the environment, Able to mold complex shapes.

D. Adding materials

Glass fibre reinforced polymer (GFRP) – 1%, 1.5%, 3%.

E. Using materials

Glass fibre reinforced polymer (GFRP) WRAPS – Double layered (single side, double side , triple side),Resin.

2. FIBRE

A. Why selecting GFRP as additive material

Fiber deformation to improve bond, Physical properties of the GFRP, Fiber packaging to simplify mixing, light weight reinforcing and to avoid environmental affect.

B. Properties of GFRP

The max percentage of GFRP is used in weight of cement for 3%, High Strength, Heavy bonding strength, light weight of concrete, Stiffness, Temperature dependent behavior, Corrosion resistance, Thermal insulation, Thermal conductivity.

C. GFRP wraps or laminates

GFRP wraps is the used for to cover beam for single side, double side, U shape and pasted the beam. Fibre reinforced polymer material systems composed of fibre embedded in a polymeric matrix, exhibit several properties which create the opportunity for their use as structural reinforcing elements. They are characterized by excellent tensile strength in the direction of the fibers.

GFRP composites do not exhibit yielding, but instead are elastic upto failure. They are also characterized by relatively low modulus of elasticity in tension and low compressive properties. Corrosion resistant and should perform better than other construction materials in terms of weathering behavior. In this study, bidirectional glass reinforced polymer laminate are used.

D. Epoxy resin

s.no	*Properties*	*Epoxy resin*
1	Density at 25 c g/cm³	1.15
2	Specific gravity	1.8
3	Flexural strength	450-550

E. Properties of concrete with GFRP

In addition to improvement cracking behavior, (GFRP) in concrete increase the dynamic load and fatigue strength. Under equivalent stress, withstand greater no. of load cycles than plain concrete.

3. RESEARCH SIGNIFICANCE

The main objective of this project is experimental investigation on strengthening of RC beam both internally and externally by using GFRP and GFRP wraps. Internally GFRP are added to 1%, 1.5%, 3% by weight of cement. Externally GFRP wraps are used to beams single side, double side, triple side and double layered. The experiment was carried out on M40 grade concrete with 0.40 water cement ratio.

A. Experimental Programme

prism specimens of sizes 700 x 150 x 150 mm made of concrete with cement, fine aggregate, coarse aggregate and GFRP.

B. Mix design

The specified design strength of concrete is 40MPa at 28 days. The specific gravity of Fine Aggregates FA and Coarse Aggregates CA is 2.64 and 2.72 respectively. The standard deviation can be taken as 5MPa. Ordinary Portland cement was used of 43grade. Coarse aggregate is found to be Absorptive to the extent of 1% and free surface moisture in sand is found to be 2%.According to IS10262-1982 clause 3.3 Table no 4. The mixing water content calculated is 185 kg/m3.

C. Mix proportion

Water	*Cement*	*Fine aggregate*	*Coarse aggregate*
140 lit	350kg	686.53kg	1313.62kg
0.40	1	1.96	3.75

4. MATERIALS AND METHODOLOGY

A .Cement

In this experimental investigation Portland pozzolona cement (PPC) was used for all concrete mixes, the cement used was fresh and without lumps. The testing of cement was done as per IS 8112-1989.The specific gravity of cement was found to be 3.15.

B. Water

Portable tab water is used for preparation of specimens and curing of specimens.

C. Fine aggregate

As per IS 383-1970, table4 sand used for experimental program was locally produced and was conforming zone- II. The specific gravity of fine aggregate was found to be 2.64.

D. Coarse aggregate

locally available coarse aggregate passing from 20mm sieve and conforming IS 383-1970 were used in present work. The specific gravity of coarse aggregate was found to be 2.72

E. Glass fibre reinforced polymer (GFRP)

The max percentage of GFRP is 3% and specific gravity of GFRP was found to be 1.74.

F. Mix design

The mix was designed as per IS 10262:2009 for M40 grade concrete with 0.40 water cement ratio. Concrete mixes are prepared by adding percentage of GFRP 0%, 1%, 1.5% and 3% for every mix.

G. Test specimens and test procedure

Cement, sand and aggregate were taken in mix proportion 1:1.81:3.75 which correspond to M40 grade of concrete respectively. The prism of size 700mm × 150mm× 150mm were used as test specimens to determine the compressive strength, tensile strength and flexural strength respectively.

5. RESULTS AND DISCUSSION

A. Analysis of beams for 28 days

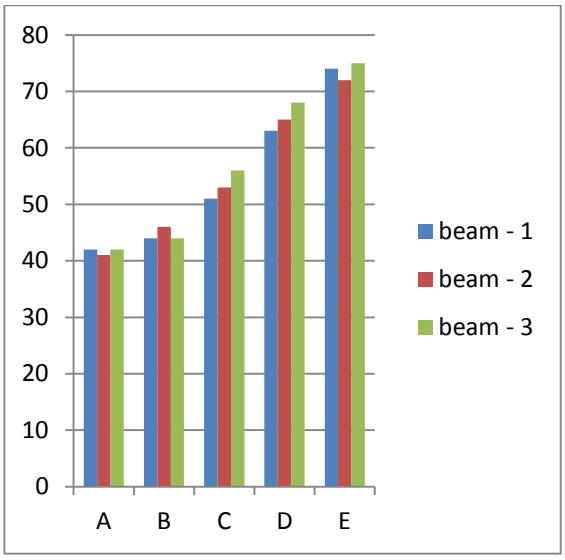
All the beams are cured for 28 days were tested on the Flexural Testing machine. The following results are to prove increasing the strength for reinforced concrete beams, reinforced concrete beam with wraps, reinforced

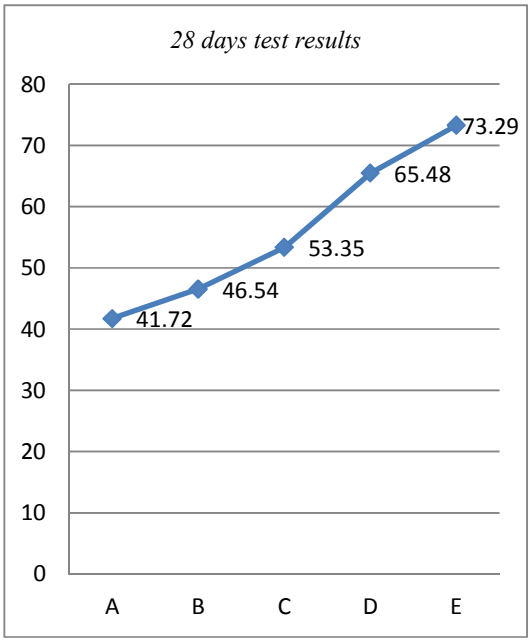
concrete beams with 1%GFRP & wraps, reinforced concrete beam with 1.5% GFRP & Wraps, reinforced concrete beam with 3% GFRP & wraps. The details of the load are thus given in the table below and shows the graphical representation of the results.

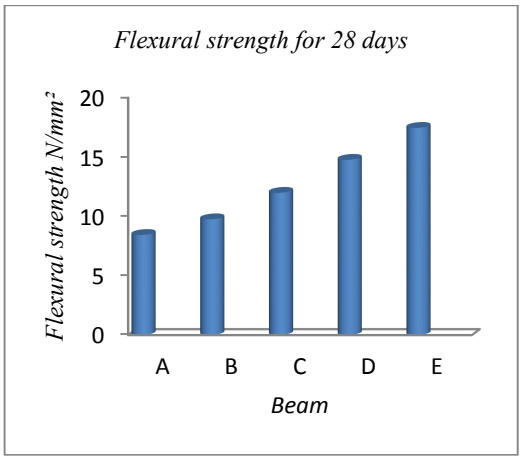
Load in KN and flexural strength of beams 28 days:

s. no	*Beam Description*	*Load in KN*	*Average load in KN*	*Flexural strength in N/mm²*
1.	*RC normal beam*	42.3 41.7 42.2	41.72	8.43
2.	*RC beam with wraps*	44.2 46.4 44.1	46.45	9.75
3.	*RC beam with 1% GFRP & Wraps*	51.3 53.3 56.2	53.35	11.98
4.	*RC beam with 1.5% GFRP & Wraps*	63.9 65.4 68.3	65.48	14.76
5.	*RC beam with 3% GFRP & Wraps*	74.5 72.7 75.4	73.29	17.45

Graphical representation of test results for 28 days







A = Reinforced concrete normal beam
B = Reinforced concrete beam with wrapping
C = Reinforced concrete beam with 1% GFRP & Wrapping
D = Reinforced concrete beam with 1.5% GFRP & Wrapping
E = Reinforced concrete beam with 3% GFRP & Wrapping

B. Results

From the above results and graphs following observations are made:

s.no	*Beam description*	*Increasing in strength comparing with normal reinforced concrete beam (%)*
1.	RC beam with wraps	10.8
2.	RC beam with 1% GFRP & wraps	22.6
3.	RC beam with 1.5% GFRP & Wraps	36.9
4.	RC beam with 3% GFRP & Wraps	43.2

To proved the strength for, reinforced cement concrete < reinforced cement concrete with GFRP wraps < reinforced cement concrete with 1% GFRP & GFRP wraps < reinforced cement concrete with 1.5% GFRP & GFRP wraps < reinforced cement concrete with 3% GFRP & GFRP wraps .

6. CONCLUSION

Therefore, from the above results the beam strength are increased for the increasing the GFRP percentage and using GFRP wraps to increasing the beam flexural strength and load carrying capacity. Its concluded that through the provision of GFRP as a additive material to the concrete it will improves various mechanical properties (flexural strength) of the members (beams) internally. That to on providing wrapping by using GFRP & epoxy resin it will additionally its strength externally also.

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