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FLEXURAL BEHAVIOUR OF REINFORCED CONCRETE BEAMS STRENGTHENED WITH BFRP SHEETS

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Abstract - *Structures can be damaged due to over-loading, earthquakes, fire, blast loading, mistakes in design calculations, corrosion of reinforcement and improper concrete mix design. It is important to study the behavior of damaged RC members, since it involves huge expenditure to demolish and reconstruct them. Externally bonded fiber reinforced polymer (FRP) has emerged as new structural strengthening technology in response to increase the need for strengthening of reinforced concrete structures.*

*The beam of size (1200*100*150)mm and skeleton reinforcement of (900*50*100)mm is used. The sheet of BFRP is cut to the different configuration like 50mm, 75mm, 100mm in width, full span with single layer. After Curing for 28 days it is tested under UTM of 600KN capacity. Observing all the results it was concluded that Load carrying capacity increased by 8 to 34% as compared to control beam. The cracks in beams to be reduced. The flexural strength of beam with BFRP sheet width of 75 mm, the percentage increase in flexural strength of beam as compare to control beam is 36% and percentage decrease in deflection as compare to control beam is 20%.so the Basalt fiber sheets contributed to strengthening more effectively.*

1. INTRODUCTION

Although Reinforced concrete (RC) structures are most likely durable, however, they deteriorate over time due to environmental reasons. The increase in applied loads along with the changes in structure use, seismic damages or even changes in the design specifications, leads to the degradation in strength and ductility in RC structures and their members. As a result they need to be developed to preserve their strength and stiffness. Traditionally, RC members was maintained by enlarging the member's size and providing additional reinforcement. The main drawbacks of this traditional strengthening method is are it increases the dead load, the additional reinforcement is prone to corrosion, it reduces the useable living space (head room and/or area) and it increases maintenance cost due to painting and coating of steel [1]. Accordingly, various techniques have been developed to sustain RC members. Steel plates were the dominated and the most widely used externally bonded reinforcing system for deficient reinforced concrete structure in the 1960's. In applying this technique, an adhesive was used as bonding material between the steel and the surface of the RC member. The adhesive layer between the two materials transfers shear forces between the concrete and the steel plate. However, steel as an externally bonded reinforcing material has been unfavorable after a period of time due to its susceptibility to corrosion and other shortcomings.

Basalt originates from volcanic magma and flood volcanoes, a very hot fluid or semifluid material under the earth's crust, solidified in the open air. Basalt is a common term used for a variety of volcanic rocks, which are gray, dark in colour, formed from the molten lava after solidification

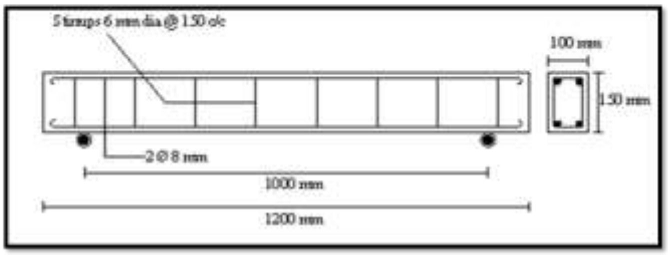
Basalt Fiber Reinforced Polymer (BFRP) and Glass Fiber Reinforced Polymer (GFRP). The test results showed that Young's modulus value of BFRP was 35-42% higher than that of GFRP composites. Also BFRP shows better performance in terms of compressive and bending strength, impact force resistance and energy absorption capacity when compared to GFRP. Considering the competition in the market and the ever-increasing economic and environmental requirements for reinforcements in polymer composites, the reinforcement potential of newer and newer fibers is investigated in the leading research institutes of the world. Basalt fiber is a possible polymer reinforcing material and can be applied in polymer matrix composites instead of glass fiber. Basalt fiber can be reinforced in thermosetting polyester matrix composites. It was established that the surface treatment of basalt fiber with silanes improved the adhesion to the matrix, reflected also in the bending strength of the composites.

2. OBJECTIVES OF PROPOSED WORK

- To increase the flexural strength of beam by using (BFRP) sheets .
- To evaluate the effectiveness of BFRP sheets and flexural performance of RC beams, a series of beams were designed, casted and strengthened to test flexural performance for different layers and curtailment.

3. EXPERIMENTAL METHODOLOGY

- Mix design of concrete beam by IS code method- M20 (1 : 1.48 : 3.16)
- Formation of skeleton reinforcement of (900 * 50 * 100)mm for (1200 * 100 * 150)mm beam.



- Casting of beams (1200 * 100 * 150) mm and cubes of (150 * 150 * 150) mm with hand mixing and tamping by rod.
- Curing for 28 days.
- Cutting of sheets to different configurations like 50mm, 75mm ,100mm in width
- Sticking BFRP sheets to the bottom of beam with epoxy material.
- Testing of beams under two point loading system by UTM.
- Analysis of cracks- Flexural & shear cracks.

3.1 STRENGTHENING OF BEAMS

The Beam is Strengthen by using following three material

- Surface preparation of concrete beam- Application of putty
- Application of epoxy material
- Application of basalt sheets

3.2 TESTING OF BEAMS

The beam is tested under Universal testing machine (UTM) having 600KN capacity with Dial Gauges for recording the deflection.

Fig -1: Universal Testing Machine (**UTM)** 600 kN capacity

3. EXPERIMENTAL RESULTS

Fig -2: Cracks in control beam

Fig -3: Crack pattern in beam with BFRP sheet

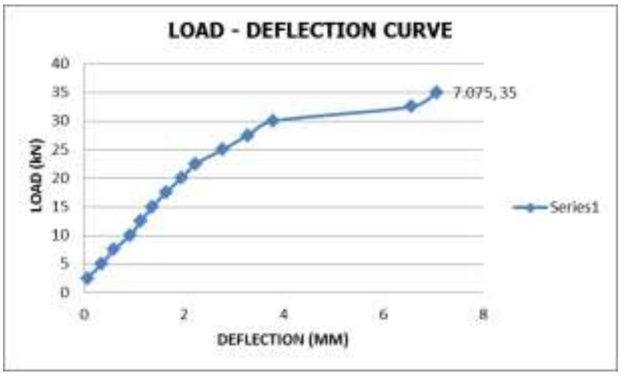


Chart 1: flexural testing of control beam

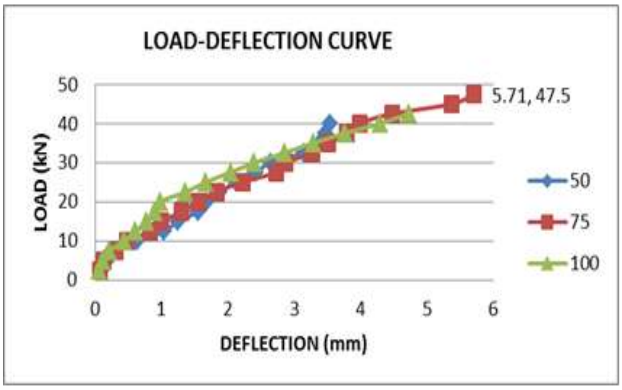


Chart 2: Single layer full span 50mm, 75mm, and 100 mm width of BFRP Sheet

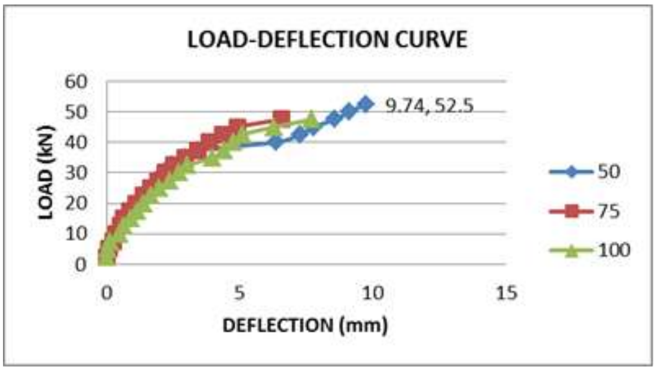


Chart 3: Single Layer Moment region 50mm, 75mm, 100mm width of BFRP sheet

3. CONCLUSIONS

- Load carrying capacity increased by 8 to 34% as compared to control beam.
- Number of cracks and their width were experimentally observed to be reduced.
- In single layer full span, flexural strength of beam with BFRP sheet width of 75 mm, the percentage increase in flexural strength of beam as compare to control beam is 36% and percentage decrease in deflection as compare to control beam is 20%.
- In single layer moment region , 75 mm width, the percentage increase in flexural strength of beam is 36 % and % decrease in deflection is 8%.
- Basalt fiber sheets contributed to strengthening more effectively.

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