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Comparative Study of Flexural Strength of R.C. Beam Using Basalt Fiber Polymer as Reinforcement

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Abstract- **In recent days, our country is experiencing a major problem in Corrosion and release of toxic gases - particularly in the field of Civil Engineering. There is a challenge for every Civil Engineer to get rid of this socio-economic problem. While in steel rebar manufacturing so many toxic gases are evolving like carbon monoxide, ammonia and Sulphur dioxide cause severe damage to the environment. Corrosion causing severe damage to sea shore structure especially it reduce the durability of the structure. In a view of this, the present investigation is aimed at reduction Corrosion and release of toxic gases by the way of utilizing Basalt fiber reinforced polymer (BFRP).It is a new material, which is used in construction and civil applications as an alternative material to steel rebar. From the studies comparison of flexural strength of the steel with Basalt rebar is carried out. The experimental investigation and analytical investigation is evaluated the performance characteristics between two materials steel rebar and basalt rebar in concrete beams. The tested beams were made of M20 Grade concrete and reinforced with basalt rebar and steel rebar. Testing made to find the flexural capacity of the beam and compressive strength of the cube. Results are compared between steel reinforced beams and basalt fiber reinforced polymer beams. From the test results showed that an improvement flexural strength and stress strain relationship and it confirms that the basalt fiber reinforced polymer is could be used as a good alternative material for reinforcement in beams.**

Index Terms- **Basalt; corrosion; flexural; polymer; Rebar.**

1. INTRODUCTION

Basalt is a natural material that is found in volcanic rocks. It is mainly used (as crushed rock) in construction, industrial and high way engineering. One can also melt basalt (1300-1700°C) and spin it into fine fibers. When used as (continuous) fibers, Basalt can reinforce a new range of (plastic and concrete matrix) composites. It can also be used in combination with other reinforcements (e.g. basalt/carbon). Some possible applications of basalt fibers and basalt-based composites are: thermal and sound insulation/protection (e.g. basalt wool, engine insulation), pipes, bars, fittings, fabrics, structural plastics, automotive parts, concrete reinforcement (constructions), insulating plastics and frictional materials. Basalt fibers are manufactured in a single-stage process by melting pure raw material. They are environmentally safe and non-toxic, possess high heat stability and insulating characteristics and have an elastic structure. When used for composite materials, they provide unique mechanical properties. They can be easily processed into fabric with high reliability .The tensile strength of continuous basalt fibers is about twice that of E-glass fibers and the modulus of elasticity is about 15-30% higher. Basalt fibers in an amorphous state exhibit higher chemical stability than glass fibers. When exposed to water at 700 C (1580 F), basalt fibers maintain their strength for 1200 hours, whereas the glass fibers do so only for 200 hours. The innovative aspect of this project is the detailed study of non-corrosive, basalt fiber composite rebar. This rebar consists of 80% fibers and has a tensile strength three times that of the steel rebar normally used in building construction. It is made by utilizing a resin (epoxy) binder .

1.1 ADVANTAGES OF BFRP

- The impact strength of basalt fiber reinforced concrete increases in about 20 times.
- Basalt fiber provide a three-dimensional concrete reinforcement comparing to usual rebar that provides two-dimensional reinforcement.
- Basalt fiber is not liable to galvanic corrosion, comparing to usual rebar that is an electrical conductor and can have the cathode effect.

- Construction time reduces due to the needless to install wire mesh.
- The fatigue strength of basalt fiber reinforced concrete increases.
- In reservoirs and underground water channels thickness of concrete cover significantly reduces, and construction time becomes shorter.
- Cost of repairs and maintenance greatly reduces due to fiber reinforced concrete long life.
- The need for concrete floors reinforcement is eliminated because of basalt fiber use, and construction time is cut in half.

II. MATERIAL PROPERTIES

The material used in the project briefly explained below based on the characteristics. For every beam specimen were designed on the Fine aggregate specific gravity of 2.50 and having fineness modulus 2.56 then fine aggregates passing through 4.75mm IS sieve conforming to zone II, having Coarse aggregate specific gravity of 2.77 and having fineness modulus of about 6.98and water absorption is about 4.7%. Most of the basalt rebar is placed in tension zone .So 10mm is attaining more strength comparing 6mm,16mm,20mm .Below the properties of basalt in Table 2.1.

TABLE.2.1. BASALT FIBRE OR REBAR PROPERTIES

Rebar Dia (mm)	10mm
Weight (gm)	163gm
Nominal Area (mm^2)	78.52mm^2
Density(gm/cm^3)	2.64gm/cm^3
Tensile strength(Mpa)	1202Mpa
Strength Ratio	1.56-1.80
Elastic modulus (Gpa)	52.00Gpa
Modular Ratio	37.7-41.5
Ultimate Strain (%)	2.31%

Fig.1. BFRP REBAR

III. DESIGN

3.1 DETAILING OF REINFORCEMENT

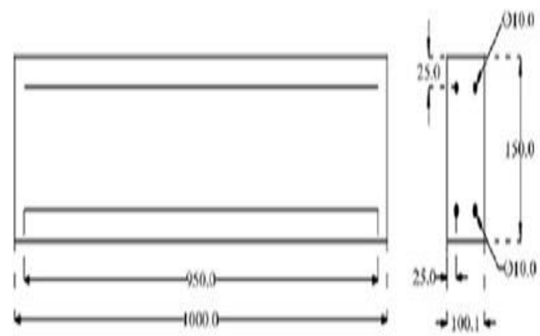

Fig.2. CONTROL BEAM

Control beams 2nos of 10mm steel bars is placed in compression zone and 2nos of 10mm bars placed in tension zone Beam is casted at the length 1000mm,and provide 25mm cover at the side

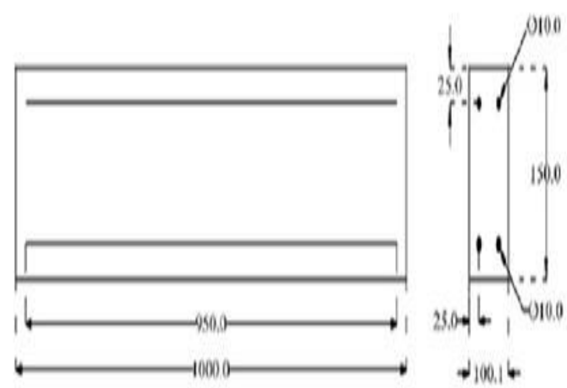

Fig.3. BFRP 1 BEAM

In BFRP 1 beam 2 nos of 10mm steel bars is placed in compression and 2nos of 10mm BFRP bars placed in tension. Beam is casted at the length 1000mm,and provide 25mm cover at the side

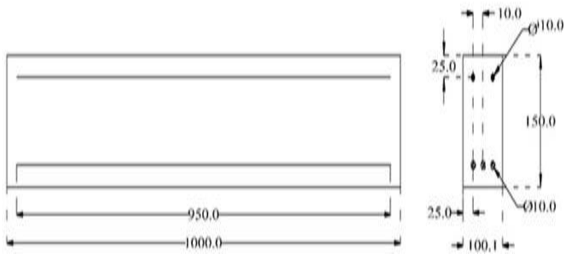

Fig.4. BFRP 2 BEAM

In BFRP 2 beam has 2nos of 10mm steel bars is placed in compression and 3nos of 10mm BFRP bars placed in tension. Beam is casted at the length 1000mm,and provide 25mm cover at the side.

IV. CASTING AND TESTING

From the above detailing beams were casted and then Tested

Fig.5. CASTING

Fig.6. TESTING

Rectangular cross section reinforced concrete beams of eight numbers were casted at size of 100mm width, 150mm depth, 1000mm overall length. Inner surface of steel mould were applied with machine oil. The measured quantity of cement, fine aggregate and coarse aggregate were mixed thoroughly, the measured quantity of water was added to the dry mix and mixing was done properly. The steel reinforcement was placed inside the mould with proper cover. Concrete was poured layer by layer and compacted and finished well. The beam specimens were removed from the mould after 24 hours of casting and concrete beams were placed in curing tank for curing for 28 days. After 28 days age of curing specimens were ready for the test .All tested beams have following dimensions: *b x h x l* = 100 x 150 x 1000 mm. During the test the beams were simply supported on two supports with span of 900mm and the supports in all the beams steel stirrups for shear having a diameter of 8mm have been provided

V RESULTS AND DISCUSSION

TABLE 5.1 TEST RESULTS OF BEAM

Beam Code	Ultimate Deflection mm	Ultimate load kN-m	First crack load kN-m
Control beam	2.34	42	6.6
BFRP-1	4.24	56.73	12.5
BFRP-2	4.86	58.25	14.3

5.2 COMPARISON OF CONTROL RC BEAM AND BASALT BEAM

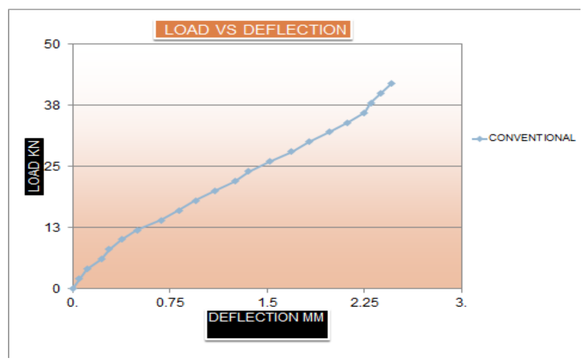

Fig.7. CONTROL RC BEAM

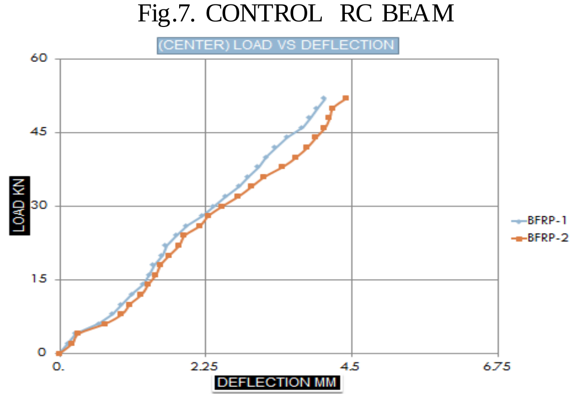

Fig.8 BASALT BEAM

The test results are given in table 2, and then graphically represented in graph 4. From then result it shows that beam having 3 nos of BFRP bars on increase in ultimate load and increase in stiffness than compared to control beams. Bond strength is also good. When comparing control beam and BFRP concrete beams BFRP shows 1.5 times increases in ultimate load and 0.35 times increase in first crack load. Almost three times of the readings of BFRP and RC beams reinforcement indicates, beam load bearing capacity in same proportion. BFRP bars reduce tensile stress which is used to prevent sudden break with long term loaded bars. The over performance of the beam was good. Beam is weightless while comparing steel rebar beam

VI CONCLUSION

From the experimental study conducted on BFRP rebar provides better results.

- When the beam is unloaded beam specimen is slightly return back to its original position.
- Basalt fiber reinforced polymer bar provide good ultimate load a i.e. stiffness is increased.
- The comparison between experimental results and one of the other FRP similar products shoes that the BFRP rods could be a good alternative material to other FRP rods.
- The bond between basalt rebar and concrete was good.
- The tested rods with good tensile strength.
- It can be used in some of civil applications like marine, underground water tank, bridges, and chemical factories.
- Corrosion Resistance and good to environment
- Weightless while comparing to R.C beam
- No toxic Gases emitted

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