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COMPARATIVE STUDY OF RC BEAM AND BEAM REINFORCED WITH GFRP BARS ALONG TENSION

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Abstract - *The corrosion of steel has increased the need for alternative. FRP bars can be used for its non corrosive property. The study involves in using Glass Fibre Reinforced Polymer bar as a replacement of steel bar along tension side of the beam. About two beams of conventional M25 grade concrete and a longitudinally replaced GFRP beams is casted and tested for its flexural behaviour. The beams are subjected to two point loading under a simply supported condition. The GFRP bars are used for its excellent corrosion resistant property.*

Key Words: **Glass Fibre Reinforced Polymer (GFRP), Conventional beam, Flexural behaviour, Fibre reinforced Polymer (FRP), Corrosion.**

1. INTRODUCTION

The one of the cause for deterioration of structures is corrosion. The steel reinforcement corroding due to various reasons needs a replacement. FRP materials are used as a replacement due to its excellent non corrosive nature. FRP materials are made of aramid FRP(AFRP), carbon FRP (CFRP) or Glass FRP ()GFRP embedded in a resin matrix (ACI 440R).In this study sand coated GFRP bars are used. GFRP bars are used in place of steel and its behaviour is studied. The property of these bars varies with steel and so guidelines proposed by ACI committee, Canadian Standard Association (CSA) and Japanese Society of Civil Engineers (JSCE) are to be followed. These bars are economical incase of rehabilitation of structures. The flexural behaviour of the beams with replaced bar is compared with the conventional beam.

2. EXPERIMENTAL PROGRAM

The study involves in casting two beams of M25 grade concrete. The beams are of 1200mm length, 230mm width and 230mm depth. A conventional beam and a beam of longitudinally replaced GFRP bars along the tension side are casted. The beams are cured for 28 days. The beams are subjected to two point loading under a simply supported condition and its flexural behaviour is tested.

3. MATERIALS

3.1 Cement

Ordinary Portland Cement (OPC) of 53 Grade conforming to IS 12269(1987) is used this investigation. The specific gravity of the cement is 3.15.

3.2 Fine Aggregate

The river sand conforming to zone II as per IS 383-1987 was used. It passes through 4.75 mm IS sieve with a specific gravity of 2.6.

3.3 Coarse Aggregate:

A maximum size of 20mm aggregate is used The specific gravity 2.8

3.4 Admixture

Super-plasticizer : Conplast SP430(G) complies with IS: 9103 :1999 and BS:5075(Part 3). It conforms to ASTM-C-494 Type F having a specific gravity of 1.22 is used as a high water reducing agent. Approximately 1% additional (As per Manufacturers manual)

Fig -1: Super plasticizer CONPLAST SP430

3.5 Water

Clean potable tap water conforming to IS 456-2000 is used.

3.6 Reinforcement

Sand coated GFRP bars of 16mm diameter are used as longitudinal reinforcement along tension side. Steel bars of Fe 415 grade is used as main reinforcement and stirrups. Main reinforcement is of 16mm diameter and 8mm stirrups are used. The mechanical properties of GFRP bars are obtained from manufacturer.

Table -1: GFRP Bar Properties

Tensile Strength f_{fu}	90,000 psi	620.6 MPa
Rupture strain $€_{fu}$	0.014	0.014
Modulus Of Elasticity	6,500,000 psi	44,800MPa

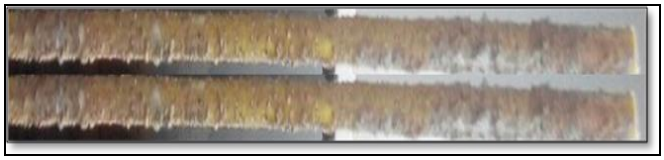

Fig -2: Sand Coated GFRP bars

4. Concrete

Mix proportion of concrete is designed as per IS10262:2009 and IS 456:2000.The proportion and w/c ratio for M25 is 1:1.61:2.96 and 0.338 respectively.

4.1 Specimen casting and Testing

150mm cube specimen and 150mm diameter and 300mm height cylinder specimen are casted and tested for compressive and tensile strength of concrete. The values are listed in the Table – 2.

Table -2: Compressive and Tensile strength

Compressive strength (N/mm^2)	Tensile strength (N/mm^2)
31	2.4

4.2 Test setup

The test setup involves a two point loading system by using a spreader beam and two rollers. A LVDT is placed at the midpoint of the beam along the tension side to measure the deflection. The point loads acts at a distance of 300mm from the midpoint along the compression side of the beam.

4.3 Test specimen

The test beams casted are of 1200mm length 230mm width and 230mm depth. The Test matrix are listed in Table -3.

Fig -3: Beam specimens

Table -3: Test Matrix

Specimen ID	Longitudinal Reinforcement	Transverse Reinforcement
M25 C	Steel(Compression and Tension side)	Steel
M25 G	Steel(Compression side) GFRP(Tension side)	Steel

5. EXPERIMENTAL SETUP

The setup of the beam in the loading frame is shown in the Fig -4.

Fig -4: Test Setup

5. TEST RESULT AND DISSCUSSION

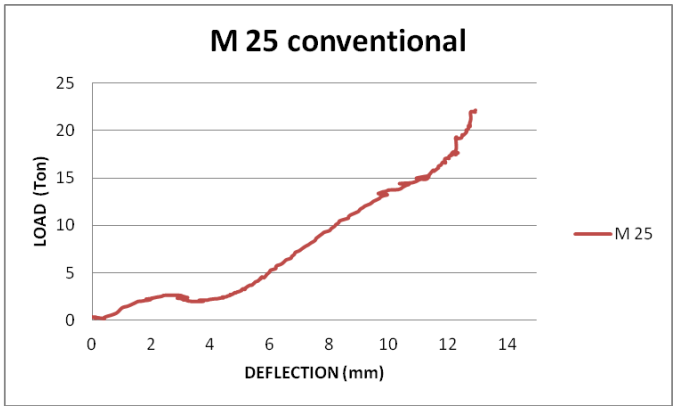

Chart -1: M25Conventional Load vs Deflection Behaviour

The M25 conventional beam load and the corresponding deflection is shown in chart -1.There is a gradual deflection for every rise in load applied.

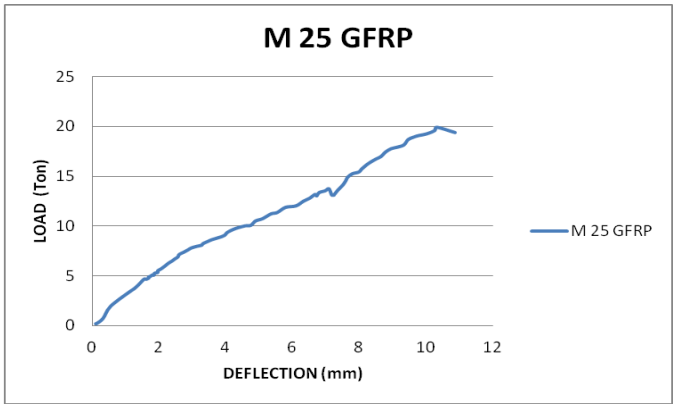

Chart -2: M25 GFRP Load vs Deflection Behaviour

The M25 GFRP beam load and the corresponding deflection is shown in chart -2.There is a gradual deflection for every rise in load applied. The beam showed brittle failure.

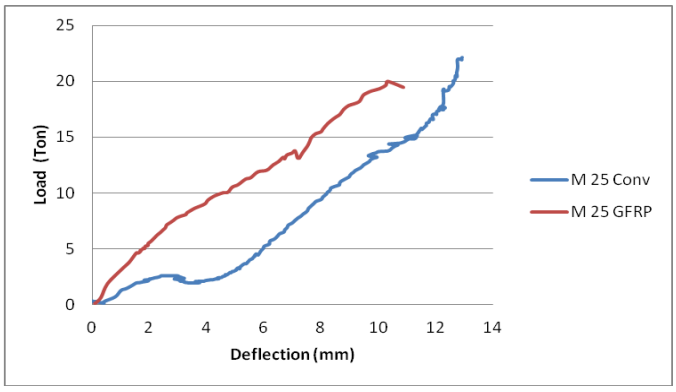

Chart -3: M25 Conv and GFRP comparison.

The deflection corresponding to the load applied is shown in Chart-3 .The deflection is found to be 20% less in GFRP reinforced beam than the conventional beam. The load carrying capacity of the GFRP reinforced beam is 12% less than the conventional beam. The GFRP beam showed brittle failure. Though the strength of the GFRP replaced beam is less than the conventional beam due to its non corrosive property it can be considered to be an replacement of steel. Since GFRP bar properties are not fully known further research are carried out worldwide.

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