International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-1, October, 2019

Strengthening of Reinforced Concrete Continuous Beams using GFRP

G.Ganesh Naidu, M.Sri Durga Vara Prasad, K.Anil Kumar

***Abstract*: This research paper gives the behaviour of reinforced concrete continuous beams under static loading by externally bonding with GFRP sheets. A standard two span continuous beams of size (300×300×2500)mm were casted. Reference beam with no external bonding is prepared to compare the values. Identical reinforcement arrangement is done for all beams. RC beams are tested for failure, load capacity and deflection analysis. Test results are compared for reference and GFRP bonded beams.**

***Keywords*: Glass Fiber Reinforced Polymer (GFRP), RC continuous beams, deflection analysis, failure characteristics.**

I. INTRODUCTION

Concrete usage in construction industry is vastly increased due to its values for strengths. In the evolution of concrete, compressive strength of concrete is supported by using rebar as reinforcement. Tensile characteristics of rebar made reinforced concrete structures an easy and efficient type of concrete in construction. Different studies have been proposed to make reinforced concrete stronger and efficient. One of such is fiber reinforced polymer usage.

FRP usage has been increased due to advantages like low-weight, mechanical strength improvement up to 3 to 5%, chemical resistant, corrosive resistant etc.

. In present study RC continuous beams externally bonded with GFRP sheets and beams are tested for failure, deflection characteristics.

II. MATERIALS

Materials used in this study are ordinary Portland cement; river sand is used as fine aggregate, passing through 4.75mm sieve. Coarse aggregate of size 12mm are used. Ordinary tap water is used for concrete mixing in all the mix water. Reinforcement in the beam is 12mm at bottom and 10mm at the top. 8 mm stirrups of high-yield Strength Deformed (HYSD) bars were provided throughout the beam with center-to-center distance of 150mm. to lift the beam 6mm bars are used as hangers.

Revised Manuscript Received on October 30, 2019.

* Correspondence Author

G.Ganesh Naidu*, Department, civil engineering department, Pace institute of technology and sciences, vallur, prakasam dist., Andhra Pradesh, India.

M.Sri Durga Vara Prasad, Assistant professor, civil Department, Pace institute of technology and sciences, vallur, prakasam dist., Andhra Pradesh, India.

K.Anil Kumar, Department of technology and sciences, vallur, prakasam dist., Andhra Pradesh, India.

III. MIX DESIGN

A proportion of 1: 1.7: 3.12 is taken for cement, fine aggregate and course aggregate for casting of beams

parameters	Cement	Sand	Water	Coarse Aggregate
Mix Proportion	**1**	**1.7**	**0.5**	**3.12**
Quantities of materials (Kg/m^3)	**368.4**	**626.8**	**184.2**	**1149.4**

Table 1: Mix proportions of RC beam

IV. TEST RESULTS

Beams are loaded at mid-span with a concentrated load and results obtained are discussed in terms of type of failure and the load vs. Deflection curve. All casted beams are tested for their ultimate strengths.

a) REFERENCE BEAM

i) FAILURE ANALYSIS:

The reference beam failed completely in shear. The failure started first at the centre span areas and then propagated towards the central support and finally failed in shear.

b) GFRP BEAMS

Total 4 beams are prepared; each one is named as GFRPRC1 (single layer of GFRP is bonded to the RC beam), GFRPRC2 (two layers of GFRP is bonded to RC beam), GFRPRC3 (three layers of GFRP is bonded to RC beam) and GFRPRC4 (four layers of GFRP is bonded to RC beam). Failure criteria of RC beams is shown is Table 2

Name of beam	Failure	P_u (KN)
REF	Shear failure	249
GFRPRC1	Delaminating with shear crack	288
GFRPRC2	Delaminating	315
GFRPRC3	Delaminating	330
GFRPRC3	Delaminating	349

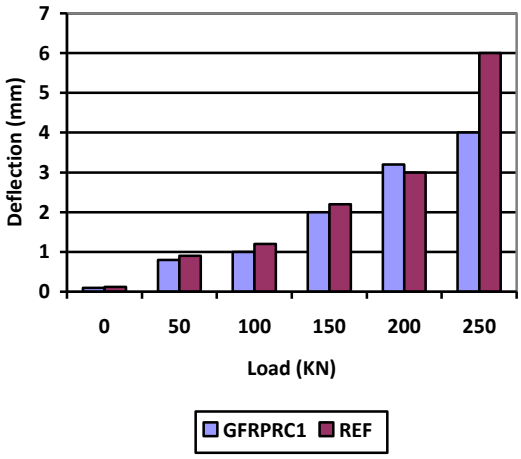
Table 2: failure and ultimate load characteristics

c) **DEFLECTION ANALYSIS OF GFRP BEAMS**

i) Deflection of GFRPRC1:

As GFRPRC1 is beam laminated with single layer of GFRP, displacement values are small compared to reference beam. Initially delaminating occurred at the bonded surface and finally beam failed in shear. First crack is occurred at 116KN and beam failed ultimately at 288KN. Deflection curves GFRPRC1 and REF beam is plotted in Fig 1.

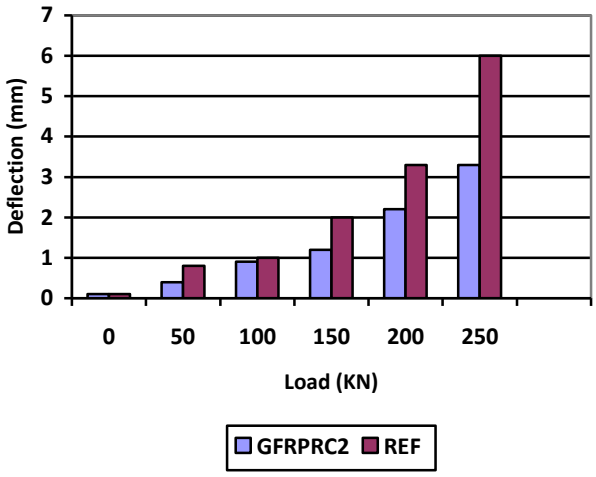
Fig 1: deflection of GFRPRC1 vs REF



ii) Deflection of GFRPRC2:

GFRPRC2 is a two layered beam. Deflection values of GFRPRC2 is less compared to REF beam, delaminating occur as failure. First cracking is occurred at 132KN and ultimately beam failed at 312KN. Deflection characteristics of GFRPRC2 and REF beam are plotted in Fig 2.

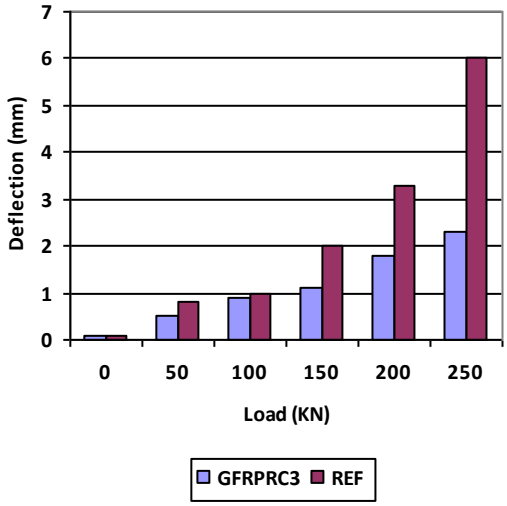
Fig 2: Deflection GFRPRC2 vs REF



iii) Deflection of GFRPRC3:

GFRPRC3 is a three layered GFRP laminated beam. These also exhort same characteristics like GFRPRC2. First cracking occur at 141KN and ultimately beam failed at 330KN. Deflection characteristics of GFRPC3 and REF are shown in Fig 3

Fig 3: Deflection of GFRPRC3 vs REF beam

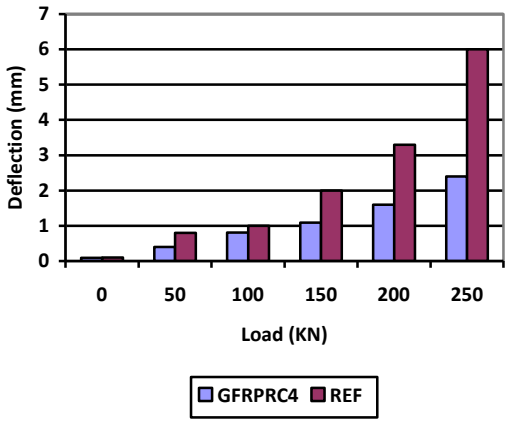


iv) Deflection of GFRPRC4:

GFRPRC4 is a four layered GFRP laminated beam. Beam failed ultimately at 349KN due to shear. Fig 4 gives the deflection characteristics of GFRPRC4 and REF beam.

I.I

Fig 4: Deflection of GFRPRC4 vs REF



V. CONCLUSIONS

From the test results following inferences are can taken

- With the increase in the layers of lamination, load carrying capacity of beam is increasing.
- Crack development in REF beam is earlier compared to GFRPRC1.
- It is evident from experimental results that deflection characteristics of REF beam is high compared GFRP laminated or bonded beam.
- Laminating of beams increases the shear values of the beam.

- Highest ultimate load carried is 349KN which is 43% more than the REF beam.

REFERENCES

1. M. Talha Junaid, Abdalla Elbana, Salah Altoubat, Zaid Al-Sadoon, Experimental study on the effect of matrix on the flexural behavior of beams reinforced with Glass Fiber Reinforced Polymer (GFRP) bars, Composite Structures,Volume 222, 2019, 110930, ISSN 0263-8223, https://doi.org/10.1016/j.compstruct.2019.110930.
2. Zhihua Xiong, Yuqing Liu, Yize Zuo, Haohui Xin, Experimental evaluation of shear behavior of pultruded GFRP perforated connectors embedded in concrete, Composite Structures, Volume 222, 2019, 110938, ISSN 0263-8223, https://doi.org/10.1016/j.compstruct.2019.110938.
3. Marco Rossini, Antonio Nanni, Composite strands for prestressed concrete: State-of-the-practice and experimental investigation into mild prestressing with GFRP, Construction and Building Materials, Volume 205, 2019, Pages 486-498, ISSN 0950-0618, https://doi.org/10.1016/j.conbuildmat.2019.02.045.
4. V Kissman, Lenin Sundar, An experimental study on strengthening of RC column with GFRP, Materials Today: Proceedings, 2019, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2019.05.430.
5. Zein Saleh, Matthew Goldston, Alex M. Remennikov, M. Neaz Sheikh, Flexural design of GFRP bar reinforced concrete beams: An appraisal of code recommendations, Journal of Building Engineering, Volume 25, 2019, 100794, ISSN 2352-7102, https://doi.org/10.1016/j.jobe.2019.100794.

AUTHORS PROFILE

G.GANESH NAIDU,Ph.D, MISTE , IAENG , Head of the department, civil engineering department, Pace institute of technology and sciences, vallur, prakasam dist., Andhra Pradesh, India. Presently working on corrosion characteristics of fiber reinforced concrete.

M.SRI DURGA VARA PRASAD, M.Tech, IAENG Assistant professor, civil department, Pace institute of technology and sciences, vallur, prakasam dist., Andhra Pradesh, India. Researching on self compacting concrete and water conservation techniques.

K.ANIL KUMAR, PG scholar, Pace institute of technology and sciences, vallur, prakasam dist., Andhra Pradesh, India.