EXPERIMENTAL STUDY ON DOUBLE SKIN COMPOSITE TUBULAR BEAM

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ABSTRACT:

This project presents the comparative Experimental study on the performance of the conventional concrete composite beam using various types of reinforcement with and without GFRP wrapping under bending. The price of steel has also rising over the last few years. The main challenge for civil engineers is to provide sustainable, environmental friendly and financially feasible structure to the society. The reinforcement in concrete plays a vital role in increasing its self weight. In order to reduce the weight of the reinforcement is replaced by hollow pipes filled with cement mortar. The hollow pipes are taken in required dimensions according to the structure. The replaced composite reinforcement is used in normal conventional concrete of M20 grade and tested for its strength. In this study, the effects of Glass Fiber Reinforced polymer (GFRP) sheets wrapped over the beam on improving the Mechanical performance of composite steel and concrete beams subjected to hogging moment. Four Specimens with different reinforcements such as Steel bars, Stainless steel Pipes, Mild steel Pipes and PVC Pipes of uniform diameter are being used in the beam and wrapping with GFRP sheets are experimentally studied for its comparative flexural strength. Several tests were conducted on different specimens and the impact of each material was studied on the structural behavior of these members under deflection for comparison purpose between the loads and lateral displacements. The specimens with wrapped GFRP sheets have large initial cracking load and crack width of the concrete have been controlled. The results showed that using hollow tubes with mortar filling and the wrapping of GFRP sheets enhance the load bearing capacity and the flexural strength of the beam.

KEYWORDS: Circular hollow tubes, Mortar filled hollow tubes, GFRP sheets, strengthening.

I. INTRODUCTION

The reinforcement in concrete plays a vital role in increasing its self weight. In order to reduce that weight the reinforcement is replaced by hollow steel pipe filled with cement mortar. The hollow pipe is taken of required dimension according to the structure. The replaced composite reinforcement is used in normal conventional concrete of M20 grade and the beam is wrapped with Glass Fiber Reinforced polymer (GFRP) sheets and tested for its strength. Concrete is the world's most used man made construction material today. It is relatively cheap and easy to form when cast in India. The most common reinforcing material for Reinforced concrete (RC) used until now and is still used today in steel. Using steel as reinforcement has numerous advantages; it is strong in tension and has a high modulus of elasticity. The thermal expansion is similar to concrete and it works well with concrete under loading. The production process for steel is very stable and thus the material properties are also very stable, then steel is easy to form and work with. But using steel as reinforcement has also some disadvantages, it can corrode with time and has low fire resistance. The price of steel has also been rising over the last few years. The main challenge for civil engineers is to provide sustainable, environmental friendly and financially feasible structure to the society. The reinforcement in concrete plays a vital role in increasing its self weight. In order to reduce the weight of the reinforcement is replaced by hollow pipes filled with cement mortar. The hollow pipes are taken in required dimensions according to the structure. The replaced composite reinforcement is used in normal conventional concrete of M20 grade and tested for its strength. Reinforced concrete (RC) is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength and ductility. The composite beam used is steel and concrete. The other kinds of composite beam used here is mild steel concrete, stainless steel concrete, PVC concrete, and the beam is wrapped with the layer of GFRP sheets. GFRP sheets has high strength ratio, high stiffness, weight ratio, flexibility in design, non corrosiveness, high ultimate strength and low density. The specimens with wrapped GFRP sheets have large initial cracking load and crack width of the concrete have been controlled. The GFRP sheets possess high heat resistance, high strength and high elasticity. The results showed that using hollow tubes with mortar filling and the wrapping of GFRP sheets enhance the load bearing capacity and the flexural strength of the beam. Since the flexural strength is more they are used in high rise buildings and seismic zones.

II. OBJECTIVES

- Flexural strength of the composite concrete beam were studied using various types of reinforcement normal rebar, stainless steel , mild steel and PVC pipes.
- The comparative experimental study on the performance of the conventional concrete composite beam using various types of reinforcement with and without GFRP wrapping under bending.

III. MATERIAL COLLECTION

A.CEMENT

The cement used was ordinary Portland cement 53 (OPC 53). The specific gravity and the Initial and final setting time of cement is determined.

B. COARSE AGGREGATE

The coarse aggregates with 20mm size are used. For coarse aggregates the specific gravity and fineness modulus values are determined.

C. FINE AGGREGATE

The sand which are locally available and passing through 4.75 mm IS Sieve is used. The specific gravity of fine aggregate is determined.

D. WATER

The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances.

E. STAINLESS STEEL PIPES

Stainless steels are notable for their corrosion resistance, which increases with increasing chromium content. Molybdenum additions increase corrosion resistance in reducing acids and against pitting attack in chloride solutions.

F. MILD STEEL PIPES

Mild steel (steel containing a small percentage of carbon, strong and tough but not readily tempered), also known as plain carbon steel and low carbon steel. Its price is relatively low while it provides material properties that are acceptable for many applications.

G. PVC PIPES

PVC stands for polyvinyl chloride, and it's become a common replacement for metal piping. PVC's strength, durability, easy installation, and low cost have made it one of the most widely used plastics in the world.

Fig no 1 Specimen collection

IV.EXPERIMENTAL INVESTIGATION

A.SPECIMEN PREPARATION

The 0.85m span beam specimen is molded. As per the design procedure 12mm sample rebar and replacement hollow sections are filled with concrete mortar and the beam are wrapped with GFRP sheets. The concrete motor filled and the wrapped GFRP sheets were found to significantly improve the capacity by preventing local inward buckling in rebar. Several tests were conducted on different specimens and the impact of each material was studied on the structural behavior of these members under deflection for comparison purpose between the loads and the lateral displacements.

Fig no 2 Beam without GFRP wrapping

Fig no 3 Beam with GFRP wrapping

B.TESTING

All tests were conducted in universal testing machine of capacity 900kN. The specimen were placed, centered and leveled. Linear voltage displacement transducers (LVDT) were used to observe the lateral deformation. The load was applied slowly and the specimen was tested to failure by applying the one point load in small increment at regular interval. The failure modes, lateral deformation and failure load were recorded up to its ultimate load.

Fig no 4 Testing of the Specimen

V. RESULTS AND DISCUSSION

For every specimen initial cracks are obtained at the critical load. This gets varied for each sample specimen. The following graph shows the total deflection in the beam form uniformly increasing loads.

A.STRENGTH COMPARISON OF COMPOSITE BEAM WITH NORMAL REINFORCEMENT

Strength of the composite beam with Normal reinforcement with the wrapping GFRP sheets and without the wrapping of GFRP sheets is determined.

Table no: 1 Strength comparison of composite beam with Normal Reinforcement

S.NO	SPECIMENS	LOAD (kN)	FLEXURAL STRENGTH (N/mm^2)
1	Composite Beam with Normal reinforcements	72	61.2
2	Composite Beam with Normal reinforcement wrapped with GFRP sheets	112	95.2

B.STRENGTH COMPARISON OF COMPOSITE BEAM WITH STAINLESSSTEEL REINFORCEMENT

Strength of the composite beam with stainless steel reinforcement with the wrapping GFRP sheets and without the wrapping of GFRP sheets is determined.

Table no:2 strength comparison of composite beam with stainless steel reinforcement

S.NO	SPECIMENS	LOAD (kN)	FLEXURAL STRENGTH (N/mm^2)
1	Composite beam with stainless steel reinforcement	42	35.7
2	Composite beam with stainless steel reinforcement wrapped with GFRP sheets	98	83.3

C.STRENGTH COMPARISON OF COMPOSITE BEAM WITH MILD STEEL REINFORCEMENT

Strength of the composite beam with Mild steel reinforcement with the wrapping GFRP sheets and without the wrapping of GFRP sheets is determined.

Table no 3 : Strength comparison of composite beam with stainlesssteel reinforcement

S.NO	SPECIMENS	LOAD (kN)	FLEXURAL STRENGTH (N/mm^2)
1	Composite beam with Mild steel reinforcement	76	64.6
2	Composite beam with Mild steel reinforcement wrapped with GFRP sheets	116	98.6

D.STRENGTH COMPARISON OF COMPOSITE BEAM WITH PVC REINFORCEMENT

Strength of the composite beam with PVC steel reinforcement with the wrapping GFRP sheets and without the wrapping of GFRP sheets is determined.

Table no 4: Strength comparison of composite beam with pvc reinforcement

S.NO	SPECIMENS	LOAD (kN)	FLEXURAL STRENGTH (N/mm^2)
1	Composite beam with PVC reinforcement	32	27.2
2	Composite beam with PVC reinforcement wrapped with GFRP sheets	74	62.9

E.FLEXURAL STRENGTH OF THE COMPOSITE BEAM

The following table shows the details of the flexural strength of composite beams of different specimens.

Table no 5: Flexural strength of the composite beam

S.NO	SPECIMENS	LOAD (kN)	FLEXURAL STRENGTH (N/mm^2)
1	Composite beam with Normal reinforcement	72	61.2
2	Composite beam with Stainless steel reinforcement	42	35.7
3	Composite beam with Mild steel reinforcement	76	64.6
4	Composite beam with PVC reinforcement	32	27.2
5	Composite beam with Normal reinforcement wrapped with GFRP sheets	112	95.2
6	Composite beam with Stainless steel reinforcement wrapped with GFRP sheets	98	83.3
7	Composite beam with Mild steel reinforcement wrapped with GFRP sheets	116	98.6
8	Composite beam with PVC reinforcement wrapped with GFRP sheets	74	62.9

VI. CONCLUSION

The performance was observed and discussed Based on the test report on the filled hollow tube beam, the following conclusions are made with, Experiments were carried out with Hollow pipes such as stainless steel, Mild steel, PVC and Normal beams.

- The beams are casted and wrapped with GFRP sheets. The strength of the beam with the wrapping of GFRP sheets and without the wrapping of GFRP sheets is compared.
- The flexural strength of the composite beam with normal reinforcement without the wrapping of GFRP sheets is given by, 61.2 N/mm^2, with the wrapping of GFRP sheets is given by, 95.2 N/mm^2.
- The flexural strength of the composite beam with Stainless steel reinforcement without the wrapping of GFRP sheets is given by, 35.7 N/mm^2, with the wrapping of GFRP sheets is given by, 83.3 N/mm^2. Flexural strength of the composite

beam with Mild steel reinforcement without the wrapping of GFRP sheets is given by, 64.6 N/mm^2, with the wrapping of GFRP sheets is given by, 98.6 N/mm^2.

- The flexural strength of the composite beam with PVC reinforcement without the wrapping of GFRP sheets is given by, 27.2 N/mm^2, with the wrapping of GFRP sheets is given by, 62.9 N/mm^2.
- Major conclusions from this experimental investigation are Load carrying capacity of beam with hollow mortar filled tubes is economical for construction techniques.
- And also found that the mild steel has carried the maximum critical load when compared to other specimens.

VII.REFERENCES

1. K. Zhang et al. (2003). Experimental study on seismic strengthening of RC columns with wrapped Alferjani1. M.B.S et al (2013): Use of Carbon Fiber Reinforced Polymer Laminate for strengthening reinforced concrete beams in shear: A review, International Refereed Journal of Engineering and Science (IRJES) ISSN (Online) 2319-183X, (Print) 2319-1821 Volume 2, Issue 2(February 2013), PP.45-53.
2. Vinodkumar.M et al (2014): Review on CFRP/ GFRP Composites used for Strengthening of Reinforced Concrete Beams, IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 2, Issue 2, Apr-May, 2014.
3. D.N. Shinde, Pudale Yojana M, Nair VeenV "flexural behaviour of reinforced cement concrete beam wrapped with gfrp sheet" Ijret: international journal of research in engineering and technology eissn: 2319-1163 | pissn: 2321-7308.
4. C. Natarajan & P. Arun kumar "Experimental Investigation of Torsional Behaviour of Glass Fibre Wrapped Reinforced Concrete Beam" 63 International journal of earth sciences and engineering issn 0974-5904, vol. 02, no. 01, February 2009, pp. 63-67.
5. N. Pannirselvam, V. Nagaradjane and K. Chandramouli "strength behaviour of fibre reinforced polymer strengthened beam" ARPN journal of engineering and sciences vol. 4, no. 9, November 2009.
6. K L Muthuram, A Chandran, S Govindarajan, & S Karunanidhi "strengthening of reinforced concrete elements using glass fibre" 35th Conference on our world in concrete & structures, 25 - 27 august 2010, Singapore.
7. Abhijit Mukherjee and Mangesh V. Joshi "Seismic retrofitting technique using fibre composites" The Indian concrete journal *December 2001 pg no: 1-7.
8. Manuel A.G. Silva and Carios C Rodrigues (2006). Size and relative stiffness effcts on compressive failure of concrete columns wrapped with glass FRP. Journal of CFRP sheets. Construction and Building Materials, 17 (6 - 7). 499-506.
9. Ta¨ljsten.B (2003): Strengthening concrete beams for shear with CFRP sheets, Construction and Building Materials 17 (2003) 15–26.
10. Strengthened with GFRP Laminates, IJCSET |December 2011 | Vol 1, Issue 11, 718-721.
11. Al-Saidy.A.H et al (2009): Effect of damaged concrete cover on the structural performance of CFRP strengthened corroded concrete beams.