International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 5, July-August 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Study the Effect of FRP Strengthening on Ultimate Load Carrying Capacity of Reinforced Concrete Beams

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ABSTRACT

The ultimate strengths of three different sets of concrete cylinders were examined. Three concrete cylinders—F1, F2, and F3—are evaluated in SET I: F1 Without wrap FRP, F2 Single Wrap FRP, and F3 Double Wrap FRP. Three concrete cylinders—S1, S2, and S3—with different FRP wrap configurations are evaluated in SET II. Three concrete cylinders (R1, R2, and R3) with different levels of FRP wrapping are evaluated in SET III. As the control concrete cylinders, the concrete cylinders F1, S1, and R1 were used. When compared to externally strengthened beams made of FRP sheets, it was found that the concrete cylinders F1, S1, and R1 could hold less weight.

KEYWORDS: *Compression, Fiber Reinforced Polymer, Flexure, Concrete, Beams, Shear*

How to cite this paper: Mohit Jain | Dr. Abhay Kumar Jha | Barun Kumar "Study the Effect of FRP Strengthening on Ultimate Load Carrying Capacity of Reinforced Concrete Beams" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-5, August 2022, pp.1721-1723, URL: www.ijtsrd.com/papers/ijtsrd51716.pdf

IJTSRD51716

INTRODUCTION

Disasters such as earthquakes, tornados, and tsunamis threaten the integrity of civil infrastructure and safety of their users. A large number of reinforced concrete buildings and bridges built in India before the1990s typically do not have sufficient capacity to resist the forcesduring such catastrophes. In order to guarantee the safety of the people; older, existing structures need to be repaired and strengthened to prevent their collapse. Efficient methods need to be developed for structural repair and strengthening. During its whole life span, nearly all engineering structures ranging from residential buildings, an industrial building to power stations and bridges faces degradation or deteriorations. The main causes for those deteriorations are environmental effects including corrosion of steel, gradual loss of strength with ageing, variation in temperature, freeze-thaw cycles, repeated high intensity loading, contact with chemicals and saline water and exposure to ultra-violet radiations. Addition to these environmental effects earthquakes is also a major cause of deterioration of any structure. This problem needs development of successful structural retrofit technologies. So it is very important to have a check upon the continuing performance of the civil engineering infrastructures. The structural retrofit problem has two options, repair/retrofit or demolition/reconstruction. Demolition or reconstruction means complete replacement of an existing structure may not be a cost-effective solution and it is likely to become an increasing financial burden if upgrading is a viable alternative. Therefore, repair and rehabilitation of bridges, buildings, and other civil engineering structures is very often chosen over reconstruction for the damage caused due to degradation, aging, lack of maintenance, and severe earthquakes and changes in the current design requirements.

LITERATURE SURVEY

The program of experimental work by Chajes et al. (1994), on small scale specimens, concentrated on

GFRP composites as the external reinforcing medium (Chajes et al., 1995a). Increases in flexural and shear capacity of beams 1120mm in length were examined when testedto failure in four point bending. These small scale beams, which again had no shear reinforcement, were externally strengthened with unidirectional CFRP tow sheets to the basic control beam configuration. To evaluate the effect of composite shear reinforcement, a CFRP sheet was wrapped around the section; again, the extent of this reinforcement along the span is unclear. It was found that the control beam was increased by 158% by adding a single CFRP sheet to the tensile face of the beam Increases in the load cracking of the concrete and yielding of the internal steel were also noted. In addition to the increase in capacity, a 115% increase in stiffness, a change in failure mode from flexural to shear, and a decrease in ductility were observed. By wrapping the beam with a CFRP sheet, shear failure was prevented and tensile failure of the composite occurred. Finally, by adding a second CFRP sheet to the tensile face, a 292% increase in capacity and a 178% increase in stiffness were achieved. It should be stressed, however, that these large percentages are a function of the initial structural capacities of the beam.

Chajes et al. (1995b) tested beams reinforced externally with CFRP plates bonded to their soffit and sides to study flexural and shear behaviors. The fiber orientation in the shear plates was in the vertical direction of the beams only. This orientation was believed to be the reason for the similarity in the load-deflection responses of flexurally strengthened beams with and without external material; the vertical fibers had little effect on the flexural behavior of the beams. The composite material used by Chajes et al. (1995b) was a unidirectional CFRP tow sheet having a dry thickness of 0.11mm and a tensile modulus of elasticity of 227.37GPa. The continuous strips were able to control shear crack opening due to their greater axial stiffness, resulting in reduced shear deflection. This result showed that, unlike the flexural soffit reinforcement, a thin sheet possible will not necessarily produce the greatest improvement in crack

METHODOLOGY

Proportioning of the ingredients ofconcrete is referred to as designing the mixture, and for most structural work the concrete is designed to give compressive strengths of 15 to 35 MPa. A rich mixture for columns may be in the proportion of 1 volume of cement to 1 of sand and 3 of stone, while a lean mixture for foundations may be in the proportion of 1:3:6. Concrete may be produced as a dense mass which is practically artificial rock, and chemicals may be added to make it waterproof, or it can be made porous and highly permeable for such use as filter beds. An air-entraining chemical may be added to produce minute bubbles for porosity or light weight. Normally, the full hardening period of concrete is at least 7 days. The gradual increase in strength is due to the hydration of the tricalcium aluminates and silicates. Sand used in concrete was originally specified as roughly angular, but rounded grains are now preferred. The stone is usually sharply broken. The weight of concrete varies with the type and amount of rock andsand. A concrete with trap rock may have a density of 2,483 kg/m^3. Concrete is stronger in compression than in tension, and steel bar, called rebar or mesh is embedded in structural members to increase the tensile and flexural strengths.

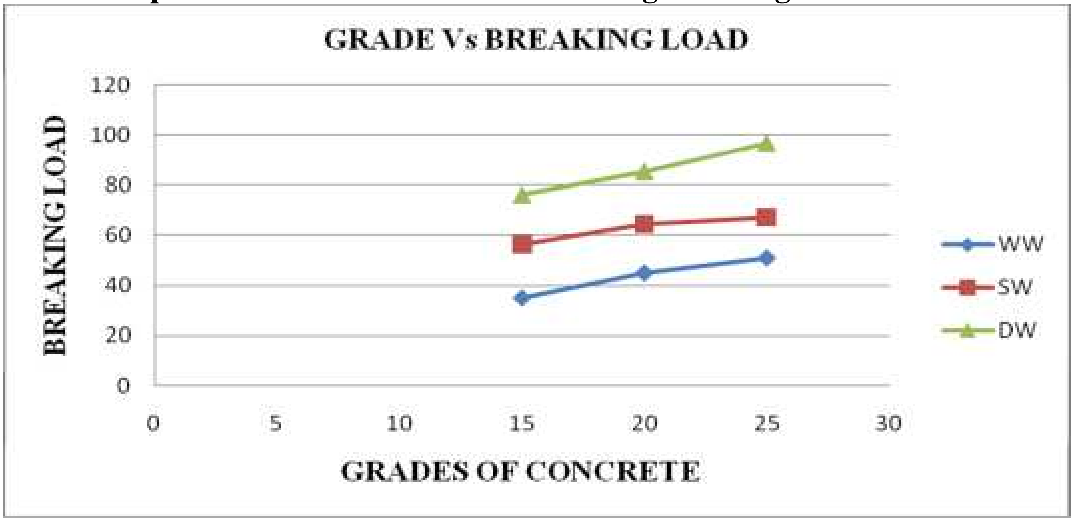
Table 1 Ultimate stresses, Ultimate load and Young's modulus of FRP plate

	Ultimate Stress(MPa)	Ultimate load (KN)	Young's modulus(MPa)
FRP plate of 2 layers	334.5	4.817	11310

Table 2 Results for M-20 grade of concrete in Case –I

Sr. No.	Grade of Concrete	Cylinder Status	Breaking Load(MT)	Strength Kg/cm2	Remark
1.	M-20	Without warp	45.75	259	Initial stage
2.	M-20	Single warp	65.45	370.55	Increased by 43% frominitial stage
3.	M-20	Double warp	87	492.56	Increased by 33% fromsingle warp

Graph – 1. Combined result for breaking load on grades case-III



CONCLUSION

For M-20 concrete grade cylinders-

Firstly we have checked the strength of normal concrete cylinder without FRP warp which is taken out for all four cases average value of compressive strength is 256.09 Kg/cm^2. After thatwe applied FRP on concrete cylinder with single warp and strength was tested which is taken out for all four cases average value of compressive strength are 367.72 Kg/cm^2 increased by 43.59% from initial stage. Now after testing FRP on concrete with single warp we applied double warp of FRP on concrete for testing the strength of cylinder and we get the strength for all four cases average value of compressive strength are 487.21 Kg/cm^2 which is increased by 32.49% from single warp and 90.26% from initial stage.

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