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Cyclic Behavior of FRP Strengthen Beam

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Abstract:-Fiber-reinforced polymer (FRP) application is a very effective way to repair and strengthen structures that have become structurally weak over their life span. FRP repair systems provide an economically viable alternative to traditional repair systems and materials. In this study analytical investigation on the cyclic behavior of RC beams strengthened using carbon fiber reinforced polymer (CFRP) sheets are carried out.

Reinforced concrete beams externally bonded with CFRP sheets with different configurations will be modeled in ANSYS14 and analyzed for the cyclic loading system. The effect of different amount and configuration of CFRP on ultimate load carrying capacity, deflection and failure mode of the beams will be investigated.

Keywords: *FEM, CFRP, Fatigue, ANSYS14.*

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I. INTRODUCTION

Fiber reinforced polymer (FRP) composite materials have been effectively utilized as a part of new development and for the repair and restoration of existing structures. Fortifying or solidifying of fortified cement and prestressed solid structures might be required as an aftereffect of an expansion in burden prerequisites, an adjustment being used, characteristic or man-made corruption of the structure, or plan or development imperfections. Repair with remotely fortified FRP support is alluring to proprietors, specialists, and temporary workers on account of the simplicity and rate of establishment, the basic proficiency of the repair, the consumption resistance of the materials, and the negligible impact that these materials have on basic measurements style, and adaptability.

The execution of structures in quakes shows that most structures, framework and segments, if legitimately planned and definite, have a noteworthy ability to ingest vitality when they disfigure past their versatile cutoff points. Albeit numerous tests have been led researching fortifying strengthened solid individuals with FRP composite materials, there are still numerous parts of their utilization that stay to be examined.

The advantages of FRP applications, when contrasted with traditional development strategies, incorporate the high quality to weight proportion, great compound resistance, simplicity of taking care of, and quick execution with lower work costs. To date, various exploration ventures have been accounted for in regards to structures fortified with FRP; in any case, the dominance of these studies included just monotonic stacking. Given that interstate scaffolds are subjected to rehashed or cyclic stacking, research on extension decks and braces fortified with FRP subject to weariness stacking is required.

The point of this exploration is to examine the impact of cyclic stacking on the fortify RCC bar with various setup of CFRP.

II. FINITE ELEMENT METHOD

The most unmistakable elements of the limited component technique that isolates it from other ordinary strategies are the division of the given area into an arrangement of basic sub spaces, called limited components. Any geometric shape that permits calculations of the arrangement or its approximations, or give fundamental connection among the estimations of arrangement at chose focuses, called hubs of the sub space, qualities as limited components.

The heap - misshaping connections can be utilized to figure the conduct of the structures practically. Nonlinear examination gives improved information of serviceability and extreme quality. The computational time and arrangement expenses of nonlinear examination are to a great degree high contrasted with direct investigation. Consequently, the system ought to be as productive as would be prudent and the numerical technique received ought to decrease the computational prerequisites. The limited component investigation is received with the distinctive material nonlinearities, for example, stress-strain conduct of solid, breaking of solid, total interlock at a split, dowel activity of the fortifying steel crossing a split, and so on. Composite layered cement being a composite material without anyone else's input.

III. MODELING

The analytical model of FRP strengthen beam consists of all elements that influence the strength, stiffness, strain, and deformation, imperfection, of the structure. Concrete is modeled as eight nodded Solid65 element, the element has three DOF at each node, Link8 element has three degree of freedom and Solid46 element has three degree of freedom.

Table 1: Material Properties

Material	Element	Poisson's ratio	Modulus of Elasticity (N/m^2)
Concrete	Solid65	0.2	$2.5x10^{10}$
Steel	Link8	0.3	$2.1x10^{11}$
CFRP	Solid46	0.25	$285x10^{9}$

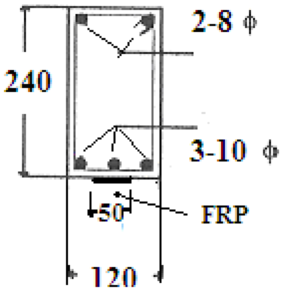

Figure 1: Beam Section

The 120mm x 240mm x 1900mm size 2 RC beams are modeled in the ANSYS11 in which both the beams consist of same tensile steel viz.- 3 no's 10mm diameter of tor steel. Both the beams are provided near top face with 2 no's -8 mm diameter tor steel longitudinal bars. The second beam is strengthen with 50mm wide strip of CFRP with 0.3mm thickness at the bottom surface of the beam aligned at the centre line of the beam whereas the first beam kept unstrengthen.

IV. LOADING

Loading arrangement for the test is shown in the Fig.2 in which load will be applied at midpoint of beam. The test conducted will be a cyclic loading test on RC and CFRP strengthened RC beams in which the loading started at zero loads and increased to 30kN and then released to zero and cycles are repeated with increment of 2kN load up to 100 sub steps as shown in Fig. 3. For each cycle, loading and unloading were repeated when reloading curve intersects with the initial unloading curve of that cycle.

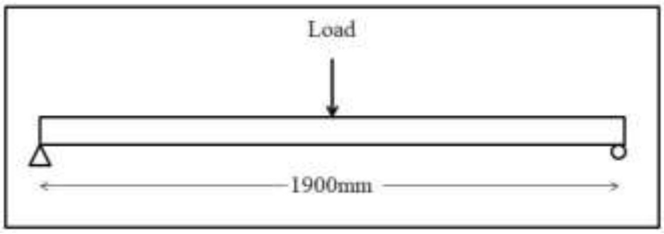

Figure 2: Loading arrangement

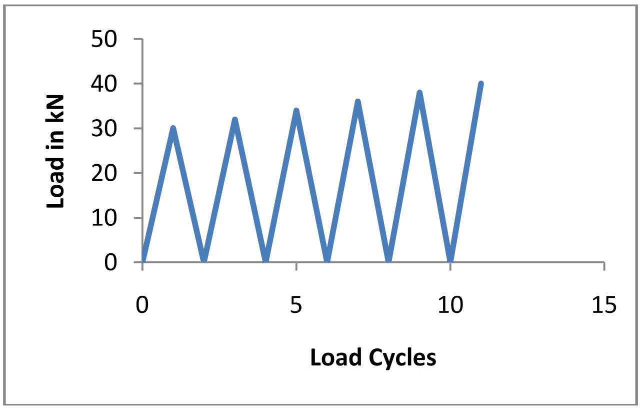

Figure 3: Cyclic loading

V. RESULTS

The results were obtained from ANSYS in the form of load deflection curves for specimen I and specimen II.

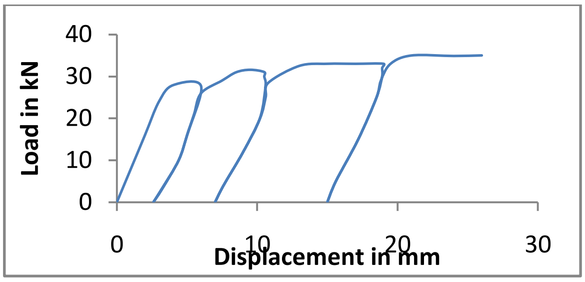

Figure 4: Load deflection curve for specimen I

Figure 4 shows the load deflection curve for specimen I which is unstrengthen RC beam. Which shows the ultimate load carrying capacity of specimen I is 34.865kN.

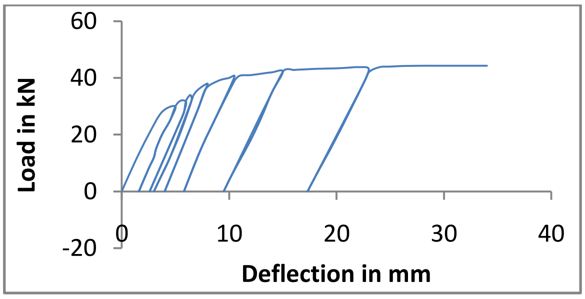

Figure 5: Load deflection curve for specimen II

Figure 5 shows the load deflection curve for specimen I which is strengthen RC beam. Which shows the ultimate load carrying capacity of specimen I is44.3kN.

CONCLUSIONS

1. CFRP material will increase the strength and stiffness of the beam to reduce the stress in steel.
2. FRP strengthen beams will survived more cycles than that of the unstrengthen beams.
3. Mid-span deflection of strengthen beams will be less as compared to that of the unstrengthen beams.
4. Failure of strengthen beam will be indicated by the debonding of the concrete and FPR.
5. Strengthening using FRP will be more effective and better in case of under reinforced RC beams having lower amount of steel.
6. Deflection at maximum load of FRP strengthened RC beams will be very less as compared to unstrengthen RC beams. Decrease in deflection due to FRP strengthening can be very useful to overcome excessive deflection problem of under reinforced RC beams having very small amount of tensile steel.

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