# Determination of Fiber-Reinforced Polymer Reinforced For Concrete Structures

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***Abstract-*** *Fiber-reinforced polymer (FRP) application is a most effective way to repair and strength of structures that have become structurally weak over their life time. FRP repair systems is provide an economically viable alternative to traditional repair systems and materials. In this study experimental work investigation on the flexural behavior of RC T-beams strengthened of using glass fiber reinforced polymer (GFRP) sheets are carried out.*

*Reinforced concrete T beams externally bonded with GFRP sheets were tested to failure using a symmetrical two point static loading system. Three RC T-beams were casted for this experimental work. All of them were weak in flexure and were having same reinforcement detailing on the structure. One beam was used as a control beam and two beams were strengthened using different configurations of using glass fiber reinforced polymer (GFRP) sheets on the T beam. Experimental data on loaded, deflection and failure modes of each of the beams were obtained. The effect of different amount and configuration of GFRP on ultimate load carrying capacity taken and failure mode of the beams were investigated on lab.*

## I. INTRODUCTION

Deterioration in concrete systems is a prime assignment faced via the infrastructure and bridge industries worldwide. The deterioration is specially due to environmental outcomes, which includes corrosion of metal, sluggish lack of power with growing older, repeated high depth loading, variation in temperature, freeze-thaw cycles, contact with chemicals and saline water and publicity to extremely-violet radiations. This hassle, coupled with revisions in structural codes had to account for the natural phenomena like earthquakes or environmental deteriorating forces, needs improvement of a success structural retrofit technologies. The structural retrofit hassle has two options, repair/retrofit or demolition/reconstruction. traditionally, the trend inside the US construction industries has been toward the latter choice. This answer has emerge as increasingly more unacceptable due to changing financial and social attitudes regarding current systems. This reality ends in the need for development of suitable structural retrofit/restore structures. traditionally, the retrofitting of reinforced concrete systems, along with columns, beams and other structural factors, concerned a time consuming and disruptive method of getting rid of and changing the low first-class or damaged concrete or/and steel reinforcements with new and more potent material. but, with the advent of latest superior composite materials which includes fiber strengthened polymer (FRP) composites, concrete individuals can now be easily and efficiently strengthened using externally bonded FRP composites.

## II. EXPERIMENTAL STUDY

### MATERIALS

### CONCRETE

It's far composed of Portland cement and water combined with sand, gravel, crushed stone, or different inert cloth together with accelerated slag or vermiculite. A strong stone-like mass is shaped from a chemical reaction of cement and water. The concrete paste is plastic and may be easily molded into any form or trowelled to provide a easy surface. Hardening starts off evolved right away after blending, but precautions are taken, commonly by masking, to keep away from fast loss of moisture because the presence of water is essential to retain the chemical reaction and growth the energy.

### CEMENT

Cement is a fabric, commonly in powder shape, that may be made into a paste generally by the addition of water and, when molded or poured, will set into a stable mass. numerous natural compounds used for adhering, or fastening materials, are known as cements, but these are labeled as adhesives, and the time period cement alone way a construction material. The maximum extensively used of the construction cements is Portland cement. it's far a bluish-grey powder acquired by finely grinding the clinker made by means of strongly heating an intimate aggregate of calcareous and argillaceous minerals.

**FINEAGGREGATE**

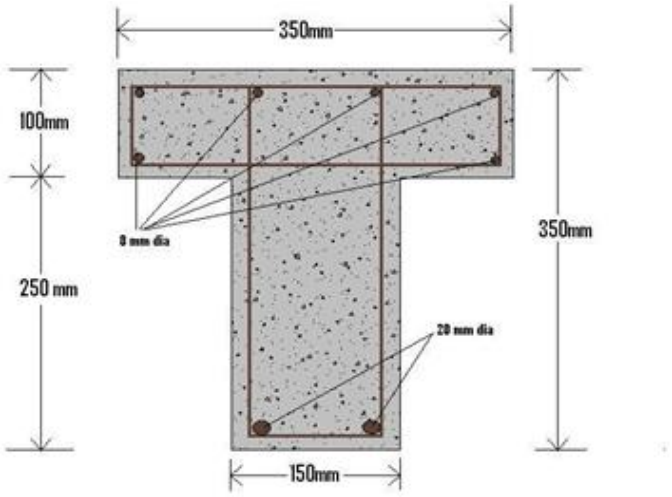
High-quality mixture / sand is an accumulation of grains of mineral count derived from the disintegration of rocks. it's miles distinguished from gravel only by means of the dimensions of the grains or debris, but is wonderful from clays which incorporate natural substances. Sands that have been looked after out and separated from the organic fabric by means of the action of currents of water or by means of winds throughout arid lands are usually pretty uniform in size of grains.

**COARSEAGGREGATE**

Coarse mixture are the overwhelmed stone is used making for concrete. the economic stone is quarried, crushed, and graded. a lot of the beaten stone used is granite, limestone, and lure rock. The ultimate is a time period used to designate basalt, gabbro, diorite, and different dark colored, quality-grained igneous rocks. Graded crushed stone usually includes only one sort of rock and is damaged with sharp edges. The sizes are from zero.25 to two.5 in (0.sixty four to six.35 cm), even though lager sizes may be used for massive concrete aggregate. gadget chorused granite broken stone angular in form is find as coarse aggregate.

**REINFORCEMENT**

High-Yield Strength Deformed bars of 20 mm diameter are used for the condition longitudinal reinforcement and 8 mm dia bar high-yield strength deformed bars are used as stirrups. The yield strength of steel reinforcements are used in this experimental program is determined by performing the standard tensile test on the three specimens of each bar. The average proof is at 0.2 % strain of 20 mm φ bars is 379 $N/mm^2$.




**FIBER REINFORCED POLYMER(FRP)**

Continuous fiber-bolstered substances with polymeric matrix (FRP) can be considered as composite, heterogeneous, and anisotropic substances with a frequent linear elastic conduct up to failure. they may be broadly used for strengthening of civil systems. there are numerous blessings of the usage of FRPs: lightweight, top mechanical homes, corrosion-resistant, etc. Composites for structural strengthening are available in numerous geometries from laminates used for strengthening of members with ordinary surface to bidirectional fabrics without problems adaptable to the shape of the member to be strengthened. Composites are also appropriate for programs where the cultured of the original structures needs to be preserved (homes of historic or creative interest) or in which strengthening with traditional techniques cannot be effectively employed.

A fiber is a material made into a protracted filament with a diameter typically within the order of 10 tm. The issue ratio of length and diameter may be ranging from thousand to infinity in continuous fibers. the principle features of the fibers are to carry the load and provide stiffness, electricity, thermal balance, and other structural houses inside the FRP

**CASTING OFSPECIMEN**

For conducting experiment for the work, three reinforced concrete T beam specimen of size as shown in the fig (Length = 2000 mm , flange width = 350 mm , web width = 150 mm, depth of the flange = 100 mm, overall depth=350 mm) and all having the same reinforcement detailing are casted. The proportion of **0.5: 1: 1.56: 3.30** for water, cement, fine aggregate and course aggregate is taken. The mixing is done by using concrete mixture. The beams is curring for 28 days. For each beam three cubes are casted to determine the compressive strength of concrete for 28 days.

**TESTING OFBEAMS**

All The three are tested one by one .one with FRP and one without FRP which is taken as the control Beam .All of three are tested in the above arrangement. The gradual increase in loading and the deformation in the strain gauge reading was taken throughout complete the test. The dial gauge reading shows for the given deformation. The load at which the first visible crack is the developed is recorded as cracking on load. Then the load is applied till the ultimate failure condition of the beam.

**BEAM NO.1- CONTRLBEAM, Deflection Values of Beam 1**

| LOAD (in KN) | At Point L/3 (in mm) | At Point L/2 (in mm) | Remarks |
|---|---|---|---|
| 0 | 0 | 0 | |
| 20 | 0.37 | 0.44 | |
| 30 | 0.52 | 0.64 | |
| 40 | 0.63 | 0.75 | |
| 50 | 0.76 | 0.88 | |
| 60 | 0.87 | 1.03 | |
| 70 | 1.01 | 1.21 | |
| 80 | 1.15 | 1.34 | |
| 90 | 1.28 | 1.55 | |
| 100 | 1.47 | 1.75 | |
| 110 | 1.59 | 1.89 | |
| 120 | 1.77 | 2.10 | Hairline crack started appearing |
| 130 | 1.92 | 2.23 | |
| 140 | 2.07 | 2.41 | |
| 150 | 2.18 | 2.53 | |
| 160 | 2.35 | 2.74 | |
| 170 | 2.55 | 2.96 | |
| 180 | 2.74 | 3.17 | |
| 190 | 2.88 | 3.31 | |
| 200 | 3.02 | 3.47 | |
| 210 | 3.15 | 3.64 | |
| 225 | 3.39 | 3.89 | |
| 240 | 3.64 | 4.18 | Ultimate Load |

**BEAM-2 Single Layered GFRP bonded at Bottom of Web from end to end, Deflection Values**

| LOAD (in KN) | At Point L/3 (in mm) | At Point L/2 (in mm) | Remarks |
|---|---|---|---|
| 0 | 0 | 0 | |
| 20 | .27 | .32 | |
| 30 | .35 | .43 | |
| 40 | .44 | .54 | |
| 50 | .57 | .66 | |
| 60 | .73 | .88 | |
| 70 | .83 | .98 | |
| 80 | .98 | 1.18 | |
| 90 | 1.13 | 1.34 | |
| 100 | 1.29 | 1.52 | |
| 110 | 1.41 | 1.66 | |
| 120 | 1.56 | 1.86 | |
| 130 | 1.71 | 1.98 | Hairline cracks appeared |
| 140 | 1.85 | 2.14 | |
| 150 | 2.01 | 2.33 | |
| 160 | 2.17 | 2.48 | |
| 170 | 2.33 | 2.67 | |
| 180 | 2.44 | 2.82 | Debonding of fiber |
| 190 | 2.62 | 2.99 | |
| 200 | 2.75 | 3.11 | |
| 210 | 2.85 | 3.24 | |
| 220 | 3.01 | 3.38 | |
| 230 | 3.11 | 3.55 | |
| 240 | 3.26 | 3.69 | |
| 250 | 3.39 | 3.83 | |
| 260 | 3.51 | 3.99 | |
| 270 | 3.66 | 4.15 | |
| 276 | 4.08 | 4.69 | Tearing of fiber |
| 290 | 4.54 | 5.41 | |
| 308 | Tearing and debonding | | |
| 310 | Ultimate Load | | |

## III. RESULTS AND DISCUSSIONS

### INTRODUCTION

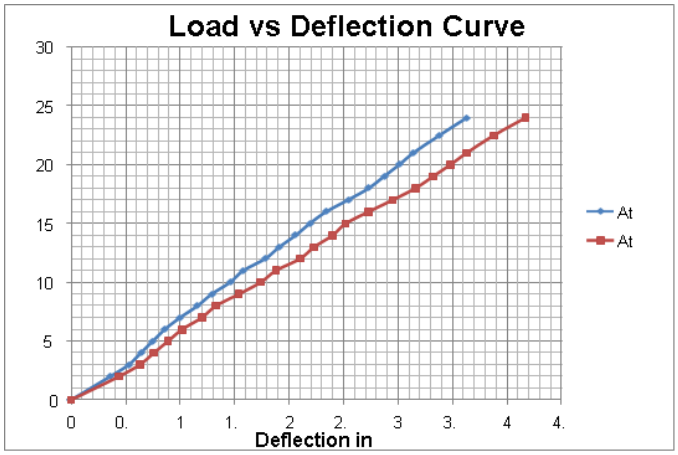
On this chapter the experimental results of all of the beams with specific sorts of layering of GFRP are interpreted. Their behavior at some stage in the check is defined using recorded records on deflection behavior and the closing load wearing ability. The crack styles and the mode of failure of each beam also are defined on this bankruptcy. all of the beams are tested for his or her closing strengths.Beams-1 is taken because the manage beam. it's miles observed that the manage beam had less load wearing ability and high deflection values in comparison to that of the externally strengthened beams the usage of GFRP sheets.

all of the beams besides the manage beam are strengthened with GFRP sheets in one of a kind patterns.Beam-2 is bolstered simplest at the soffit from give up to cease. Beam-three is additionally strengthened only at the soffit but for the period L/three to 2L/3. Deflection conduct and the closing load sporting capacity of the beams are mentioned. The closing load carrying ability of all of the beams at the side of the character of failure is given in desk 4.1.

### LOAD DEFLECTIONANALYSIS

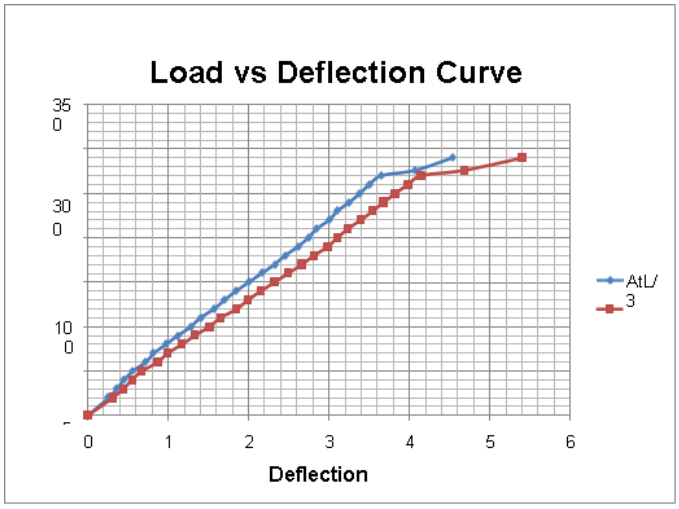
right here the deflection of every beam at extraordinary positions is analyzed. Mid-span deflections of each beam are compared with the manage beam. additionally the weight deflection conduct is as compared among exceptional wrapping schemes having the equal reinforcement. it's miles noted that the conduct of the flexure poor beams while bonded with GFRP sheets are higher than the manage beams. The mid-span deflections are decrease whilst bonded externally with GFRP sheets. using GFRP sheet had effect in delaying the boom of crack-formation.

**Load vs. Deflection Curve for Control Beam 1-**



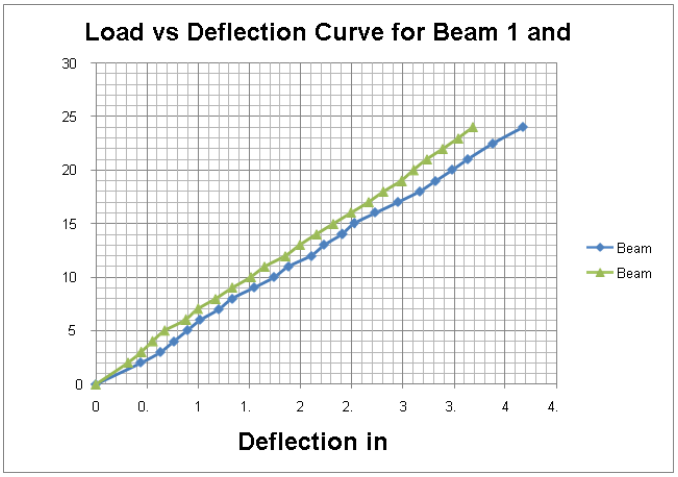

Beam 1 is taken as the control beam which is weak in flexure. In Beam1 no strengthening is done. Two point static load system loading is applied on the beam and at the each point at increment of the load, deflection at L/3, L/2 and 2L/3 are taken with the help of dial gauges. Using this load and deflection data, load vs. deflection curve is plotted. At the load of 120 KN initial hairline cracks appeared. Later with the increase in loading values the crack propagated further. The Beam1 failed completely in flexure test.

**Load vs. Deflection Curve for Beam 2**




Beam-2 is reinforced simplest on the soffit from give up to stop . factor static loading is applied at the beam and on the every increment of the burden, deflection at L/3, L/2 and 2L/three are interested in the help of dial gauges. the usage of this load and deflection facts, load vs. deflection curve is plotted. at the load of 130 KN initial hairline cracks seemed. Later with the increase in loading values the crack propagated further. Beam-2 failed because of fracture of GFRP sheet after which flexural failure of the beam befell

**Load vs. Deflection Curve for Beam 1 and 2**




From this figure it's far determined that deflection in case of Beam-2 which has been bolstered with GFRP at the soffit is controlled to a certain quantity with admire to the manage Beam 1.And the ultimate load has also accelerated to a positive percent which has been illustrated inside the discern four.

## IV. CONCLUSIONS

The prevailing experimental study is performed on the flexural behavior of bolstered concrete T-beams reinforced by GFRP sheets. Seven strengthened concrete (RC) T-beams vulnerable in flexure having same reinforcement detailing are casted and tested. From the take a look at outcomes and calculated electricity values, the subsequent conclusions are drawn:

1. The ultimate load carrying capacity of all the strengthen beams were enhanced as compared to the ControlBeam1.
2. Initial flexural cracks appear for higher loads in case of strengthened beams.
3. The load carrying capacity of the strengthened Beam 2 was found to be maximum of all the beams. It increased up to 37.5 % more than the control beam 1.

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