Analysis of RC Beams Repaired with CFRP Laminates

T.P.Meikandaan, M.Hemapriya, P.Mugilvani, R.Chitra

Abstract: ***Retrofitting materials like aluminum bars, steel overlays and glass fiber mixes has been utilized in the development field for a long time. Carbon fiber mixes are the ongoing expansion to the retrofitting materials. Trial and expository investigation have been done and compared.Total number of 6 shafts yet of which 3 are control bars and the other 3 pillars pre harmed 70%of extreme burden and after that enveloped by the base with CFRP laminates.Experimental examination completed by applying two-point load. Investigative examination by FEM specifically utilizing ABAQUS the predications utilizing the proposed diagnostic model are in great concurrence with the exploratory outcomes.***

Key words: carbon fibre, epoxy, flexural, retrofitting, rehabilitation

I. INTRODUCTION

A. General

The current structures that are under seismic tremor activity, incompletely shafts are enduring harm. Then again, while deciding the presentation of the current structure during seismic arrangement that can happen, concerning as conceivable without expanding the mass of the structure, the hugeness of reinforcing the pillars turns out At each condition, therefore at either fix on fortify examinations, deciding the association between tech-nical fix systems and the shaft limit becomes a force to be reckoned with. Toward this path, thinks about are being finished by methods for being looked from changed perspective a heading. [1],[3],[5] The upkeep, recovery and overhauling of basic individuals, are maybe one of the most urgent issues in structural building applications. In addition, an enormous number of structures built in the past utilizing the more seasoned plan codes in various pieces of the world are fundamentally dangerous as indicated by the new plan codes. Since substitution of such inadequate components of structures acquires a colossal measure of open cash and time, reinforcing has turned into the satisfactory method for improving their heap conveying limit and expanding their administration lives. Framework rot brought about by untimely decay of structures and structures has lead to the examination of a few procedures for fixing or fortifying purposes. One of the difficulties in reinforcing of solid structures is determination of a fortifying strategy that will improve the quality and functionality of the structure while tending to confinements, for example, constructability, building tasks, and spending plan. Auxiliary fortifying might be required because of various circumstances.

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C Finite Element Models

The FEM adjustment concentrate included demonstrating a solid pillar with the measurements and properties. Because of the symmetry of cross-area of the solid bar and stacking, symmetry was used in the FEM; just one fourth of the bar was demonstrated.

II. BEAM CASTING

If there should arise an occurrence of a pillar or some other auxiliary part, the formwork is the shape, concrete is the material, it need not be hot and liquid as it is very plastic and streams, contingent upon the usefulness of the blend. The solid is permitted to harden, that is, it is permitted to set.This procedure of pouring cement in it's shape, that is, the formwork is called putting. Furthermore, the entire procedure inside and out is called throwing. [8],[10] ,[12]

Mould Size

Height = 0.2m
Length = 1.5m
Width = 0.1m

Volume Of Concrete (Number Of Beam 3)

V =l*h*w
V =1.5*0.2*0.1 V
=0.03m^3 V
=0.03*3
V =0.09m^3

III. DETAIL ABOUT 20 CHANNEL DATA LOGGER

A . Introduction

Measurement of physical parameters like load, pressure, linear dimensions, and vibration quantities such as acceleration , velocity frequency , and strain induced in structures, temperature, relative humidity ,ION concentration etc. are required to be made precisely and accurately for many process industries and control applications .most of these quantities were measured in earlier days purely by mechanical means and methods .the measurements were tedious and cumbersome to make and the results were usually available in visual from like a pointer needle moving over a graduated dial only . Hence the utilization of these measurements by way of feedback and process controls was achieved manually by means of skilled operators.

Strain gauge is one such instrument transducer which prevalently used now days for measurement purposes. These strain gauges are being used to sense load, it is termed as load cell – is called a pressure cell while sensing pressure cell while sensing pressure and is known as electrometer while used for sensing vibration. [13], [15] ,[17]

B Load Frame

A high solidness bolster structure against which the test powers can respond. The heap edge involves a base bar, two sections, and a moving crosshead.

Figure 1 : Loading Frame

C. Hydralic Jack

A pressure driven jack is a gadget that is utilized to apply overwhelming burdens by applying a power by means of a water driven chamber. Water driven jacks lift burdens utilizing the power made by the weight in the chamber. [14],[16], [18]

Figure 2 :Hydraulic Frame

IV. RESULT OF CONTROL BEAM

Load (Tonne)	Control Beam 1		Control Beam 2	
	Lvdt 1 (mm)	Lvdt 2 (mm)	Lvdt 1 (mm)	Lvdt 2 (mm)
0	0	0	0	0
0.5	0.7	0	0.6	0.1
1.0	0.9	0.3	0.9	0.3
1.5	1.1	0.4	1.1	0.5
2.0	1.4	0.6	1.3	0.6
2.5	1.8	1.0	1.7	0.9
3.0	2.4	'1.5	2.3	1.4
3.5	2.8	1.7	2.8	1.6
4.0	3.4	2.3	3.5	2.2
4.5	3.8	2.7	3.7	2.6
5.0	4.5	3.4	4.4	3.3
5.5	5.8	4.8	5.7	4.8
6.0	6.1	5.1	6.02	5.2
6.5	6.3	5.5	6.3	5.5
7.0	6.5	5.9	6.6	5.8
7.3	6.7	6.3	6.9	6.1

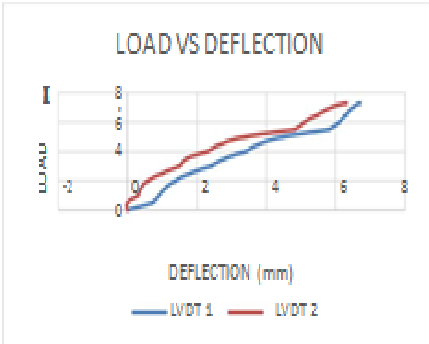


Figure 3 : Load Vs Deflection Graph For Control Beam SB-I

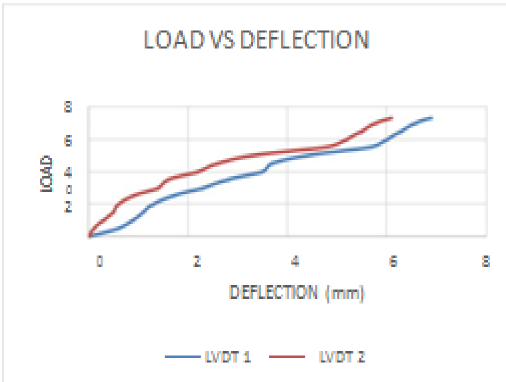


Figure 4 : Load Vs Deflection Graph For Control Beam SB-II

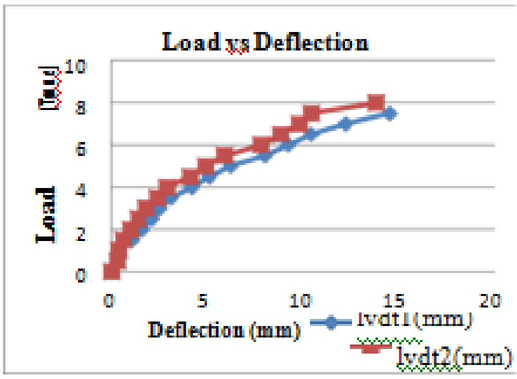


Figure 5: Load Vs Deflection Graph for Test Result Of CFRP Bottom Wrapping Multiple Layer For Predamaging (70% For FB-I)

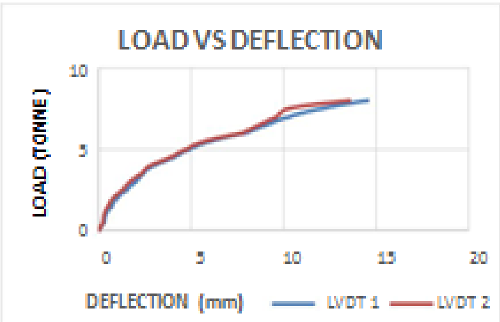


Figure 6: Load Vs Deflection Graph for Test Result Of CFRP Bottom Wrapping Multiple Layer For Predamaging (70% For FB-II)

V. ANALYTICAL INVESTIGATION

A. Software

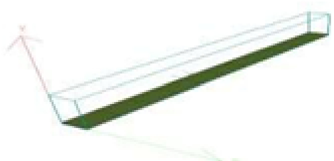
- ABAQUS
- ANSYS

VI. WRAPPING PATTERN OF CFRP

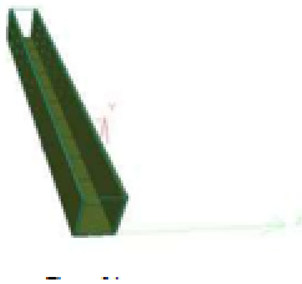
CFRP sheets used in present investigation are fabric type E-carbon of grade 400 GSM. The sheets used were of bidirectional fibre orientation with tensile strength of 3450 N/mm2.

A Types of wrapping pattern for beam

• **Bottom Wrap-** The underside of the beam wrapped with one and two layers of GFRP throughout the length and designated



• **U Wrap -** The following are the different types of U wraps: The beam wrapped with one and two layers on the underside and bottom half depth, throughout the length and designated. [26],[28],[30]



• **Special Wap or Sides Wrap -** The beam wrapped with one and two layers on the underside and bottom half depth, along a length of either ends of the beam and the remaining unwrapped portion of the beam was wrapped on the underside alone and designated.

VII. ANALYSIS

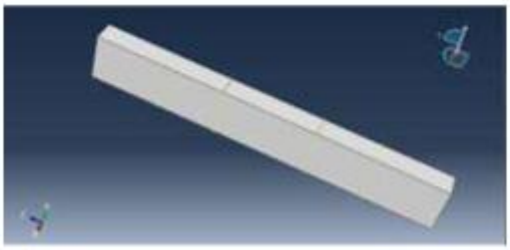
One of the targets of this examination is to build up a limited component model speaking to the R.C.C. pillars to examine the heap avoidance conduct of wrapped and unwrapped examples. Numerical examinations were performed utilizing the ABAQUS suite limited component program to foresee a definitive stacking limit of rectangular fortified solid bars reinforced by CFRP composites, Linear material conduct, as it identifies with steel strengthening bars, plain concrete and fiber-fortified polymer were reenacted utilizing fitting constitutive models. The impacts of wrapping with CFRP on a definitive quality of the bars were researched. [20],[22], [24]

VIII. BEAM MODELLING

A. Modelling Of Concrete Element

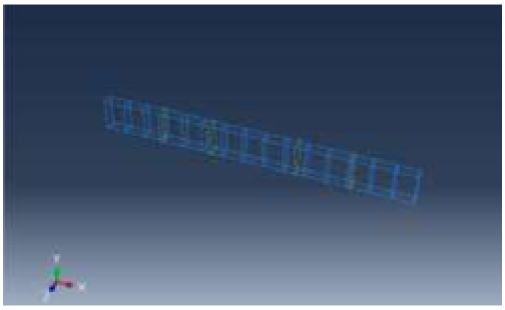
In ABAQUS the concrete element was modelled using 3D solid element.

IX.

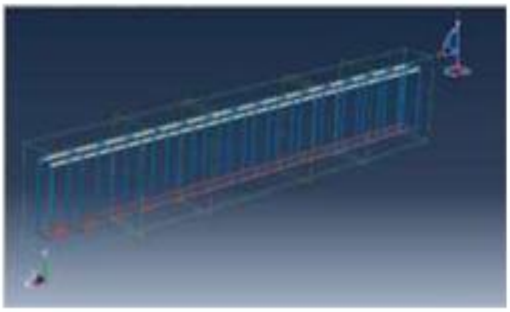


B. Modelling Of Steel Reinforcement Element

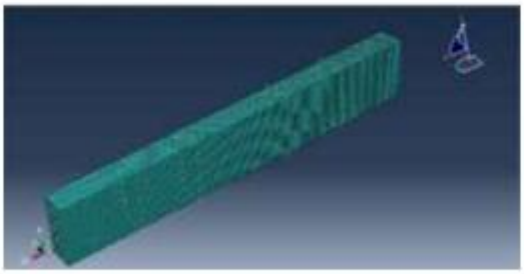
The steel reinforcement bar element was modelled using 3D wire element



C. Assemblies modelling of Concrete beam and Steel Reinforcement

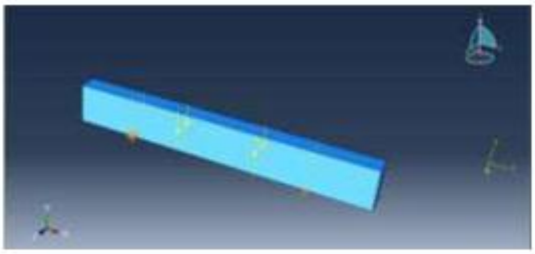


D. Finite elements meshing of normal strengthened beam

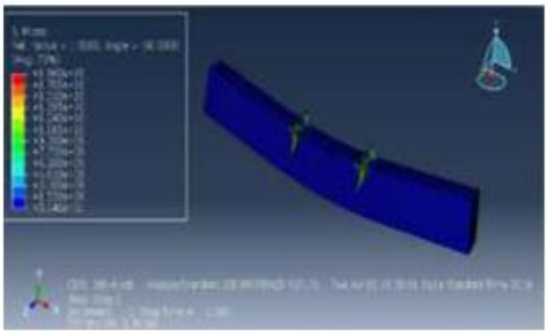


E. Modelling of boundary condition and loading applied

The model was simply supported with boundary conditions of hinged and roller supports on either sides with 2-point loading on top on the beam.



F. Deformation pattern of normal beam at ultimate load

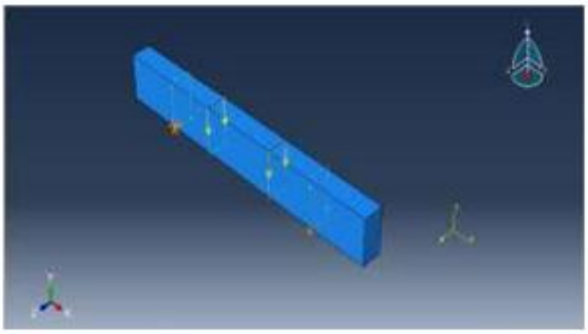


A. Modelling procedure of a beam damaged at 70% of the ultimate load

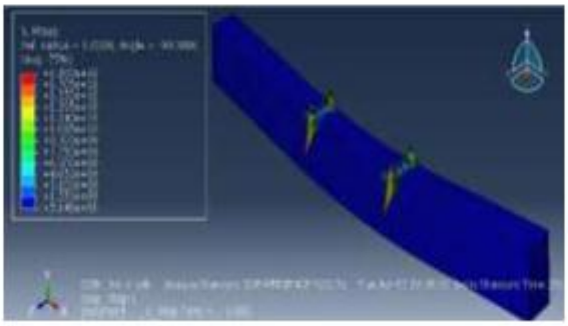
The modelling of the beam and the reinforcement is same as the that of the control beam represented above.

1. Modelling of boundary condition and loading applied

The beam has been given the same boundary condition which was given to the control beam and the load which is being provided on the beam below is 70% of the ultimate load at which the control beam failed. [32],[34],[36]



2. Deformation Pattern of normal Beam pattern at 70% of the Ultimate load



B. Modelling procedure of the 70% pre-damaged beam wrapped with CFRP composite laminate

The modelling of the concrete beam and the steel reinforcement is same as that of the control beam

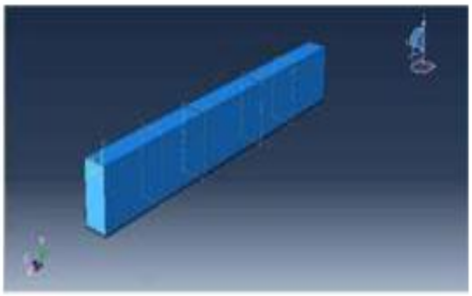
1. Modelling of adhesive/ epoxy

Modelling of adhesive was done on the basis of the specific properties of the material using 3D solid element.

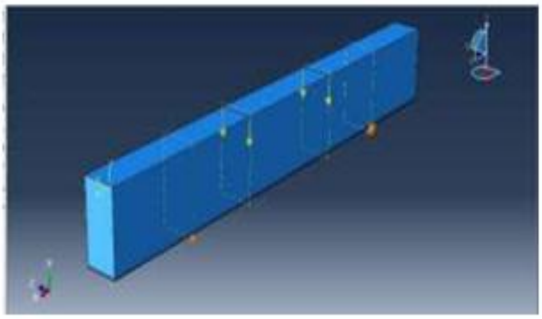
2. Modelling of CFRP composite laminate

Modelling of CFRP composite laminate was done using 3D solid element

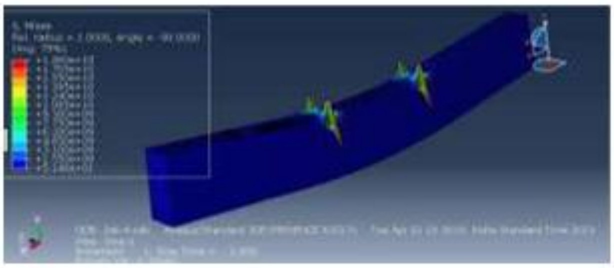
3. Assembly of concrete beam, reinforcement details, adhesive and the CFRP laminate



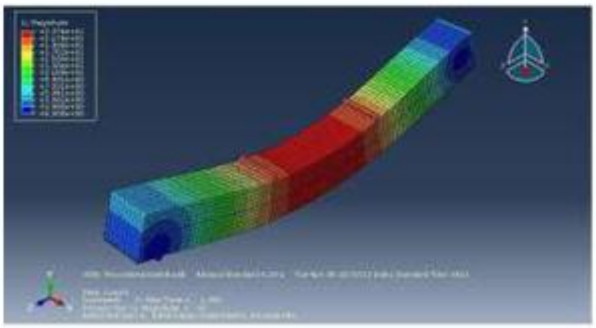
4. Modelling Of Boundary Conditions And Load Applied Simply Supported Just Like Control Beam



5. Deformation pattern of normal beam wrapped with CFRP composite laminate



6. Deformation Pattern Of Fully Wrapped Flexure Strengthened Beam Model At Ultimate Load



7. Comparison Of Analytical And Experimental Load Deflection Shear Beam

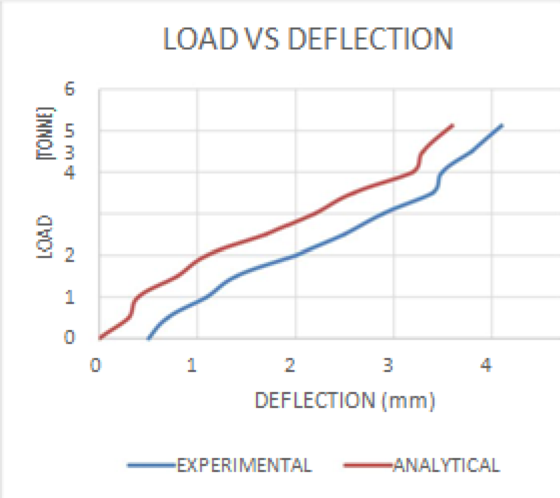
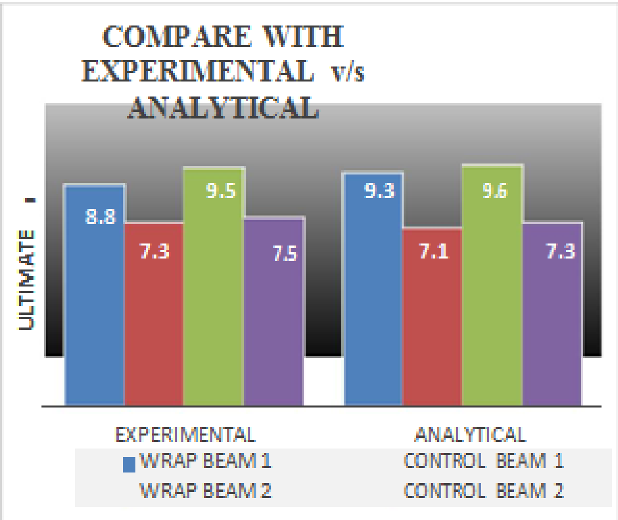


Figure 7 - Comparison of analytical and experimental load deflection shear beam

6. Comparison Ofexperimental V/S Analytical Output



X. CONCLUSION

Based on the experimental and analytical results the following conclusions has been made.

- The predictions using the suggested analytical model are in good agreement with the experimental results.
- The flexural strength of the bottom wrapped beams is higher than the control beams.
- The peak value of the load of the strengthened beams is around 28%higher than the control beams. [38],[40],[42]

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