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ANALYTICAL STUDY ON STRENGTHENING OF RC CANTILEVER BEAMS WITH COMPOSITE MATERIALS BY ANSYS SOFTWARE

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ABSTRACT

This paper deals with study of the behaviour of RC beam using different types of rebar materials such as steel and composite. RC beams can be retrofitted by FRP. FRP is one of effective technique for retrofit of beam, number of FRP available in current market namely CFRP,GFRP,KFRP,ARAMID,BORON. For analysis of steel and composite materials we are using CFRP&GFRP materials by ANSYS software for obtaining good results. In this paper we are showing solution for both steel reinforcement beam and FRP beam, and parameters calculated are displacement, shear stress, flexural strength and also graph is plotted between stress v/s strain

KEYWORDS: Ansys, Composite Element, FRP , Finite Element Anlysis

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1. INTRODUCTION

A beam is a structural element which has one direction (length), Considerably larger than other 2 dimension (depth & width) & it is supported properly. Beams is the most common structure, built to transfer the load to its supporting structure

Rehabilitation of the structure can be in the form of strengthening of structural members, prepare of damaged structure for seismic deficiencies. Strengthening is a means of enhancing the structure performance of an existing structure beyond its current level when the strength of a concrete is enhanced its design life extended several economic and environmental problems can be avoided since concrete is bulky rarely recycled

Reinforced concrete beam can be retrofitting by FRP (Fiber Reinforced Polymer) is one of the effective technique for retrofit of beam .Retrofitting of beam FRP is popular now days because of low material cost, light weight ,corrosion free and ease of application. Number of FRP available is current market namely Carbon Fiber Reinforced Polymer, Glass Fiber Reinforced Polymer, and Kevlar Fiber Reinforced Polymer. Some of the FRP are also available in three types namely plates sheets and bars

For Structural application, the FRP can be used in two ways. In first way the FRP can be used as a sheet or plate to the structural member in order to provide the strengthen the damage structure by the FRP application . The strengthening and Retrofitting of the structural member such as column beam and slab with FRP application is most effective method. And in the second way the FRP can be used as rebars in reinforced concrete member instead of the use of steel bar some are worked on RC structure which is damaged during earthquake and they tried to retrofitting of that reinforced structure with fibre reinforce composite. They presented paper on finite element analysis of beam retrofitted with different fibre reinforced polymer composite sheets carried out using ANSYS software. They applied GFRP, CFRP and KFRP on same size of beam and then did modelling and analysis by ANSYS. 's objective is to compare performance of above three retrofitted beams with controlled beam. Finally concluded from the ANSYS results, deflection of the retrofitted beam with CFRP is minimized about 73% compared to controlled beam, deflection of the retrofitted beam with GFRP is minimized about 65% compared to controlled beam, deflection of the retrofitted beam with KFRP is minimized about 60% compared to controlled beam and load carrying capacity of retrofitted beam is higher than the controlled RC beam specimen[1].

conducted ANSYS based analytical investigation on simulate behaviour of failure mode of RC beams strengthened in flexure and shear by Fibre reinforced polymer (FRP) laminate. Carried out study on four beams model, from those two were control beams and remained was strengthened with CFRP. Author obtained load deflection relationship until failure and crack pattern by ANSYS and that result compared with experimental results available in literature. Observed numerical result seen good agreement with experimental results. Based on analytical results concluded that ultimate load carrying capacity was increased comparatively, flexural

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strength increased substantially while CFRP applied on tension face and load carrying capacity of beam strengthened by U-warp CFRP was found to be higher compared with CFRP applied on tension face only[2].ecarried out experimental and analytical investigation on preloaded retrofitted beam with GFRP for enhancement in flexural strength. They took seventeen beam for experimental study, out of that two were control beams and fifteen were preloaded at 0%, 40% and 90% of control beam. New arrangement of FRP for strengthening the beam in which they were apply full length of single layer, they reduced length and width in second and third layer. Carried out analytical investigation using ATENA 3D software which are based on finite element method. Concluded from the analytical and experimental results, new arrangement so effective that was shift the flexural crack away from the flexural region and also come out from the debonding failure. They observed load vs. deflection not more than 5% varied in experimental and analytical results, failure mode are also remarkable compared [3]. conducted analytical investigation on strengthened RC simple beam with externally bonded FRP sheets technique, that's beam was loaded in flexure, shear and a combination of flexure and shear. Used ANSYS software to perform structure linear and non-linear analysis. Studied main parameter control beam of different schemes of FRP sheets in flexural, shear and combination flexural and shear. Investigator compared that results and conclude that beam capacity and ductility directly proportional to CFRP sheets applied on the beam but at the same time author observed that the beam capacity didn't increased with increased in CFRP sheets but ductility did [4].

2. THE DEFINITION OF COMPOSITE MATERIALS

The material such as composite materials which is defined as the strong carry-load materials which are embedded in a somewhat weaker material. The stronger material is usually referrible. To as reinforcement and the weaker material is usually referrible to as the matrix. The strength and rigidity that can be obtained from the reinforcement and in turns helps to support the structural load. The position and orientation can be maintained by the matrix, the reinforcement seems to be more brittle.

3. ROLES OF THE MATRIX AND REINFORCEMENT IN COMPOSITES

The matrix plays the role of continuous phase of the composite materials. the shape to the structure is given by the matrix. Therefore, matrix materials that can be helpful in shaping the structure and in holding the structure are especially useful. The matrix is composites mixture of various components its firstly encounters various forces might be imposed. The reinforcement play the role of to providing strength, stiffness and other mechanical properties to the composite. The components of the composites material are used in the various fields aircraft, construction and industial. There are three most important common existing types which are as fallow fiber glass, carbon fiber and aramid fiber with composites of reinforeced. These composite materials are so interrsting that they are further divided in to subtypes which inturns providing various wide variety of composites .

FIBER GLASS – it is a defined as polymer of fiber reinforced made of a various plastic matrix reinforced by fine fiber of glass. Which are having very lightweight, extremely strong and robust material. When we come to the properties of strength it is somewhat lower than carbon fiber and its stiffness is very less, the material is typically brittleless, and very less expensive of raw materials.

CARBON-FIBER-REINFORCED POLYMER- it is defined as an light fiber reinforced polymer and extremely strong and its consists of carbon fibers. The CFRP also consists of other fibers, such as aramid, e.g. Kevlar, Tarpon, aluminum or glass fiber, carbon fiber

4. USAGE OF COMPOSITE MATERIALS

The usage of the various composite materials in the construction of the building structure as beam column slab foundation. the composite materials such as glass fiber carbon fiber which are having the wide , advantage it will help in the resistance of the chemical effect and resists the deflection of the beam and helps in decreasing the flexural failure of the beam not only in the civil field these composites which are used in arospace industries electronic field and in computer software field. the physical property of the glass fiber reinforced polymer are having higher than that of the young's modulus of the HYSD bars and compared to GFRP CFRP (carbon-fiber reinforced polymer) are most stronger than the that of the GFRP and HYSD rebars not only rebars we can use these GFRP and CFRP as plates element for strengthening of the beams the young's modulus of the GFRP and CPRP play very important role in the beam analysing ,the passion ratio of the GFRP and CFRP will not give such sever effect on the analysing only young modulus will play the important role

Composites for Structural Applications

Composites which are having long applicable in the construction industry. Applications which has the range of from non-structural gratings and claddings to full structural systems for industrial supports, buildings, long span roof structures, tanks, bridge components and complete bridge systems. They are more advantage in resisting the of corrosion effect and less weight which as concluded that attractive in many less stress applications. the use of extension high performance FRP in primary structural applications, however, has been there is much development activity because of slower to gain accepatance. Composites materials are playing important role in the immense opportunities by increasing role as an alternate material to replace timber, steel, aluminum and concrete in structural buildings.

Construction

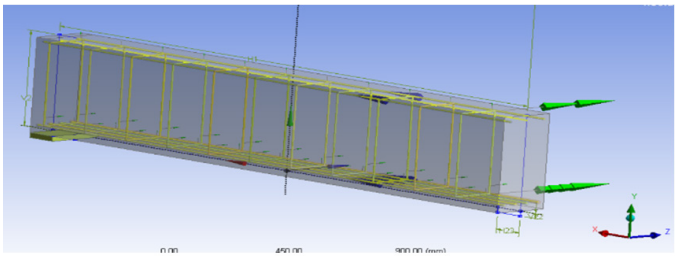
The priority for the adaptation can be hold by the construction of composites in place of conventional materials being used like doors and windows, paneling, furniture, non-structural gratings, long span roof structures, tanks, bridge components and complete bridge systems and other interiors. Composite materials which are of various components find extensive applications in shuttering supports, special architectural structures imparting aesthetic appearance, large signage's etc.

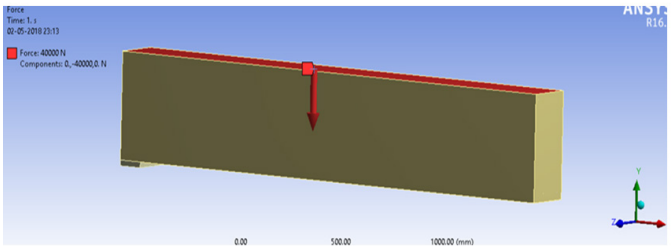
The various advantages such as resistance corrosion , longer life, less maintenance, ease in workability, resistance to fire etc. Application of the composites for the damage repairing, seismic retrofitting and upgrading of concrete bridges finds to be very increased adoption as well good way to increase the service life of the existing structures, for new bridge structures were also be consider as an good economic solution by application of composites.

5. OBJECTIVES

- Determination of deformation, flexural strength, shear stress and load deflection curves for HYSD bars CFRP&GFRP bars
- Comparing all the 3 beams results with specified

6. METHODOLOGY





7. MODELLING OF THE RC BEAM

1. Go to software workbench open up new project that is static structure and give the naming RC concrete beam
2. First click on the engineering data give the material property for concrete and steel by selecting the isotropic tool in left side of the screen
3. Now go to geometry double click it will take the time select the XY plane and look at view to display XY plane in perpendicular
4. Go to sketch select the line an and select rectangular draw the rectangular give the dimension which ever you required length and width vertical and horizontal respectively
5. Go to modelling select the sketch and extuded and give the property operation as frozen material and give value for depth and generate
6. Now in order to provide rebars select face and new plan give the Z offset and give the – value and draw the line connecting from one edge to other and give the required offset cover value. Now go to concept select the line from sketch and give the cross section and provide the radius of diameter of the rebar. Now go to the pattern select the line body and select the edge point and give the required number and generate. Same procedure is followed while providing the rebars at top face but we have to select new plane to obtain rebars at top
7. For providing the stirrups the points are selected at top and bottom the connection between bars and stirrup must give appropriate and line must connected each point and selected and applied for frozen material ad generated and cross section and pattern must provided as same as while provided during rebars
8. Once it completed all the line body must be separated with proper naming to justify top dia, bottom diameter and stirrups
9. Once its is completed thus it is minimized
10. Now go to model double click go to geometry and right click insert commands and right the program for the concrete

    A)BEAM MATERIAL PROPERTIES:-

    ET, matid ,SOLID65
    R, matid,0,0,0,0,0,0
    RMORE,0,0,0,0,0
    MPDATA,EX,MADIT,29250
    MPDATA,PRXY,MADIT,0.2
    MPTEMP,MATID,0
    TB,CONCR,MATID,1,9,
    TBTEMP,22
    TBDATA,1,0.3,0.8,1.5,25

    For line body rebars give this below program

    REBAR MATERIAL PROPERTIES:-

    ET,MATID,LINK180
    MPDATA,EX,MATID,,2e5
    MPDATA,PRXY,MATID,,0.3
    TB,BISO,MATID,1,2,
    TBDATA,,460,2100,,,,
    R,MATID,12,,0

    A)Description about the commands

    ET-Element
    MATID-Materail property
    MPDATA-Material property
    EX-Young's modulus
    PR – Possion ratio
    R- Result
    PR-Pre prossessor
11. GO to mesh generate the mesh
12. Now go to the static structure select points and give the support condition
13. Give the loading condition
14. Take the components and make the X&Z components as free apply loads at Y condition
15. Now go to the solution insert the total deformation and stress and select the require results
16. Insert the commands for the solving the solution

    /PREP7
    ESEL,S,ENAME,,65
    ESEL,A,ENAME,,180
    ALLSEL,BELOW,ELEM
    CEINTF,0.001,
    ALLSEL,ALL
    /SOLU
    OUTRES,ALL,ALL

    A)Description about the commands

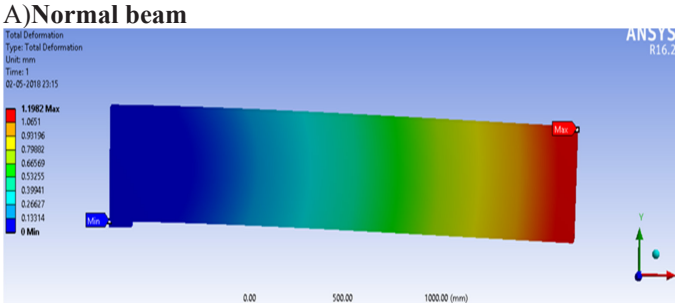
    ESEL - Element selection solid Element name 65
    A-Link

ALL Selection
CEINTR- Clearance between 2 nodes
SOLU- solution
Dimension of the beam
Length =2500mm
Young's modulus of steel = 2.1*105
Depth =475mm
Young's modulus of GFRP = 8.9*1011
Width = 240mm
Young's modulus of CFRP = 8.5*1011
Posion ratio for CFRP = 0.23 & GFRP = 0.1

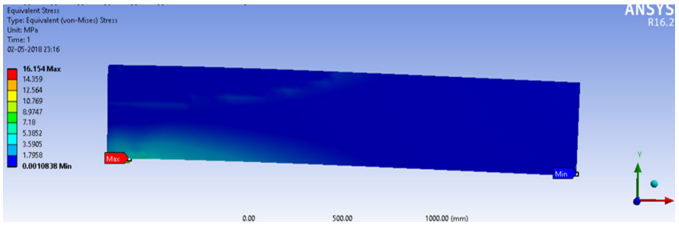
8. RESULTS AND DISCUSSIONS

SL/NO	Property	Steel	GFRP	CFRP
1	Displacement mm	1.19	0.043	0.041
2	Flexural stress MPa	16.15	5.27	5.19
3	Shear stress MPa	3.22	1.28	1.33

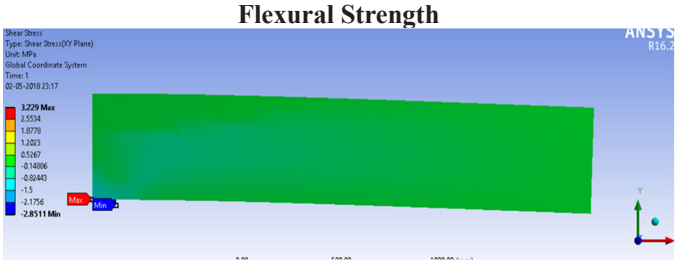
A)Normal beam



Total Deformation

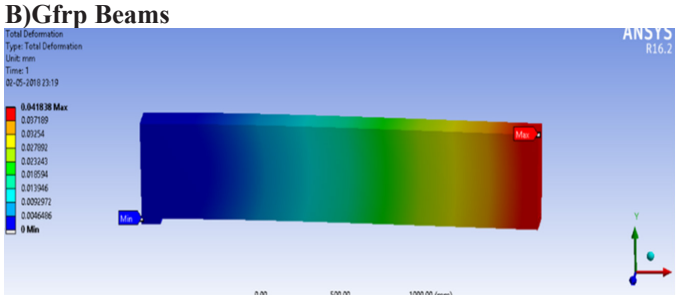


Flexural Strength

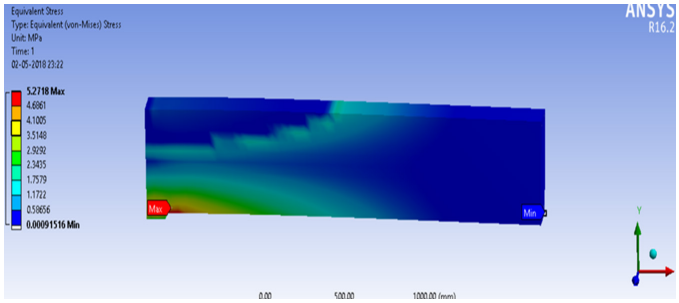


Shear Stress

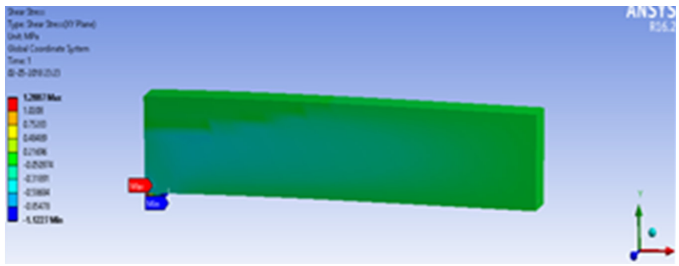
B)Gfrp Beams



Flexural Strength



Shear Stress



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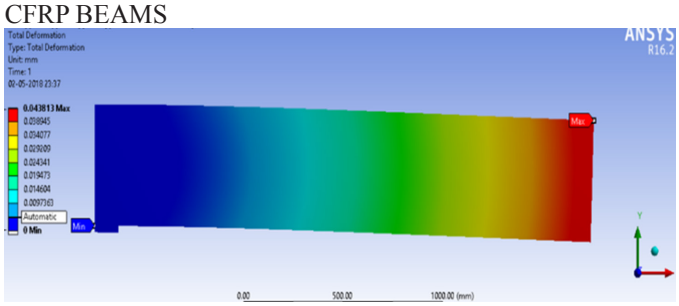
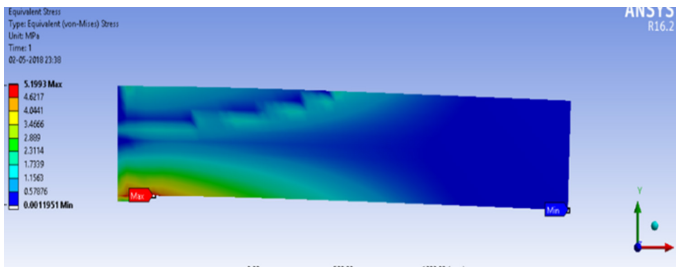
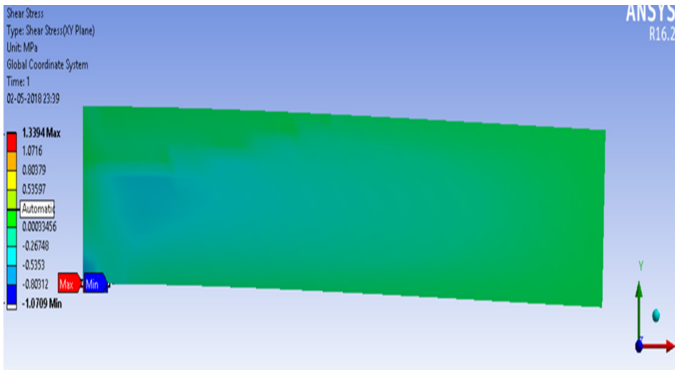
CFRP BEAMS



Total Deformation



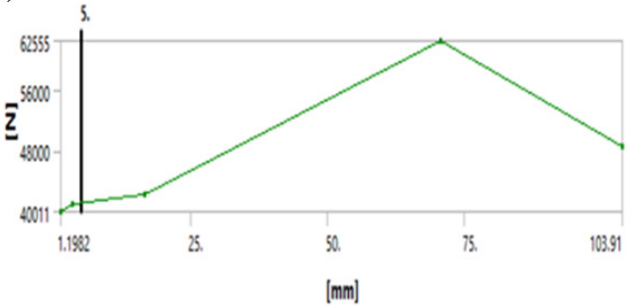
Flexural Strength



Shear Stress

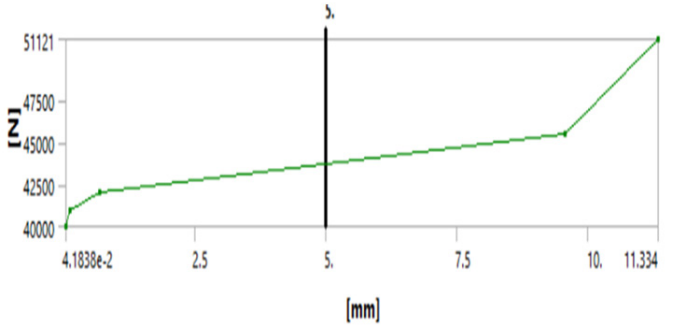
9. LOAD V/S DEFLECTION

A) NORMAL



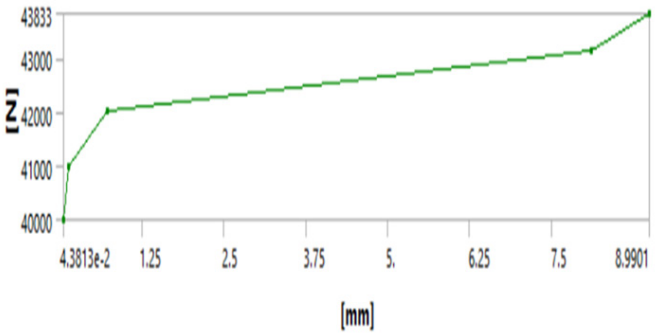
	Steps	Time [s]	Total Deformation (Max) [mm]	[E] Force Reaction (Total) [N]
1	1	1.	1.1982	40011
2	2	2.	3.3949	41025
3	3	3.	16.48	42368
4	4	4.	70.762	62555
5	5	5.	103.91	48531

B) GERP



	Steps	Time [s]	Total Deformation (Max) [mm]	[E] Force Reaction (Total) [N]
1	1	1.	4.1838e-002	40000
2	2	2.	0.12317	41000
3	3	3.	0.68626	42005
4	4	4.	9.5685	45550
5	5	5.	11.334	51121

C) CFRP



	Steps	Time [s]	Total Deformation (Max) [mm]	[E] Force Reaction (Total) [N]
1	1	1.	4.3813e-002	40000
2	2	2.	0.12817	41000
3	3	3.	0.70677	42006
4	4	4.	8.1088	43139
5	5	5.	8.9901	43833

9. CONCLUSIONS

The present work is carried out for the strengthening of the RC beam using composite material with the help of ANSYS software. Here we compared the various results with normal beam and FRP beams we calculated deflection, flexural strength, shear strength and load deflection curves. The deformation is reduced 96.5% while using GFRP & 96.3% while using CFRP compared with HYSD bars. Flexural strength for GFRP is increased up to 67.3% compared to HYSD and 70% for CFRP . The Shear stress decreased by 60.% with use of GFRP and 58.6 % with the use of CFRP materials

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11. CODE BOOKS

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3. ACI 440-06. “Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars”
4. ACI 440R-07. “Report on Fiber-Reinforced Polymer (FRP) Reinforcement for Concrete Structures