

# Analytical Study on Strengthening of RC Tee Beams with Composite Materials by ANSYS Software

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**Abstract:-** This paper deals with study of the behaviour of RC tee beam using different types of rebar materials like steel and composite. RC tee 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. For analysis of steel and composite materials we are using CFRP&GFRP materials by ANSYS software for obtaining good results. In this paper beam is analysed for both steel reinforcement and FRP, 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 analysis.

## 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.

Reinforced concrete beam can be retrofitting by FRP (Fiber Reinforced Polymer) is one of the effective technique for retrofit 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 strengthening 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. In the second way the FRP can be used as rebars in reinforced concrete member instead of use of steel bar.

## 2. THE DEFINITION OF COMPOSITE MATERIALS

A composite material is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from individual components.

## 3. Roles of the matrix and reinforcement in composites:

**Role of reinforcement:** Reinforcement give high strength, stiffness & other improved mechanical properties to composites. Also their contribution to other properties such as co-efficient of thermal expansion, conductivity etc. is remarkable.

**Role of matrices:** Even though having inferior properties than that of reinforcements, its physical presence is must.

- To give shape to composite part.
- To keep the fibers in place
- To transfer stresses to fibers
- To protect reinforcement from environment such as chemicals & moisture.

**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.

**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

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



GFRP BARS



Different types of GFRP bars



Different types of CFRP bars

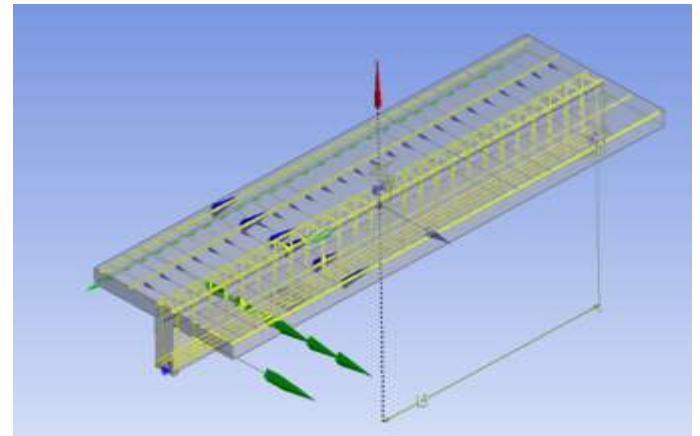
#### 4. USAGE OF COMPOSITE MATERIALS

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 but composites also used in aerospace industries electronic field and in computer software field.

#### 5. OBJECTIVES

- Determination of deformation, flexural strength, shear stress and load deflection curves for HYSD bars CFRP&GFRP bars

#### 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-Material property
- MPDATA-Material property
- EX-Young's modulus
- PR - Possion ratio
- R- Result
- PR-Pre processor

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

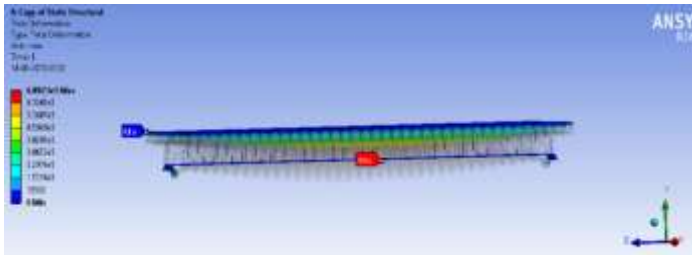
- ESEL - Element selection solid Element name 65
- A-Link
- ALL Selection
- CEINTR- Clearance between 2 nodes
- SOLU- solution
- Dimension of the beam N/mm<sup>2</sup>
- Length =8000mm
- Young's modulus of steel = 2.1\*10<sup>5</sup>
- Depth =450mm thickness of flange = 150mm
- Young's modulus of GFRP = 8.9\*10<sup>11</sup>
- Width of flange = 2750mm web = 350mm
- Young's modulus of CFRP = 8.5\*10<sup>11</sup>
- Posion ratio for CFRP = 0.23 & GFRP = 0.1

**8. RESULTS AND DISCUSSIONS**

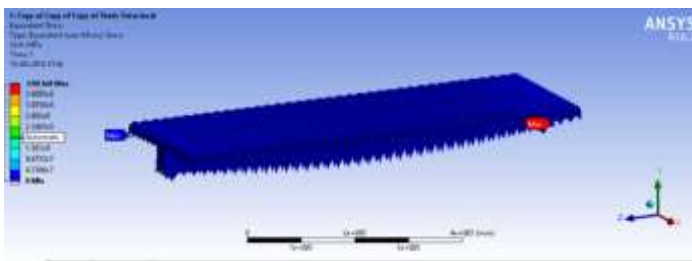
| SL/NO | Property            | STEEL | GFRP  | CFRP  |
|-------|---------------------|-------|-------|-------|
| 1     | Displacement mm     | 0.03  | 0.001 | 0.008 |
| 2     | Flexural stress MPa | 3.90  | 3.70  | 2.50  |
| 3     | Shear stress MPa    | 1.58  | 1.25  | 1.23  |

**A) HYSD BEAMS**

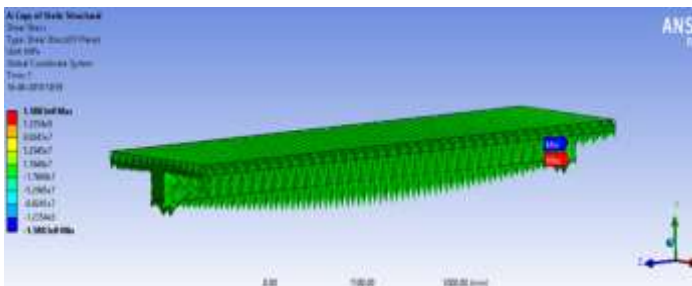
**TOTAL DEFORMATION**



**FLEXURAL STRESS**

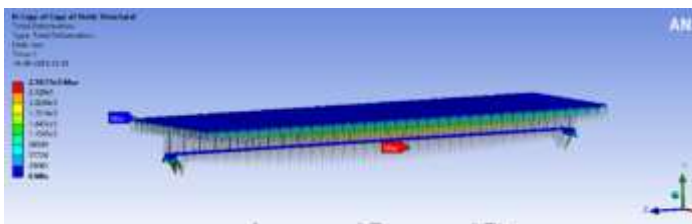


**SHEAR STRESS**

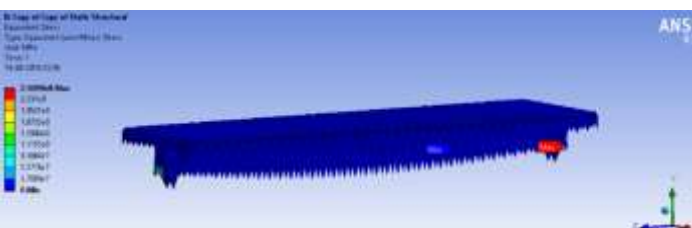


**B) CFRP BEAM**

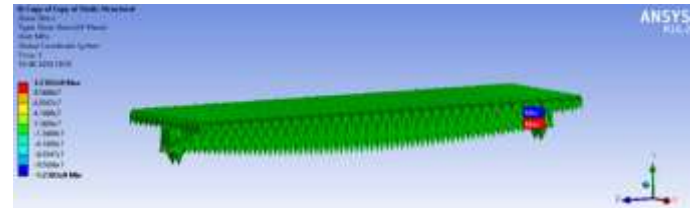
**TOTAL DEFORMATION**



**FLEXURAL STRESS**

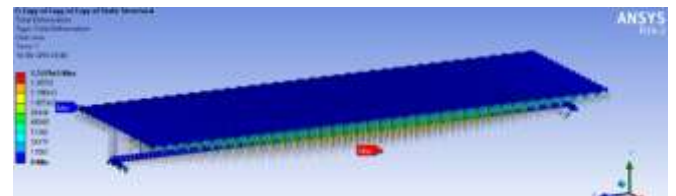


**SHEAR STRESS**



**C) GFRP BEAMS**

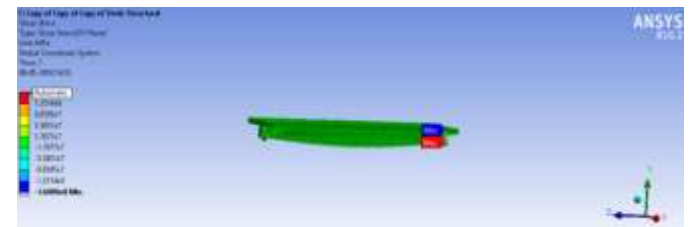
**TOTAL DEFORMATION**



**FLEXURAL STRESS**

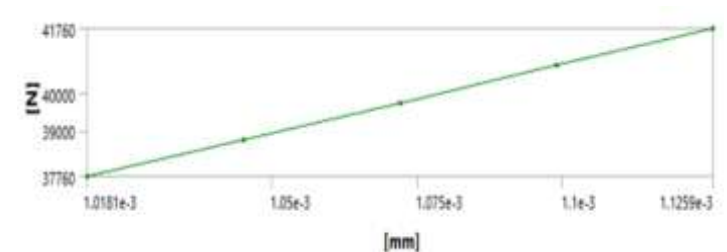


**SHEAR STRESS**



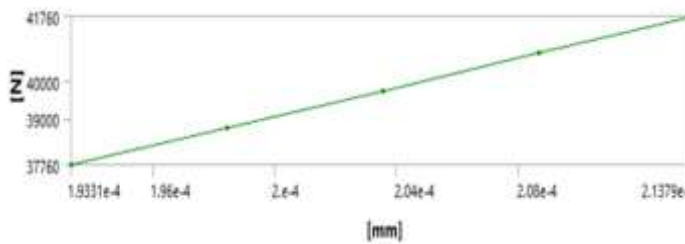
**1.9 LOAD V/S DEFLECTION**

**A) NORMAL BEAMS**



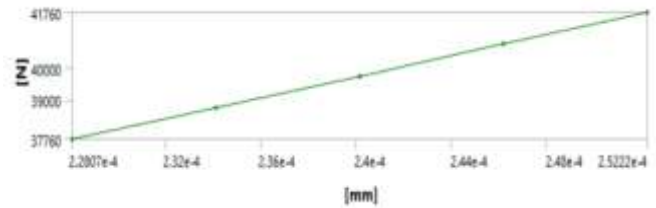
| Steps [s] | Directional Deformation (Max) [mm] | [E] Force Reaction (Total) [N] |
|-----------|------------------------------------|--------------------------------|
| 1 1       | 1.0181e-003                        | 37760                          |
| 2 2       | 1.045e-003                         | 38760                          |
| 3 3       | 1.072e-003                         | 39760                          |
| 4 4       | 1.099e-003                         | 40760                          |
| 5 5       | 1.1259e-003                        | 41760                          |

**B) GFRP BEAMS**



| Steps [s] | Directional Deformation (Max) [mm] | [E] Force Reaction (Total) [N] |
|-----------|------------------------------------|--------------------------------|
| 1 1       | 1.9331e-004                        | 37760                          |
| 2 2       | 1.9843e-004                        | 38760                          |
| 3 3       | 2.0355e-004                        | 39760                          |
| 4 4       | 2.0867e-004                        | 40760                          |
| 5 5       | 2.1379e-004                        | 41760                          |

**C) CFRP BEAMS**



| Steps [s] | Directional Deformation (Max) [mm] | [E] Force Reaction (Total) [N] |
|-----------|------------------------------------|--------------------------------|
| 1 1       | 2.2807e-004                        | 37760                          |
| 2 2       | 2.3411e-004                        | 38760                          |
| 3 3       | 2.4014e-004                        | 39760                          |
| 4 4       | 2.4618e-004                        | 40760                          |
| 5 5       | 2.5222e-004                        | 41760                          |

**CONCLUSION**

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 77.58 % while using GFRP & 62.42% while using CFRP compared with HYSD bars. Flexural strength for GFRP is increased up to 5.88% compared to HYSD and 35.79% for CFRP. The Shear stress decreased by 22.15% with use of GFRP and 20.88 % with the use of CFRP materials

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