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REVIEW ARTICLE

ANALYSIS OF CONCRETE BEAM WITH CFRP LAYERS USING ANSYS

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ABSTRACT

Carbon Fibre Reinforced Concrete (CFRC) beam width examination has been analysed in the latest study. CFRC materials are the commonly used material in the structures more than other materials to determine the problems in concrete structures. They give strength and stiffness to concrete beam. ANSYS tool has been employed in the current study to solve concrete problem. Result of thickness of the CFRC has been defined in the current paper by studying the deformation and strain generated. Four different set has been designed all having the same outer dimensions. To change the thickness of CFRC concrete beam dimensions has been decreases and results have been compared with the beam which is made of concrete only. Base beam dimensions are 350×300 mm^2 and length is 3500mm. Three thickness of CFRC have been assumed 2mm, 3mm and 4mm. From the results it has been found that beam with beam with 4mm thickness CFRC shows less deflection with respect to the other beams, which indirectly means CFRC beam, has higher strength with respect to simple concrete beam. Weight comparison of all the beam has also been conceded out which represents that with 4mm thickness CFRC is lighter in weight compared to the others.

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INTRODUCTION

In the recent years Fiber Reinforced Concrete (FRC) materials have dominate over other materials to resolve the problems in concrete structures. They are new class of compound materials and are made of fibers, resin or polymers and additives. The fiber materials for example carbon and glass provide stiffness and potency to FRC. CFRC is a variety of fiber reinforced concrete that is generally utilize in outer surface building and as architectural precast concrete various types of the recent uses of FRC added the use of fibres range around 1% by amount of concrete. Recent trial made it possible to integrate relatively huge volumes of glass, steel and synthetic fibres in concrete. Fibre appropriate of reinforcing concrete has been produced from steel, glass and organic polymers. FRC is a new construction material that is getting hold of importance with increasing. Additions of fibre reinforcement in separate form enhance various engineering properties of concrete.

Beneficial properties of the FRC linked to concrete are

- more tensile strength
- Impact resistance
- Water resistance
- Resistance cracks in concrete
- Low thermal expansion
- Low weight and low density

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MATERIAL PROPERTIES

Table 1 shows the properties of the concrete and CFRC material considered in the study.

Table 1. Properties of the material considered

Material	Concrete	CFRC
Density (kg/m^3)	2300	1800
Elastic modulus (Pa)	3×10^{10}	2.4×10^{11}
Poisson's ratio	0.18	0.32

Objective of research

- ANSYS tool has been utilized to simulate the CFRC behavior to study the effect of Beam.
- Effect of CFRC material on the strain and deformation generated has been studied and analyzed.
- Effect of CFRC thickness has also be studied.
- Effect of CFRC materials on the weight carrying capability of beam.

Literature Survey

Osman ET. Al. (2016) they identified numerical analysis by ANSYS software program was done by modeling 27

reinforced concrete beams (RCB) with and without CFRP sheets. This shows the force of the enhanced FE models and reliability of the ANSYS FE simulation. Pradeep singh ET. al. (2016) identified simulation of concrete reinforced beams use of ANSYS FEM software package. Primary the plain concrete beam will be modeled in ANSYS after that the FRP substance will be coated over it. Result of tension and various loading circumstances investigates in this Research. G.M. Chen ET. al. (2015) Analyzed a dynamic explanation approach for overcoming convergence complexities in simulating the bonding crash in FRP-strength Concrete beams.

Fifty-seven beams analyzed employing finite element plan with ANSYS V12. Kiran M. ET. al. (2014) they analyzed the working of RCB is analyzed by finite element technique. A organize beam is investigated employ a precise set of manage information and is then evaluated to the following models by changing the parameters. It is experiential that by increasing the tension steel, the initial cracking behavior is not exaggerated. However it has additional effect in the post damage segment of the beam. Parandaman et al. (2014) they studied the finite segment study of beam designed with various fiber toughened polymer composite sheets employing ANSYS

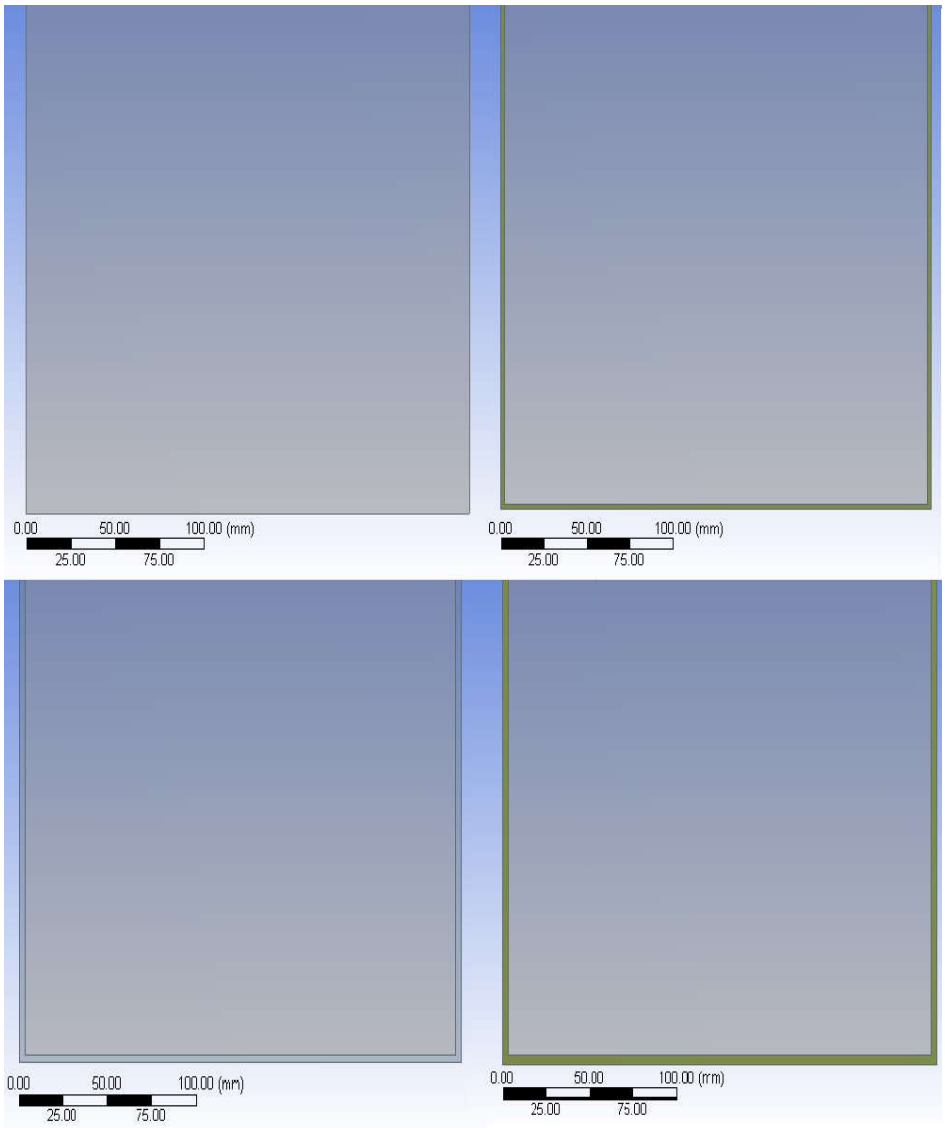


Figure 1. Geometry of the all the beam (Zoomed view) Meshed view

Numerical values are obtainable to explain that a proper dynamic approach efficiently overcomes the convergence difficulty and offered precise predictions of test consequences. Jayalin. D. et. al. (2015) discussed about Finite Element structure has been designed by use of Ansys 15 to analyze concrete beams with gaps. The gaps in beams are developed for function channels and pipes.

They studied about beams strengthened by Carbon Fiber toughened Polymer and Glass Fiber toughened Polymer Concrete plates. Nasr Z. Hassan et al. (2015) analyzed transverse gaps are frequently offered during concrete beams to contain utility ducts and pipes. Finite element examination has been applying with the purpose of analyses this problem.

Software. Three RC beams by special FRP composite plate samples were modeled employing Pro-E software.

MATHEMATICAL PROBLEM

Four geometries have been designed for the present study. Outer dimensions of all beams have been kept same. Added layer of Carbon fiber polymer is of 2mm, 3mm and 4mm. Figure 1 shows the geometry of all the beams. Figure 2 shows the meshed outlook of the geometries drawn. Same meshing element size has been considered for meshing for both the geometries.

Boundary conditions

Two types of boundary condition have been let in the present work one is the load and other are fixed supports.

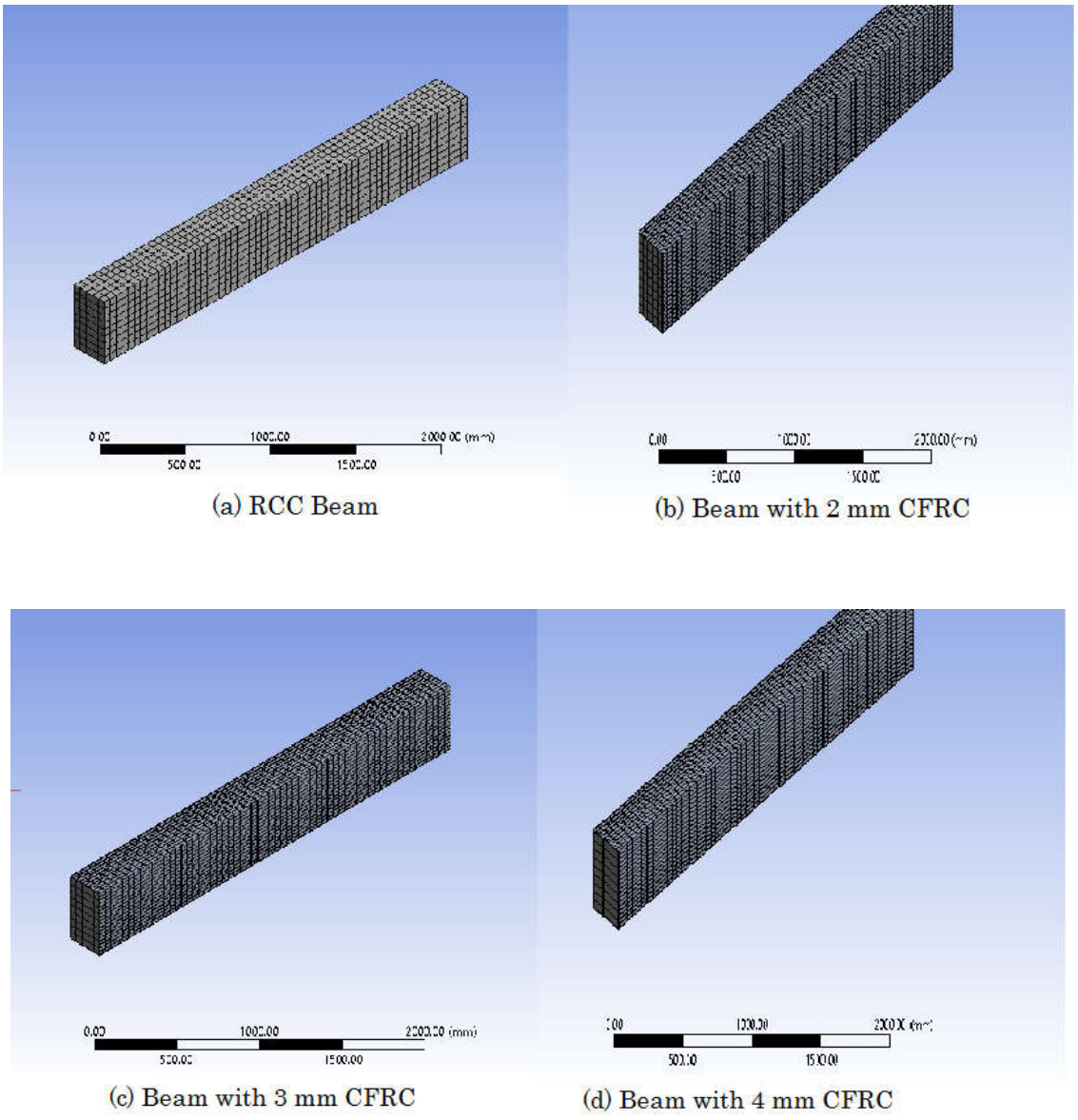


Figure 2. Meshed views of all the beams

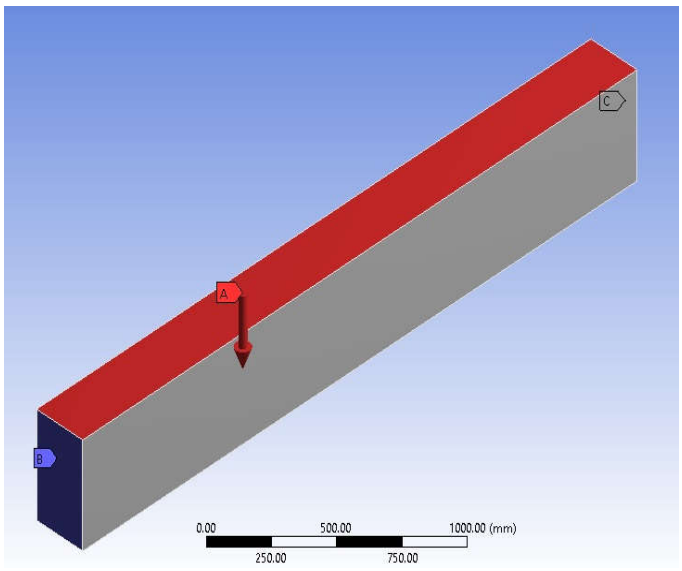
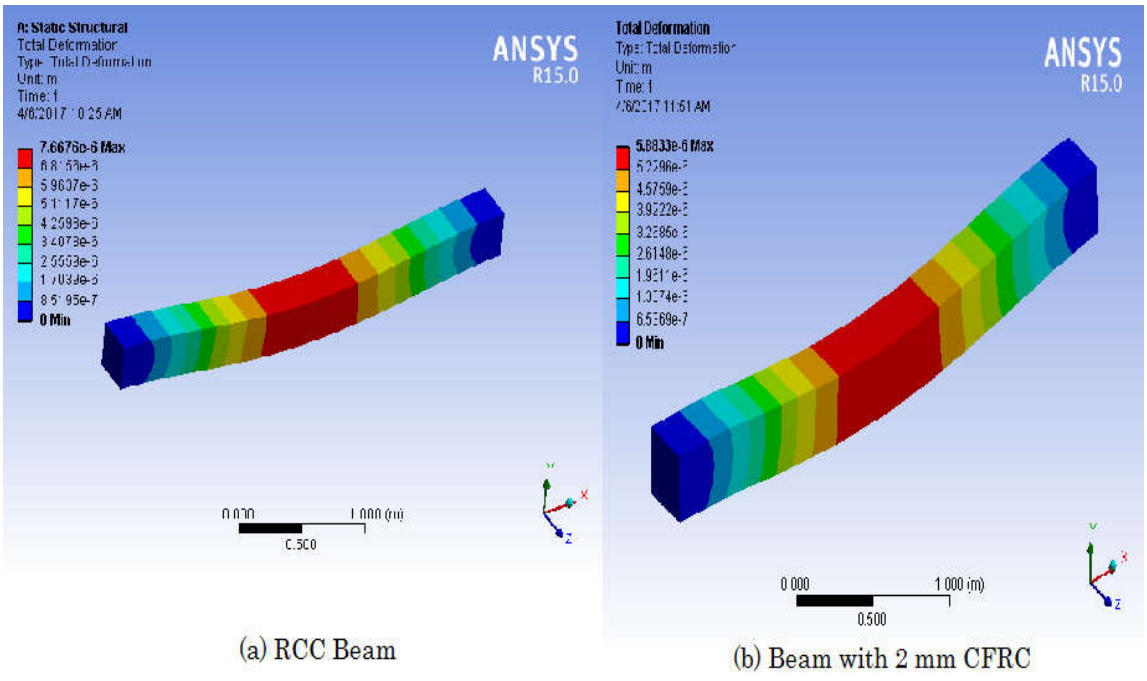
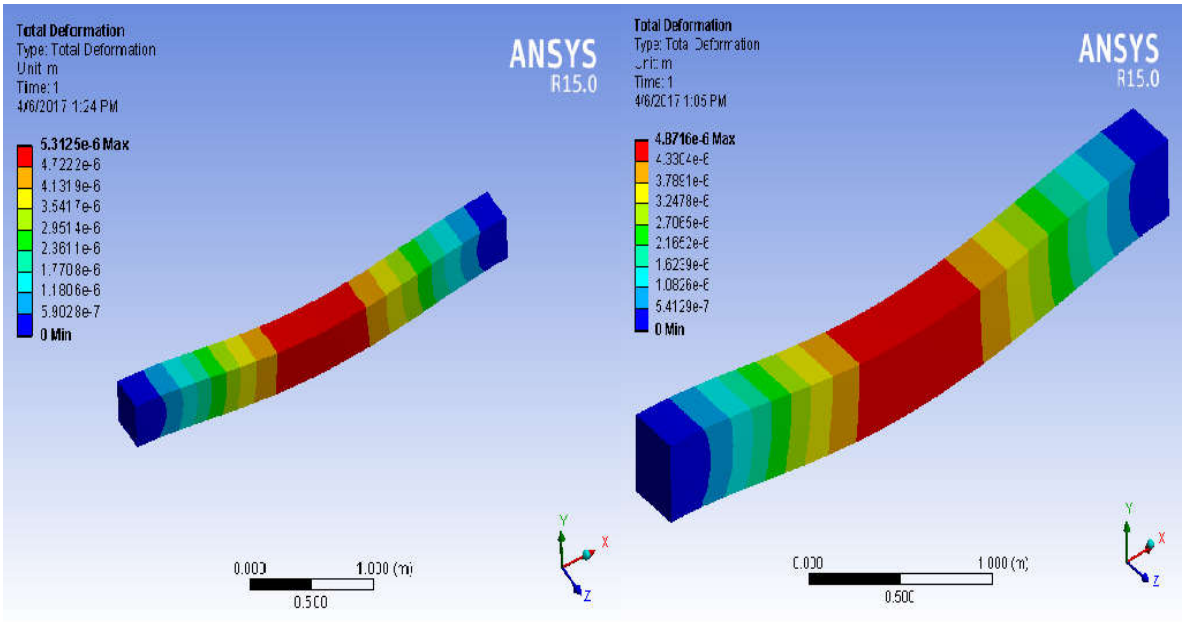


Figure 3. Boundary condition



(a) RCC Beam

(b) Beam with 2 mm CFRC



(c) Beam with 3 mm CFRC

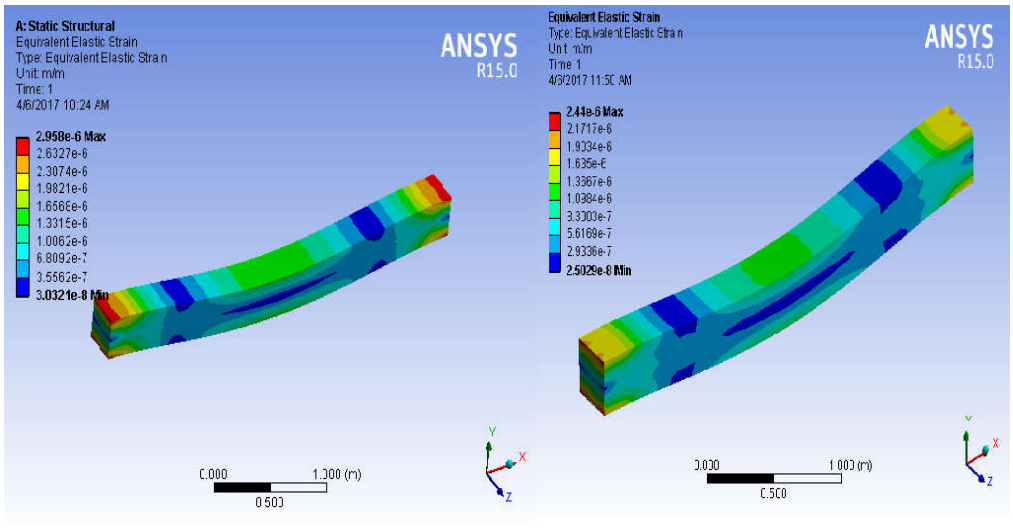
(d) Beam with 4 mm CFRC

Figure 4. Total deformation generated on all the beams

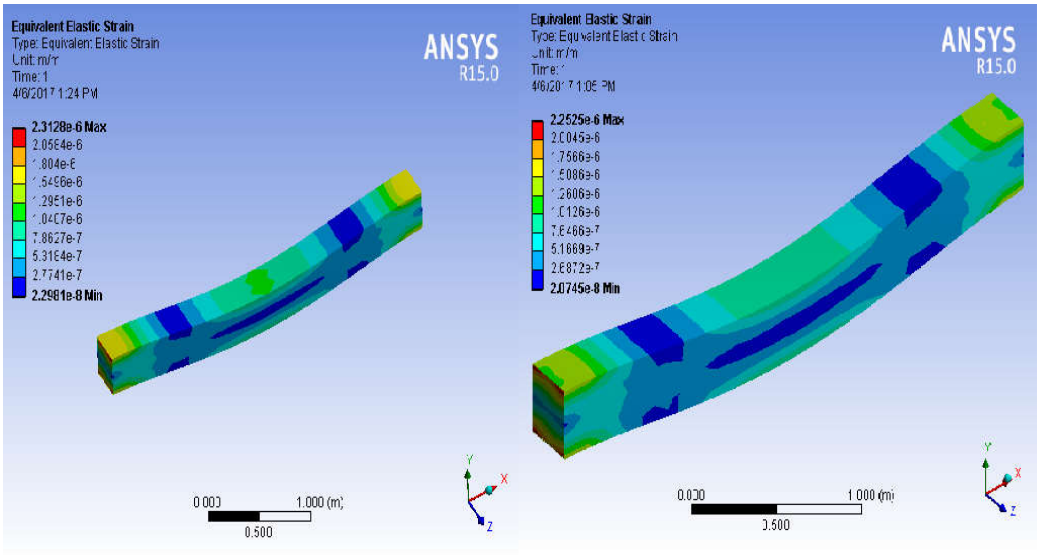
Table 2. Weight comparison

Beam types	Weight in terms of mass	Volume occupied
Concrete beam	746.28 kg	3.675×10^{8} mm³
Beam + CFRC (2mm)	742.39 kg	3.675×10^{8} mm³
Beam + CFRC (3mm)	739.53 kg	3.675×10^{8} mm³
Beam + CFRC (4mm)	736.68 kg	3.675×10^{8} mm³

2000 N Load has been applied at the top surface of the geometries while fixed supports have been applied at the vertical sides of the geometries. ANSYS 15.0 student version has been uses for present study. To study the cause of CFRC deformation and strain analysis have been conducted. A vertical load of 2000N has been applied on both of the geometries. Figure 4 Explain the total deflection generated in the beam. Color bar has been put on the left side of the figures which shows the amount of deflection generated in the beam. From the color bar it can be noted that the CFRC beam shows less deformation compared to the simple concrete beam which indicates that the CFRC beam has high potential of load carrying ability regarding the simple concrete beam. Table 2 represents the comparison of the weight in terms of beam mass.

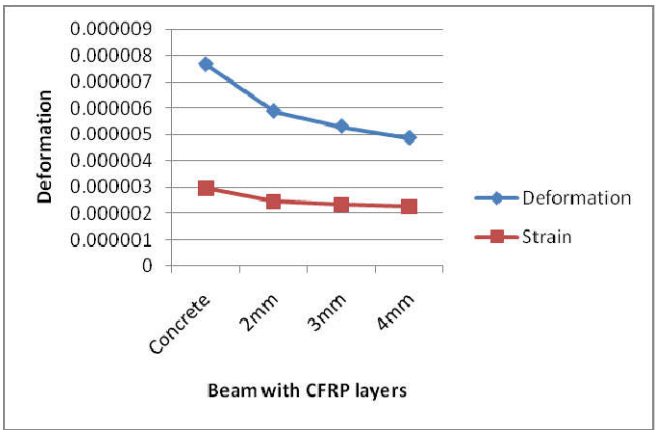


(a) RCC Beam (b) Beam with 2 mm CFRC



(c) Beam with 3 mm CFRC (d) Beam with 4 mm CFRC

Figure 5. Strain generated on all the beams



One can also observe that the volumes occupied by all of the beams are same only change in weight is different. From the table it can observed that the as we give the CFRC layer in the beam weight of the beam is reducing continuously and beam having highest thickness of CFRC is lightest in weight. Figure 5 shows the equivalent von misses strain generated on all the beams.

It can be noticed that the maximum and minimum amount of strain generating in the beam is decreasing by giving the CFRC layer and also within the increment in the thickness of the CFRC layer. Which means change in length is less for CFRC beams is less compared to beam made of concrete only. Graphs Shows the changes in deflection and strain of beam as per CFRP layers variations.

As per results we can see that the weight of the concrete beam is higher than the CFRP wrapped beam. Weight decreases when coating of CFRP material increases and it makes beam better stable during deformation and also decreases the strain rate during loading of beam. A result shows the variations of CFRC layers with respect to thickness and increases the beam strength and decreases weight of beam.

Conclusion

From the above study work the following conclusion are made:

- Effect of CFRC can be studied by finite element software like ANSYS.
- CFRC of 4mm thickness beam has higher strength compared to simple concrete beam for particular loading conditions.
- CFRC beam with 4mm thickness is lighter in weight (736.68 kg) compared to simple concrete beam of same dimensions (746.28 kg).
- Amount of deformation generated is less for heavy rate of load applied for beam with CFRC compared to simple concrete beam.

Future Scope

- Effect of other FRP material can be studied.
- Effect of number of layers can be studied.
- A further research for development of new technologies in composite construction such as Glass fiber polymer and CFRP, Basalt fiber reinforced polymer used to minimize the weight of concrete and increases the strength of the beam.

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