AN INVESTIGATION OF COMPOSITE AND STRUCTURED STEEL AS REINFORCEMENT IN CONCRETE STRUCTURES FOR DIRECTIONAL AND TOTAL DEFORMATION USING ANSYS

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ABSTRACT

The use of composite materials has been increased in strengthening of concrete columns in recent years. One of the applications is to use FRP (fiber reinforced polymer) reinforcement instead of steel reinforcement in concrete columns. In this project, the results of an analytical investigation on the behavior of RC column reinforced with Steel bars and Fiber Reinforced Polymer (FRP) bars are compared and discussed. The chief objectives of this project work was to investigate fiber composite as a reinforcement in concrete structures as a replacement of structural steel structures, to compare the Structural behavior of Structural Steel and FRP reinforced Column. Comparison was done for concrete columns reinforced withFRP and structured steel for directional deformation and total deformation. From the comparison graph it is clearly understood that the properties of composite bars are better than that of steel bars.

Keywords: Composite, FRP, Directional deformation, Total deformation, Reinforcement, Columns

I. INTRODUCTION

Composite materials now days find wide range of applications in engineering field, especially in mechanical and civil engineering applications. Composites are considered due to its greater strength, light weight and corrosive resistant. In structural applications, composites find their way in strengthening of reinforced concrete structures and other components. It is necessary for many reasons such as earthquakes, inadequate strength-strain properties etc. In addition to traditional strengthening methods such as externally-bonded steel plates, jacketing, advanced composite materials has become widespread in the strengthening of reinforced concrete (RC) structures.

Especially, usage of fiber reinforced polymers (FRP) materials for strengthening has rapidly increased in recent years. Due to their lightweight, high strength, resistance to corrosion, speed and ease of application and formed on site into different shapes can be made them preferences. The composite materials (FRP) applications are used for strengthening of reinforced concrete structures instead of classical method. The benefits of this material externally bonded FRP sheets and strips are currently the most commonly used techniques for strengthening in concrete structures.

II. PROJECT DETAILS

2.1 Objectives

The chief objectives of this project work are:

1. To investigate fiber composite as a reinforcement in concrete structures as a replacement of structural steel structures.
2. To compare the Structural behavior of RCC and FRP Column.
3. To compare concrete columns reinforced withFRP and structured steel for directional deformation and total deformation.
4. To get best possible dimensional parameters of reinforced composite columns from the results.

2.2 Column Details

Columns are vertical structures used to support buildings and other structures. The typical geometry of column structures is shown in fig 3.1 below.

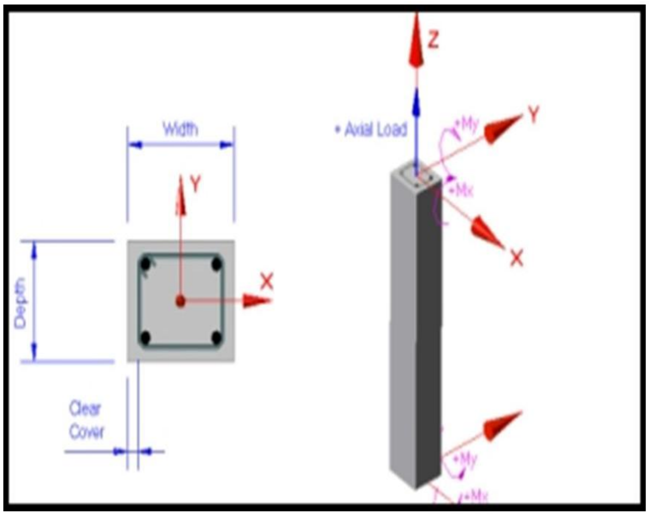


Fig1 Geometry of Reinforced Column

2.3 Calculation Parameters

For calculation purpose a two storey building is considered. Such structure is considered because since the aim of the project work is to find replacement for structural steel with composite small regular structure is taken. Already the application of composites isused for super structures since cost is not a problem. Steels are still used commonly in small buildings. That is why two storey buildings are used for the project.

The load calculated for the selected building is 11,978 N (for two storey building), Length of all Column is 2500mm and area of column selected is0.0625 $m^2$and total Pressure considered for analysis is 1871562.5 Pa which is obtained by using the formula Pressure= (Load/Area). Also for the structure 8 columns are considered per storey and so each column has to carry a pressure of 233945.3125 Pa.

III. FINITE ELEMENT MODELLING

3.1 Material Modelling

In this project we are considering the concrete and the carbon fiber reinforced polymer (CFRP) and typical concrete and the steel structure for the analysis. In our analysis we are considering a solid geometry having different reinforcement materials. The element type so considered was SOLID186; it is a higher order 3-D 20-node solid element that exhibits quadratic displacement behavior. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions. The element supports plasticity, hyper elasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyperelastic materials.

For the perfect discretization, correct number of nodes, elements and contact elements are required. In our analysis we are considered the medium type of meshing. The coarse type of meshing gives us a divergent type of results and the fine type of meshing gives a convergent result and it took a lot of time for obtaining the result. The average number of elements, nodes and contact element are shown below.

Table 1 Meshing Details of Column structure with reinforcement

Sl. No.	Particulars	Numbers
1.	Number of total nodes	147701
2.	Number of contact elements	34752
3.	Number of spring elements	0
4.	Number of bearing elements	0
5.	Number of solid elements	29524
6.	Number of total elements	64276

After the meshing the contact elements should be specified, here we have five different solid bodies for the contact. Four of them are the reinforcement structures and the base solid structure is concrete. Here the reinforcement we considered are steel and Carbon Fiber Reinforced Polymer (CFRP). In our analysis the diameter of the reinforcement were varying from 6mm, 8mm, 10mm and 12mm. The structural properties of the different reinforcement and concrete structures were analyzed with varying reinforcement diameters.

3.2 Modelling the Structure

In our analysis we are considering a two storey building. ANSYS Work Bench was used to analyze the column structure for the standard load combinations for the two storey building.

The modeling has been done with a specific dimension of column length 2500mm and column base and top face area 0.0625 m^2 for concrete and the reinforcement dimensions were varying from 6mm to 12mm with an increment of 2mm diameter. The reinforcement are taken as circular cross section. The modeled column is shown in Figure 4.3 below.

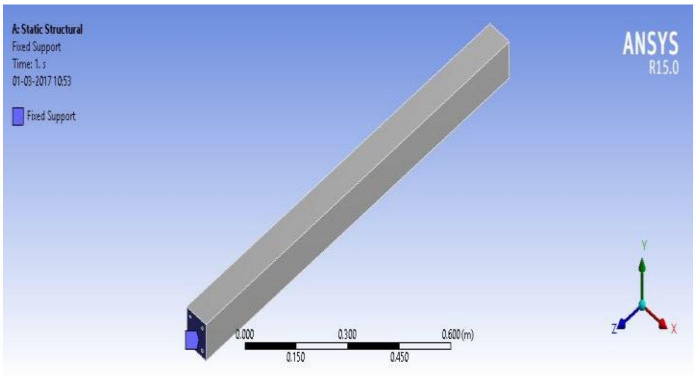


Fig 2 Geometry of Column Using ANSYS

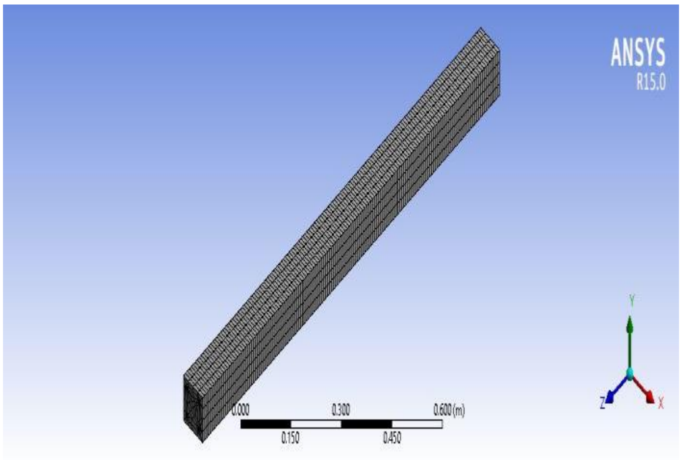
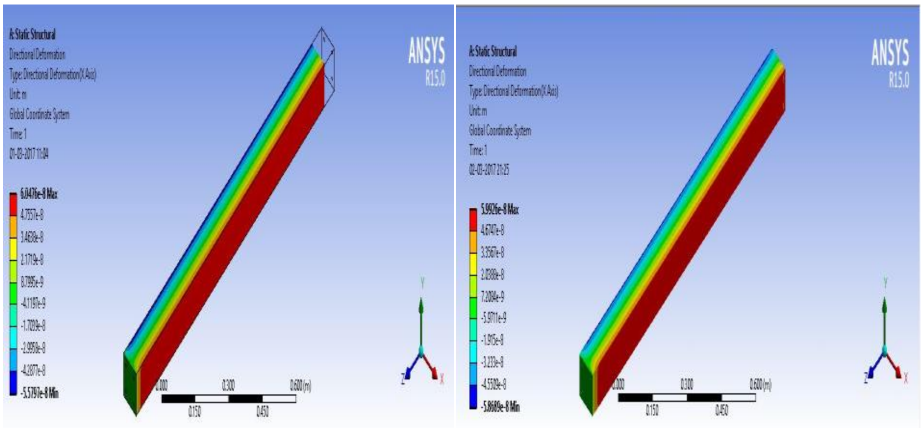


Fig 3 Meshed View Modeled Using ANSYS

IV. PERFORMING ANALYSIS AND INTERPRETING RESULTS

The following Figures show the results of the work. It shows directional deformation and total deformation of structured steel and FRP composites.



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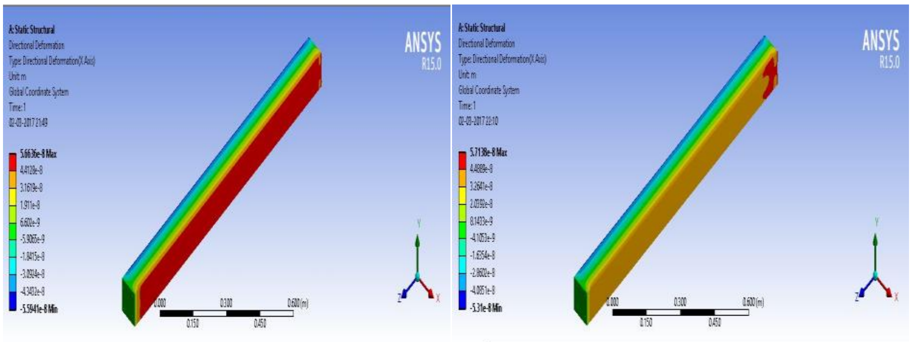


Fig 4 Directional Deformation 6 mm to 12 mm RC Steel Bars

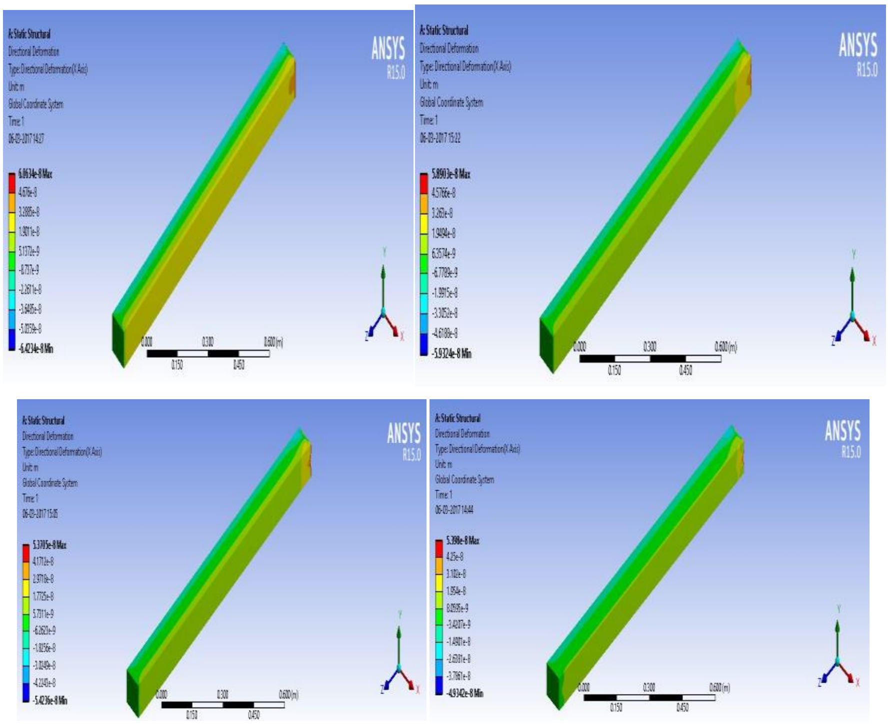
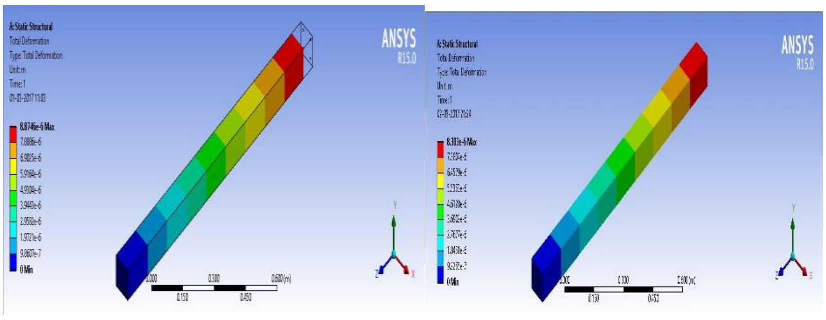


Fig 5 Directional Deformation 6 mm to 12 mm RC Composite Bars



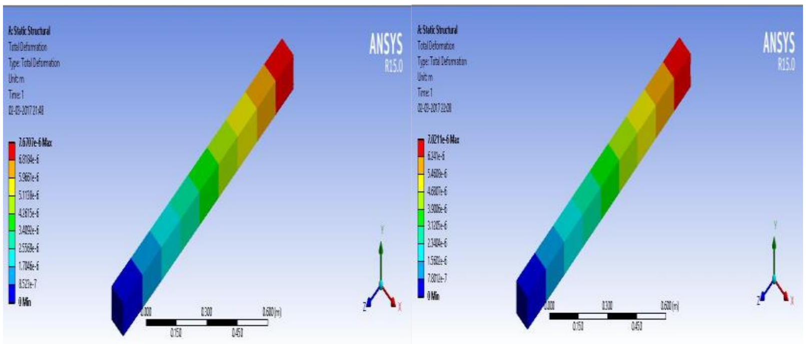


Fig 6 Total Deformation 6 mm to 12 mm RC Steel Bars

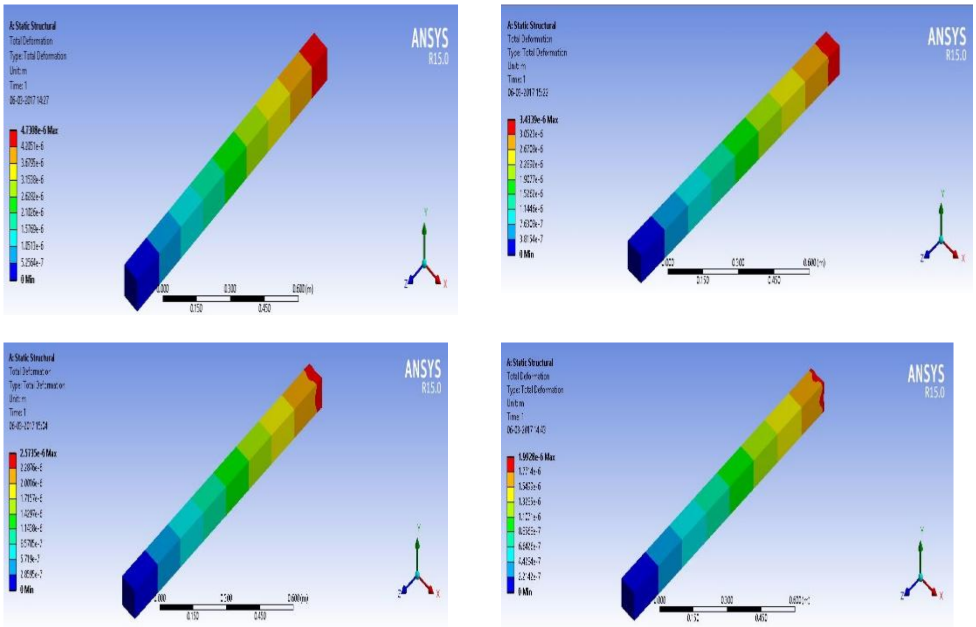


Fig 7 Total Deformation 6 mm to 12 mm RCComposite Bars

V. RESULTSAND DISCUSSIONS

A Graph was plotted to compare the values of structured steel and composite from the values tabulated below. The range of diameters used was from 6mm to 12 mm.

Table 2 Comparison of Deformation Values of Structural Steel and Composite

Sl No.	Parameters	Structural Steel Reinforcement				Composite Reinforcement			
		6mm	8mm	10mm	12mm	6mm	8mm	10mm	12mm
1	Total Deformation (µm)	8.87	8.30	7.67	7.02	4.73	3.43	2.57	1.99
2	Directional Deformation (e-2 µm)	6.05	5.99	5.66	5.71	6.06	5.89	5.37	5.40

The graphs plotted by using Rod diameter in X-axis and Total and Directional Deformation in Y-axis and the comparison are made.

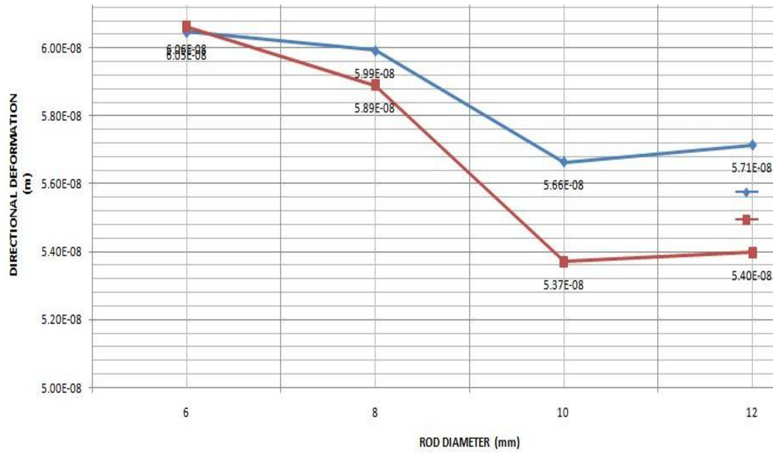


Fig 8 Comparison Graph Of Steel and Composite (Directional Deformation Vs Rod Diameter)

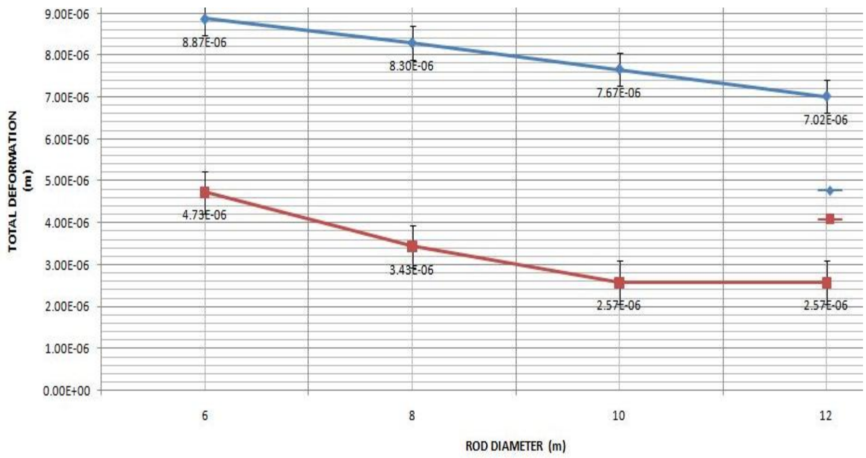


Fig 9 Comparison Graph Of Steel and Composite (Total Deformation Vs Rod Diameter)

VI. CONCLUSION

- An Investigation of Composite as Reinforcement in Concrete Structures was done using ANSYS.
- The Concrete columns reinforced with FRP and steel is compared for directional deformation, total deformation
- From the comparison graph it is clearly understood that the properties of composite bars are better than that of steel bars.

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