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Strengthening of the RC Member with Steel Bars, Strips and CFRP Materials

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ABSTRACT: The present work is aimed at strengthening of RC member with steel bars, strips and CFRP materials. Deterioration in concrete structures is a major challenge faced by the infrastructure and bridge industries worldwide. Lack of durability of Reinforced concrete structure has thus not only massive economic implication to a nation's well-being, but it is also one of the greatest threats to sustainable growth of concrete and construction industries. The aim of the project is to investigate the behaviour of RC column externally bonded with CFRP sheets. This will help enable designers to accurately design impact resistant structure using FRP as strengthening method.

KEYWORDS: column, CFRP materials, Abaqus, stresses, displacement, structural analysis.

I. INTRODUCTION

The structure once constructed does not remain as it is forever and it has to bear certain different load and their combination during its life span. These load results decrease in deficiency and hence strength of structure. Due to which structure get deteriorated such as cracks and bends appear in the structural member. Whenever a structure is affected by all such loadings, we are left with two options i.e. either repair or reconstruction. But among this reconstruction proves to be very costly and that may be double to that of initial cost of construction.

As structure build in past are not constructed as per our new codes of design which make them structurally unsafe and replacement require huge amount and time. So, at last we are left with Repairing or Retrofitting methods which is economical to us. But maintenance, rehabilitation and up gradation of structure is also a challenging task. For rehabilitation purpose fibre reinforced polymer (FRP) have proved to be an efficient material. It can be used for providing strength to new as well as existing structures.

II. LITERATURE REVIEW

The present work is aimed at strengthening of RC member using steel rods, strips and CFRP material. A literature review is carried out on various studies of FRP materials in columns, beams and slabs. A review of the work is presented in the following paragraphs.

Megha Puri (2019) carried out strengthening of the existing beam using FRP Sheets. The experimental study is done on the behavior of reinforced concrete beams strengthened by CFRP sheets. Five reinforced concrete beams having same reinforcement detailing were casted and tested. From the test we found that ultimate load carrying capacity of all strengthen beams were enhanced as compared to control beams.

B. V. Manjari & S. Vignesh (2020) studied enhancing the structural performance of column using GFRP rebar and hybrid fiber. In this study an experimental study on columns with hybrid fibre and GFRP rebars was performed. Their performance was evaluated by comparison with a conventional steel reinforced column. Six hybrid columns with fibre and GFRP rebar and three conventional concrete steel reinforcement columns were casted and tested under different eccentric (0,0) (0,25) (0,50) loadings. The fibres used were steel and glass fibres which improves the concrete strength

property. Tests were done to check the load carrying capacity of columns for both axial and eccentric loads, deflection, and buckling nature of column. The GFRP rebars were able to withstand the peak concentric and eccentric loads without crushing and local buckling. Also, after load removal, deflected GFRP column regained its original position and crack width also reduced. In steel reinforced column, steel rebar was yielded column and after load removal, no deflection regain and crack width reduction were found. The performance of HYFC rebar was 18% greater while considering to that of conventional concrete column.

C. Raghavendra Reddy et al. (2016) investigate the strengthening of RC beam both internally and externally by using GFRP and GFRP Wraps. The main aim of this study is to investigate the beam internal strength GFRP and external strength GFRP wraps. After investigation it found that the beam strength is increased for the increasing the GFRP percentage and using GFRP wraps to increasing the beam flexural strength and load carrying capacity.

Ben Abey Alex & Sneha M Varghese (2018) studied experimental study on strengthening of RC slab using GFRP sheets. The purpose of this project is to study the effect of GFRP sheets with various arrangements as strengthening technique for reinforced concrete slabs. Experimental study on strengthening of RC slab with Glass FRP were conducted and the results obtained are, load carrying capacity and overall performance of slab with GFRP laminate was significantly higher than the non-strengthened slab & the strength performance of Reinforced concrete slab strengthened using GFRP by Strip arrangement was higher than other specimens.

Ankit Raj Sinha et al. (2020) reviewed feasibility and utilization of GFRP in Concrete structure. In the study, a review was conducted to discuss aspects of the GFRP bars in RC members. After studying it found that the ultimate load of the steel reinforced beam is 29% higher than the GFRP reinforced beam & the ultimate deflection of the GFRP beam is greater than that of the steel reinforced beam.

III.METHODOLOGY

In this study, strengthening of RC member using steel rods, strips and CFRP materials in ABAQUS software is to be done. The result of this analysis will include load carrying capacity, ultimate load, equivalent stress, bearing strength etc and the meaningful conclusion will be given.

1. In present research we are going to use column and beam for analysis in software
2. Modelling of column and beam will be done in ABAQUS software, simultaneously running the model and analysis will be done
3. Obtaining different structural parameter i.e., load carrying capacity, ultimate load, equivalent stresses, bearing strength.
4. Observation of results and conclusion.

IV. STRUCTURAL MODELLING

In this study strengthening of RC member using steel rods, strips & CFRP materials is done by using ABAQUS. The result will include all structural parameters and then will compare with normal column. Software used is ABAQUS.



Fig 1.Design of column using RC concrete and steel Reinforcement.

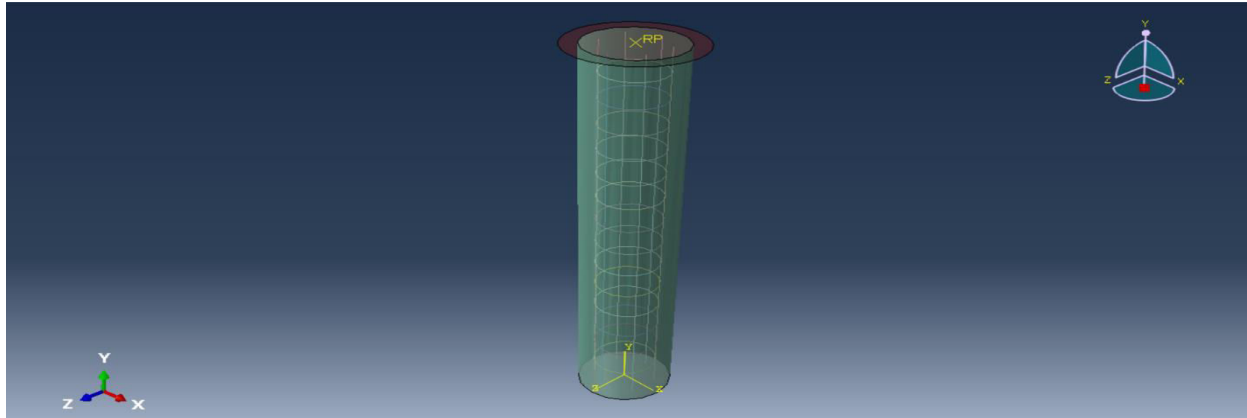


Fig 2. Design of column using RC concrete, steel and CFRP material

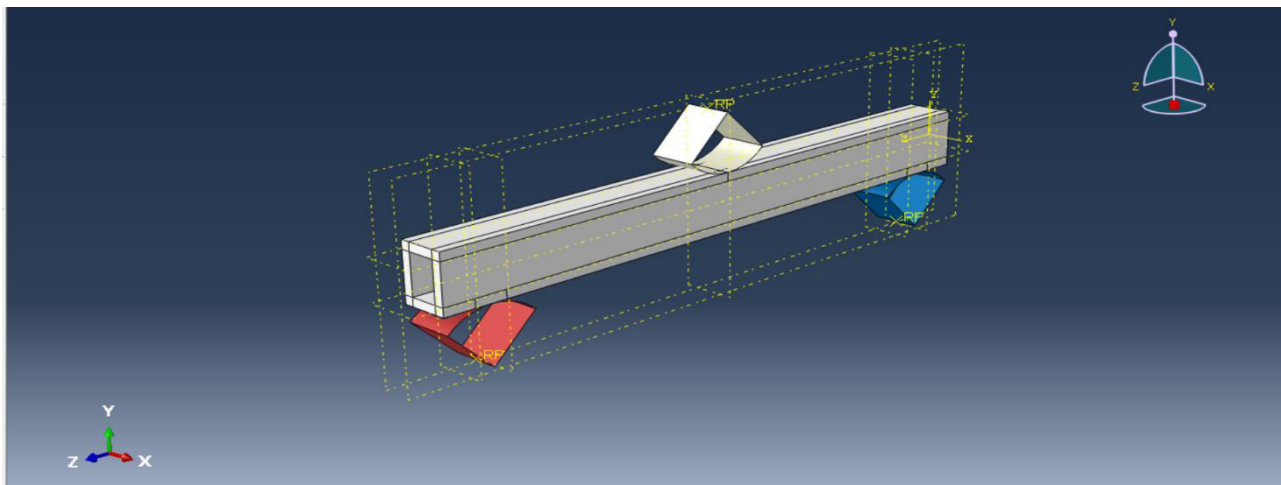


Fig 3. Design of beam using RC concrete, steel and loads and supports

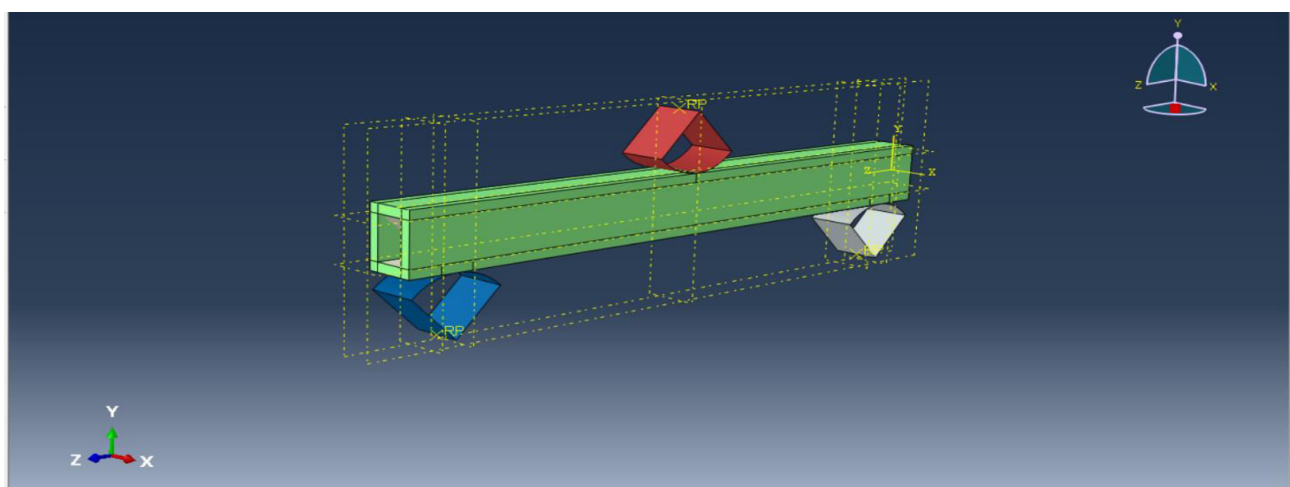


Fig 4. Design of beam using RC concrete, steel and CFRP material

V. PRELIMINARY DATA

Following are some preliminary data assumed or defined for the work.

Circular Column
Size :300mm Dia

Concrete Property:

Assumed,
Concrete -Class B50

Properties:

Young modulus- 5100MPa
Poisson Ratio – 0.19

Steel Property

Young modulus – 210GPa
Poisson Ratio - 0.3
Mesh – 25mm

CFRP Property

8 layers of CFRP sheets are used
Size: 150mm
Thickness- 1.46cm

Data for beam

Size: 150x200mm
Concrete and steel property same as above
CFRP sheets are wrapped internally
Eight layers of CFRP sheets are used

VI.RESULTS

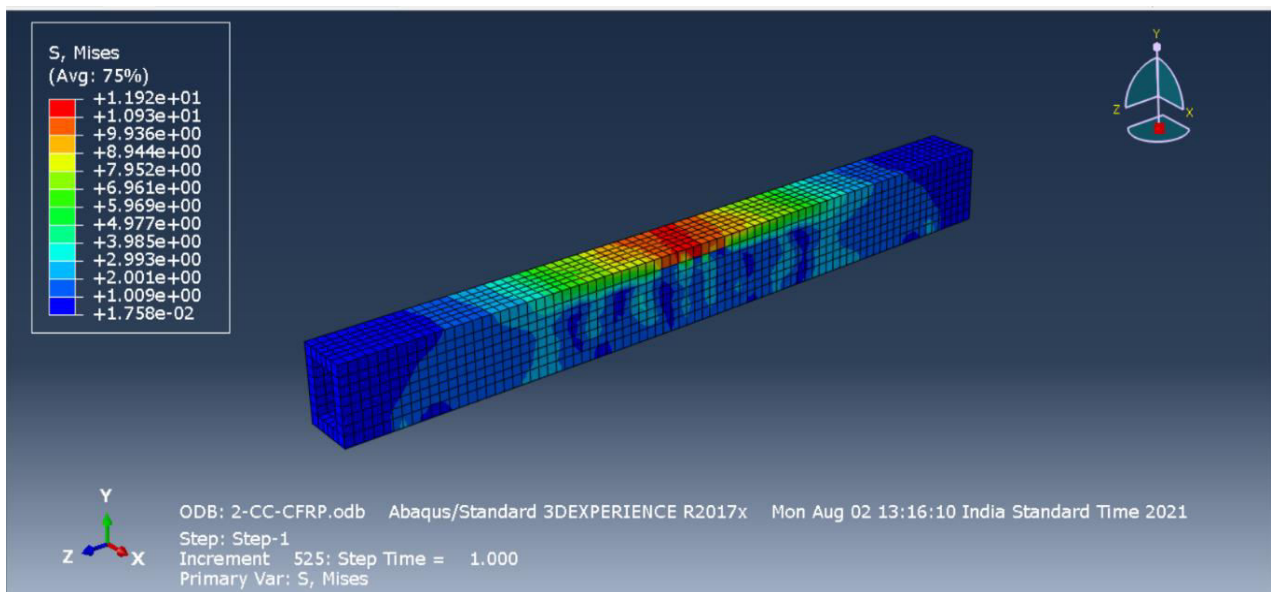


Fig 5. Normal stress on beam

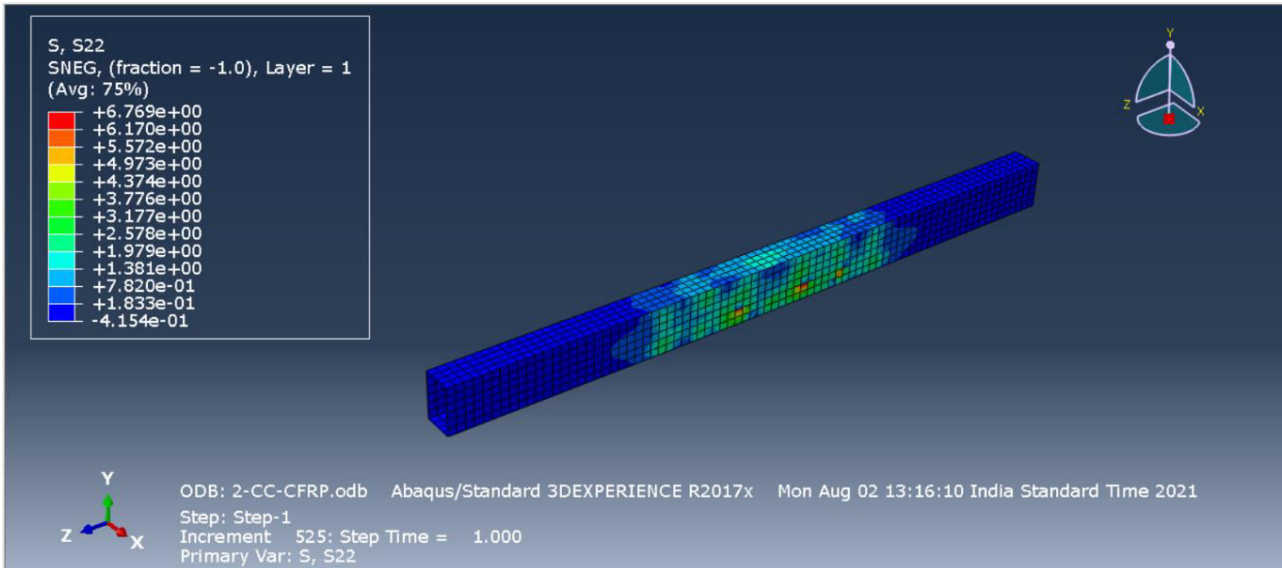


Fig 6. Normal stress on CFR

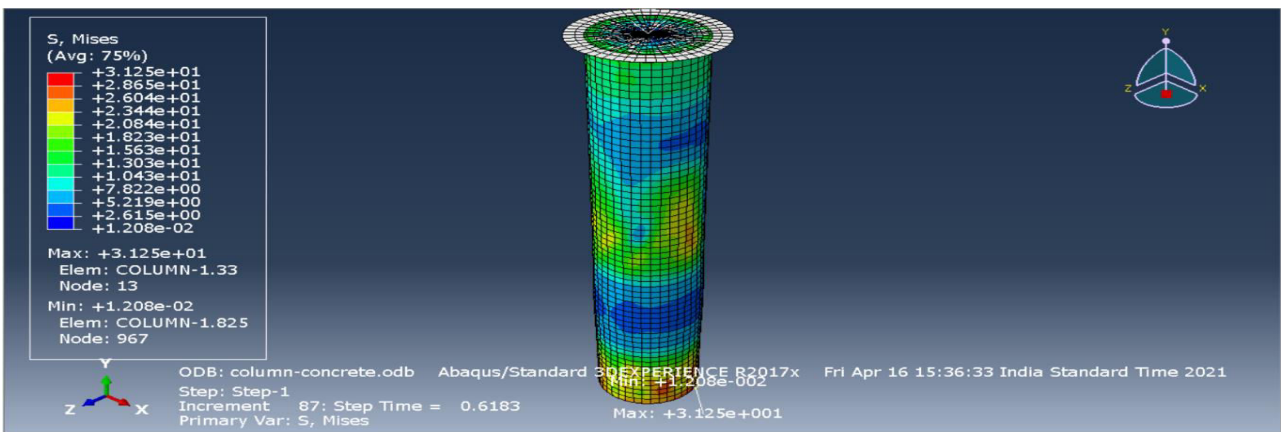


Fig 7. stress on COLUMN

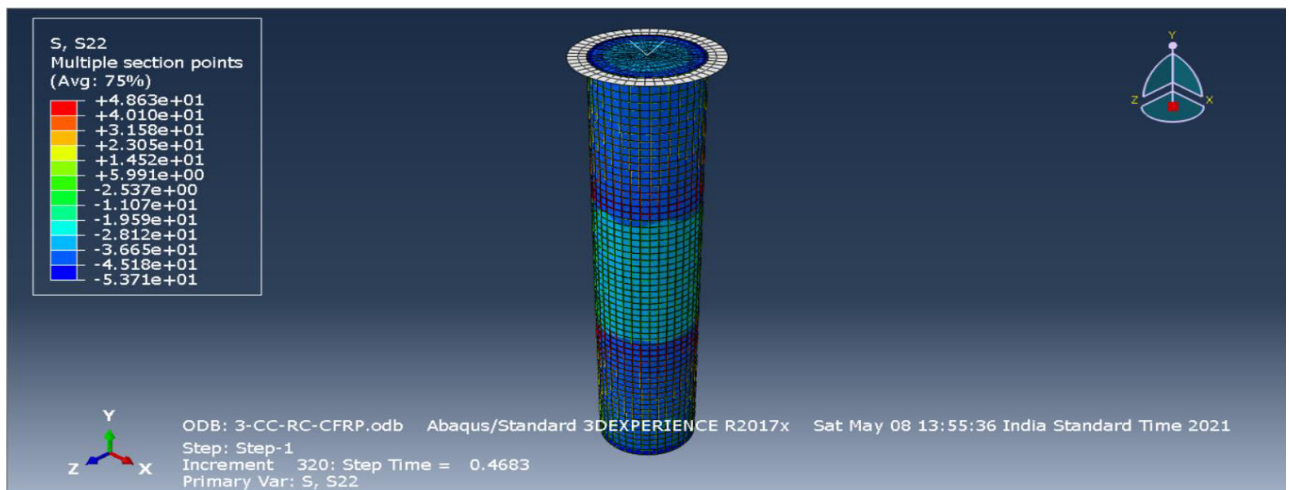


Fig 8. stress on CFRP

VII. CONCLUSION

Based on the analytical results of RC member, following conclusion are made

1. The ultimate load carrying capacity of the beam reinforced with steel bars wrapped using FRP was found to be more than the beam reinforced with steel bars without FRP wrapping.
2. The deformation of the beam reinforced with steel bars wrapped using FRP was found to be slightly lesser than the beam reinforced with steel bars without FRP wrapping as per the analysis made in ABAQUS 17.
3. The strengthening of beams using carbon fibre sheets is found to be more effective in improving the flexural strength and ultimate load capacity of beams.
4. The bonding between the FRP sheet and the concrete is intact up to the failure of the column which clearly indicates the composite action due to FRP sheets.
5. Wrapping of reinforced concrete column with CFRP leads to improvement in yield load, yield deflection, ultimate load, stresses, displacement, ultimate deflection and energy ductility values
6. In general, CFRP wrapping is an ideal material for improving the performance of reinforced concrete RC member.

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