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Comparative Study of Temperature Analysis for CFRP, GFRP and ARAMID Over Columns

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Abstract: The main objectives of the research project are to study the thermal effects on reinforced concrete columns with different FRP wrapped on it. Replacement of steel by the GFRP reinforcing bars or grids would enable engineers to design thinner panels. Beside the advantages of possibility to make the layers and the whole thickness of the wall thinner, this cause also a number of research challenges, not yet clarified. Only a few results were carried out over the thermal properties if FRP. Here we prepare a FEA modal with different thickness and the FRPs are wrapped along the column. The FRP used here are GFRP, CFRP and ARAMID. The cases are analyzed in transient thermal condition with circular shape to get a result of stress and deformation in different rate of temperatures with 3mm thickness for the composite materials. The heat transfer analysis is carried out in ANSYS software. All above mentioned research needs create best computational possible research activities. Project should cover the answers for above questions and explain which of them are the most relevant for the whole system, so the construction of new efficient panels with use of well-known and recognized materials would be possible. Further aim is then better recognition in the field of durability properties of FRP which can affect the design as well as the production process.

Keywords: CFRP, GFRP, ARAMID, Finite Element Analysis

I. INTRODUCTION

Research shows that fibre-reinforced polymers (FRPs) can be used efficiently and safely in strengthening and rehabilitation of reinforced concrete structures. However, the use of FRPs in buildings has been limited because relatively little is known about the behavior in fire performance of reinforced concrete structural members that have been strengthened with FRP . FRP are composite materials which are made up of fibers and polymer matrix. FRP are of different types such as GFRP, CFRP, ARAMID etc. FRP materials are used in construction of bridges, aerospace industries etc. FRP materials are highly versatile and they are available in tubes, sheets, bars, tendons and many other forms.

For a long duration, civil engineers have been in search for other materials instead of steels and its alloys to decrease the high expenses of repair and curing of structures spoiled due to corrosion. Composite materials which are made by the mixture of two or more different materials in a very small range earned escalating popularity in the engineering field. FRP (Fiber Reinforced Polymer) is quite a new range of composite material manufactured from fibers and its resins which proves an effective and reasonable material for the expansion and repair of new and failing structures in civil engineering. Mechanical properties of Fiber Reinforced Polymer make them suitable for International wide applications in construction worldwide. Glass fibers are the most common FRP among all industries, although carbon, glass and aramid fiber composites are found in aerospace, automotive and sporting goods applications. Since columns are the most critical members in a structure, it should be protected well. Due to fire and explosions, the column may get failed early than other members. The failure of column leads to the failure of the entire structure. In this investigation, the fibre reinforced polymers are used to wrap the column to know its performance at higher temperatures.

II. SCOPE

The scope of the study includes the following.

- To get a better idea on modern building techniques.
- To do a comparative study between GFRP , CFRP & ARAMID
- The transient analysis gives a comprehensive idea about the structures subjected to heat.

- Can introduce remedial measures to improve the performance of the poor material.
- Helps for the future research

III. OBJECTIVES

The main objective of this research is to know about modern building techniques and to know more about different polymer materials that can protect the structure from heat. At the end of this research it should be able to:

- Understand which material performs more with high temperature.
- Understand the variation of properties like stress and deformation for different materials for transient temperature analysis.
- Understand the thickness of the polymer needed to withstand with high temperature.

IV. METHODOLOGY

- Modelling using appropriate design software
- Assigning material properties
- Selection of suitable elements from ANSYS element library
- Discretization of the structure
- Solving the problem with appropriate loads and boundary conditions

V. MODELLING

A circular shaped column is wrapped with different FRPs of 3mm thickness each. CFRP, GFRP and ARAMID are used to wrap the column. The columns are with 400mm diameter and 3000mm length from end plate to end plate. The longitudinal steel reinforcement in the columns consisted of eight 16mm diameter bars, which were symmetrically placed with 40mm clear cover to the spiral reinforcement. The lateral reinforcement for the columns consists of 8mm diameter deformed steel spiral with a c/c pitch of 40 mm.

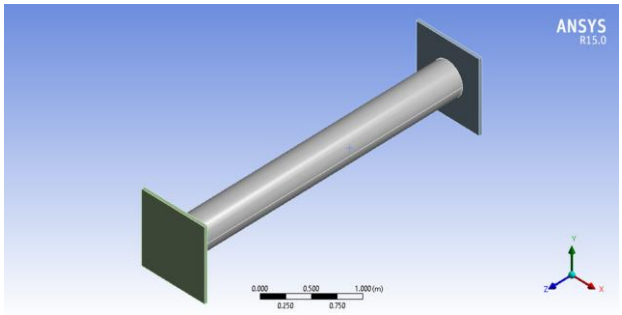

Fig 1 Proposed modal

A. CFRP encased column

Here the model is analyzed with CFRP and is wrapped around the column.

Properties of CFRP

- High Strength to weight ratio.
- Rigidity.
- Corrosion resistance.
- Electrical Conductivity.
- Fatigue Resistance.
- Good tensile strength but Brittle.
- High Thermal Conductivity in some forms.

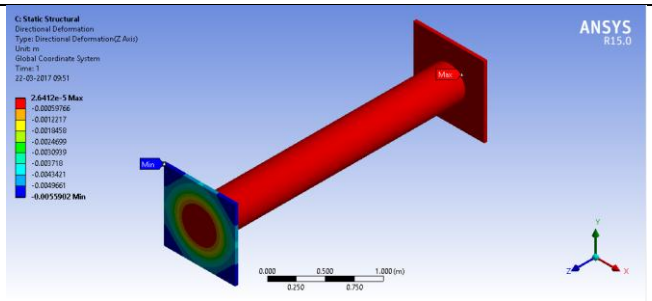

Fig 2 Deformation of CFRP column

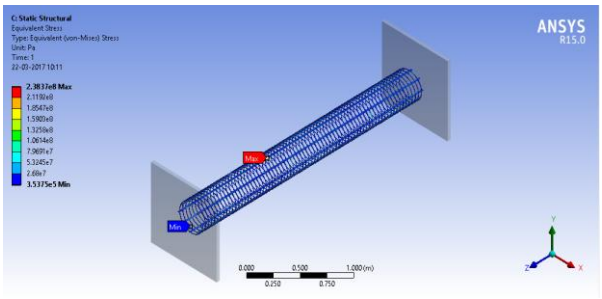

Fig 3 Stress in CFRP column

B. GFRP encased column

Here the model is analyzed with GFRP and is wrapped around the column.

Properties of GFRP

- GFRP has a very high strength to weight ratio
- Virtually any shape or form can be molded
- Low Maintenance
- Research shows no loss of laminate properties after 30 years

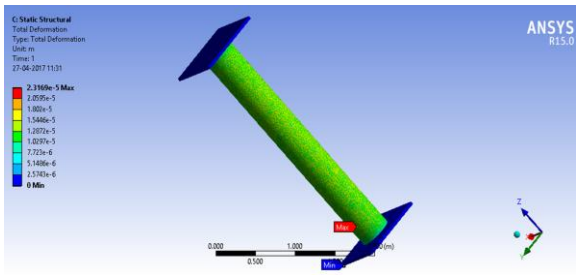

Fig 4 Deformation of GFRP column

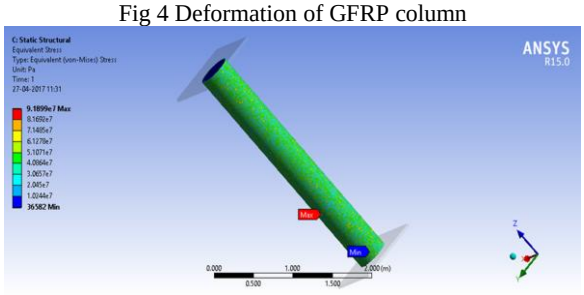

Fig 5 Stress in GFRP column

C. ARAMID encased column

Here the model is analyzed with ARAMID as wrapped around the column.

Properties of ARAMID

- High strength.
- Resistance to absorption.
- Resistance to organic solvent, good chemical resistance.
- No conductivity.

- Low flammability.
- Excellent heat, and cut resistance.
- Sensitive to acids and ultraviolet radiation

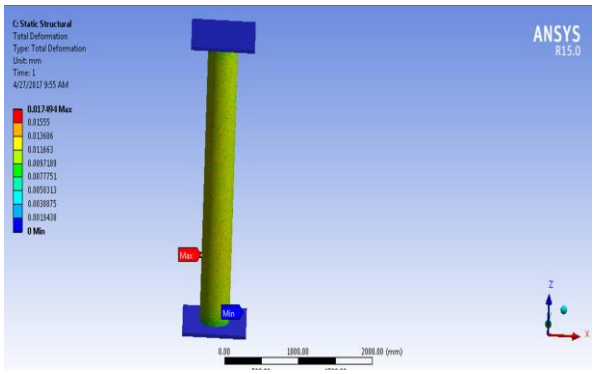

Fig 6 Deformation of ARAMID column

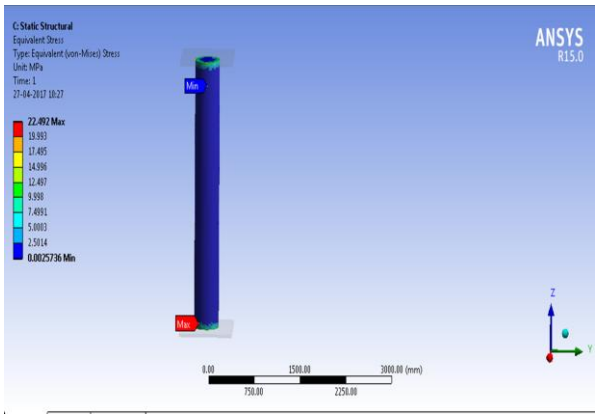

Fig 7 Stress in ARAMID column

VI. RESULTS AND DISCUSSION

From the transient thermal analysis it is clear that ARAMID encased column has lesser deformation as compared with CFRP and GFRP.

Table 1 Deformation and stress of FRPs

MATERIALS	DEFORMATION(mm)	STRESS(MPa)
CFRP	0.0264	238.37
GFRP	0.0231	91.899
ARAMID	0.0174	22.492

VII. CONCLUSIONS

Analytical study has been conducted to understand the behavior of encased concrete columns in a structure during heat transfer analysis. ANSYS software is used to carry out the analysis. Comparison of CFRP, GFRP and ARAMID columns are analyzed in transient thermal condition. And the following conclusions have been drawn from it.

- Among CFRP, GFRP and ARAMID, ARAMID shows less deformation.
- During the comparison of CFRP and GFRP, GFRP shows better results in heat resistance for same thickness.
- GFRP has 14.29% less deformation than CFRP of same thickness.

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