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# STRENGTHENING OF HOLLOW BEAM USING DIFFERENT MATERIAL

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**Abstract:** This paper presents an experimental study of structural material optimization by introducing hollow core in RC beams. The study aims to examine the behaviour of reinforced concrete beam with epoxy and compare it with reinforced beam. By material optimization we can reduce the dead loads which contribute to seismic effect in high rise structure. The beam is casted with steel reinforcement and another beam is casted with steel reinforcement and hollow pipe along with closure cap/plug. So that the use of hollow pipes, the volume of concrete and weight of concrete is reduced. An experiment is carried out on a beam.

**Keywords:** Reinforcement, Concrete, Hollow -beam, Epoxy, Polystyrene pipes

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## INTRODUCTION

A long study structural element which is attached to the upright frame columns. Generally used to resist load applied laterally and also characterized by their manner of support, shape of cross-section length and their material is defined as beam. The loads acting on the beams produces two types of forces that is shear force and bending moments.
The beam which is empty, unfilled or vacant from inside used to resist load applied laterally is defined as Hollow beam.
Problem definition and specification is generally taken with respect to and consideration to the flexural strength and shear strength of beam and also, we concentrated on the materials which are majorly used in casting of beam that is amount of concrete. Major amount of concrete is used and wasted and we are concentrating to use less amount of concrete.

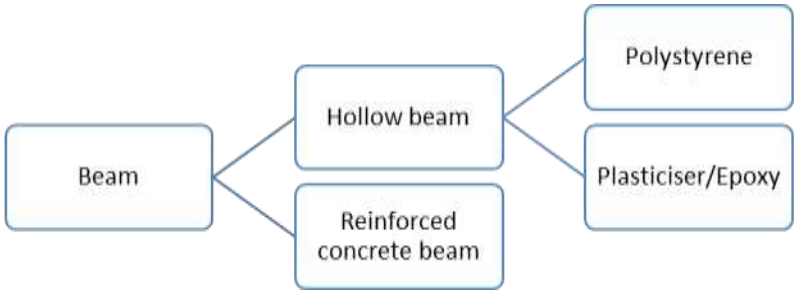

Figure 1 Overview

## OBJECTIVES

The objective is to study on introducing a new method by replacing some amount of concrete and creating air voids using CFRP/Polystyrene pipes without affecting the geometry section and achieve high strength compared to Reinforced concrete beam.

## LITERATURE REVIEW

1. **Title:** Flexural Performance and Deflection Prediction of Rectangular FRP-Tube Beams Fully or Partially Filled With Reinforced Concrete**.**

**Author:** Radhouane Masmoud, Ahmed Abouzied.
This paper represents the CFFT beam which is partially filled with concrete by having FRP tubes inside the section of beam in tension zone. This paper shows the experimental results indicate the performance of the CFFT beam in the terms of strength and deformability as compared reinforced concrete beam. The FRP tubes in the CFFT beam act as the reinforcing the section and concrete lies in the compression zone. In this paper the new equations and assumptions are introduced brason's equation for the prediction of the accurate moment of inertia of CFFT rectangular beam before and after load are applied. In the CFFT beam the flexural stiffens is very high before the cracking due to the high gross moment of inertia (Ig), and the gross moment of inertia decreased after the cracking of the concrete. After yielding of steel flexural stiffness decreased of the CFFT beams but unlike the RC beams. As compared to the RC beam

the steel reinforcing CFFT beam has higher ductility, higher stiffness and superior strength. A rectangular CFFT beam fully filled with FRP tube has 97% more flexural strength as compared to the RC beam and it fails in the tension zone. In the circular CFFT beam having the FRP tube inside the section has 115% higher as compared to the RC beams and fails in compression zone. In the partially filled CFFT beams has higher strength and the weight ratio then the RC beams while in the fully CFFT beams reduce the dead weight of the structure.

2. **Title:** Axial Behaviour of CFRP-Strengthened Circular Steel Hollow Sections.
**Author:** Punitha Kumar, R.Senthil.
In this paper they check the behaviour of the CFRP steel circular hollow section beam under the axial static loading and axial cyclic loading. In this paper while checking the behaviour of CFRP steel circular hollow section the failure modes are load deformation and load strain. In this beam the failure pattern is buckling in the outwards at end of the specimen and in at the mid height the lateral buckling observed. After the peak load on the specimen the failure of modes are observed at the end and mid height of the specimen. At the end rupture of CFRP is followed. While in increase of slender ratio the static and the axial cyclic compressive strength of the circular hollow section decreased. In the strengthened CFRP specimen increased the static axial capacity by 39.47% and the axial cyclic capacity increased by 41.02%. Under both loads the load carrying capacity, ductility and stiffness is improved in the CFRP strengthening and there is also delayed in the overall buckling of the steel.

3. **Title:** Flexural Behaviour of Reinforced Concrete Beam with Hollow Core at Various Depths.
**Author:** Nibin Varghese, Anup joy
According to this paper the simply supported RC beams, the zone below the neutral axis is tension zone and zone above the neutral axis is compression zone. The reinforcement is provided in tension zone as the concrete is weak in tension zone. The concrete acts as the stress transfer medium between tension and compression zone. When there is partially replacement of concrete in tension zone their reduction in weight and saving of materials. In this paper they focus on the optimization of the hollow core using PVC pipes in tension zone of RC beams. While using the PVC pipes in the RC beams can reduce the dead load which contributes in the seismic effect of high rise structures. When the PVC pipes used in the low stressed zone instead of concrete the strength is increased by 21% of RC beams. In this paper it also observed that there is no requirement of extra labour and time. Economy and reduction of weight depends on the replacement of the concrete. When the effective length and depth in increased the saving of concrete is more.

4. **Title:** Improvement of Torsional Resistance in Ultra-High Performance Fibre Reinforced Concrete Beams.
**Author:** Karim Fr , Abu Bakar BH , Choong Kok Keong.

In this paper shows the behaviour of the concrete cover of ultra high performance fibre reinforced concrete rectangular solid beam under pure torsion. The behaviour of the ultra high performance fibre reinforced concrete has high compressive and high tensile strength. In this paper they focused on the thickness of the concrete cover. After the test the outcomes were that the trosional resistance is at on peak and the crack load is between 113% to 134% respectively, of the estimated value based upon the thin walled tube theory. In this paper they calculated the torsional resistance and twisting angle at cracks and peak loads. Whereas the thickness of the concrete cover is the inflection point for the trosional resistance. The strain in stirups and longitudinal reinforcement is reduced by 50%.

5. **Title:** Partially coherent circular and elliptical dark hollow beams and their paraxial propagations.

**Author:** Xiang Lu, Yangjian Cai

For the circular and elliptical symmetry a theoretical model is proposed to describe the partially coherent dark hollow beam. The characteristic of the partially coherent circular/elliptical dark hollow beam depend upon the parameters of the beam. In this paper the cross spectral density of the beam is expressed as a super position of a finite sum of partially coherent Gaussian Schell modal beams and the characteristic of the beam is depends upon the parameters of the beam. After the numerical test it observers that the propagation factor and propagation properties of beam are related to the initial coherence and other beam parameters.

6. **Title:** Analytical approach for predicting full torsional behaviour of reinforced concrete beams strengthened with FRP material.

**Author:** A.R. Zojaji

In this paper the torsional capacity is increased by the U jacketing fabrics by the full wrapping configuration. A new innovation is done for the torsional response of the reinforced concrete beam using fibre reinforced plastic based on the softened membrane modal for torsion. After the test they observed that the continuous FRP sheets are more convinient then the FRP strips. The main aim of this paper to perform the analytical modal to check the torsion behaviour of the reinforced concrete beam using FRP based on the softened membrane modal for torsion. In this they attempts the SMMT modify algorithm. The analytical models are based on the compression field theory, modified compression field theory and softhead truss modal. By using this modals we can predict entire torque twist curve by considering the tension stress in equilibrium equations

7. **Title**: Experimental study on bonding property between FRP and concrete.

**Author:** Yao Yun , Zou Hao

In this paper the methods used for bond anchorage test are pull test and charpy test. In this test the load is applied by electro hydraulic servo universal testing machine by giving uniform load. To eliminate the effect of compressive stress on bond performance of FRP and concrete from loading end using the loading end it will separate the reinforcement and concrete.

Considering the anisotropic properties of FRP the steel tubes loaded end anchorage before the test. The properties of FRP are corrosion resistance, light weight, high strength and anti electromagnetic performance. To extend the service life and to reduce the cost of construction and repair their is and improvement in performance and durability of reinforced concrete structure. The combined foundation between the FRP and concrete which gives the sufficient bonding force and also transfer the force and has a deformation to common resistance. They have studied the bond stress between FRP and concrete of different diameter, different buried depths, different surface forms, and different concrete cover thickness by pull out test. Analyses of advantages and disadvantages are based on bond slip curve measured on FRP and the existing models of bond slip.

8. **Title**: Behaviour of reinforced concrete beam with circular opening in the flexural zone strengthened by steel pipes.

**Author:** R. Rajkumar, N.Uma Maheshwari, Lalramghaki Hauhnar

In this paper they check the behaviour of RC beams with circular opening in flexural zone strengthened by steel pipes and also they used finite element analyses software ANSYS. Four beams were cast using M30 concrete and Fe415 steel where as one beam with unstrengthened circular opening and two beams with strengthened circular opening for experimental study. They compare the behaviour of beams by experimental and analytical results. They observe that 10% deviation occurs in experimental and analytical results. By comparing experimental and analytical result 10.7% increment in load carrying capacity of convectional beam and minimum deformation in unstrengthened beam.

**Material**

(a) Concrete: Concrete is the mixture composed of cement, water, aggregates, sand and admixtures. Generally, acts as the basic material for designing of beam. It resists compressive load.

(b) Reinforcement: steel bars are used in beam to transfer tensile load.

They are categorized in 4 types.

i. Hot Rolled Deformed bars
ii. Mild Steel Plain Bars
iii. Cold Worked Steel Reinforcement
iv. Pre-stressing Steel.

(c) Carbon fibre reinforced polymer: It is an extremely strong and light fibre reinforced plastic which contains carbon fibre.

(d) Epoxy: Epoxy resins, also known as polyoxides, are a class of reactive prepolymers and polymers which contain epoxide groups.

(e) Fly ash: Ash produced in small dark flecks by the burning of powdered coal or other materials.

(f) F.R.P (Fibre Reinforced Plastic): It is a polymer made of polymer matrix reinforced with fibres. Fibres like glass, carbon, aramid and basalt are majorly used. In rare cases paper, wood

and asbestos are used. F.R.P is generally used in Aerospace, Automotive, marine and Construction industries.

(g)P.V.C (Polyvinyl Chloride): Polyvinyl Chloride is an insoluble plastic polymer is generally used in construction of pipe and general applications such as doors and windows. Basically it comes in two form Rigid and flexible.

(h)Polystyrene: Polystyrene is a solid or foamed material or Synthetic Aromatic Hydrocarbon Polymer made of monomer styrene. [www.wikipedia.org]

**RESULT AND CONCLUSION**

We casted three cubes of M25 grade using polystyrene pipe and Epoxy as an admixture and After 28 days of curing we conducted Compression test in which we came to the conclusion that the bonding of concrete is poor with Polystyrene pipe and Epoxy followed by the Strength which resulted 17.60N/mm$^2$.

According to above mentioned literatures we concluded that while using PVC pipes in the reinforced beams it only reduces dead load on the structure and can save concrete. If FRP tubes are used 97% flexural strength increased compared to RC beams. The FRP and concrete gives sufficient bonding force .In CFRP strengthening load carrying capacity, ductility and stiffness is improved and overall buckling of steel is delayed.

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