BEHAVIOUR OF CONFINED CONCRETE COLUMN COMPARISON OF ANSYS AND STADD PRO

MR.S.BHARATHI DASAN[1]
Assistant Professor,
Head of the Department
Department of Civil,
Prist University, Puducherry Campus

N.VENKATA KRISHNAN[2]
Final Year Student ,
Master of Engineering
Department of Civil,
Prist University, Puducherry Campus

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ABSTRACT: The strengthening techniques of RC column using carbon fiber reinforced polymer band wrap are used to strengthen the columns. This technique is simple to use and has many advantages over other available methods. The CFRP wrap enhances the axial load carrying capacity and the ductility of RC column. This paper deals with Experimental and analytical studies of different parameters on RC columns wrapped with carbon fiber reinforced polymer (CFRP) are taken and investigated. A total of four columns were prepared and wrapped with CFRP cloth of different thickness 0.35 mm and 0.7 mm. In which 2 are control specimens and rest are wrapped specimens. In this topic we study the combined effect of internal steel ties and external CFRP band ties. The columns were tested under axial compression, the results demonstrated significant enhancement in the compressive strength, stiffness and ductility of the CFRP wrapped RC column as compared to unconfined RC column were identified and discussed. Analytical models for ultimate stress and strain, load vs deflection of confined concrete were compared with experimental results.

Keywords: CFRP band wrap, axial stress-strain behaviour, axial compression, ductility, confined concrete

INTRODUCTION

In this study discussed about protection and strengthening techniques of RC column with CFRP band wraps. This techniques achieved by encasing column with CFRP composite jackets that provided lateral confinement to the concrete enhances strength of column. Improve the strengthening with externally bonded CFRP to be applicable to many types of RC structures. This method has been implemented structure as columns, beams, slabs, wall, chimneys, tunnels and silos. A number of techniques have been developed to fabricate CFRP composite jackets the most commonly used are wrapping of fabric. The CFRP material has higher stiffness and durability and corrosion resisting if compared to other composites material.

The CFRP confinement is to increase the load carrying capacity and energy absorption ability. The uses of external CFRP reinforcement may be generally classified as improving confinement and ductility of compression member and shear strengthening. The RC columns subjected to axial compressive loading on specimens having a cross section of 150 mm diameter and height of 1200 mm.

The objective of this study is necessary for the implementation of externally bonded CFRP reinforcement for the repair of the concrete structure, in the case of member subjected to compression where enhancement of strength and ductility is the results of lateral confinement of concrete.

OBJECTIVE

- To investigate the effectiveness of CFRP wrapping for circular RC column.
- To study the axial stress-strain behaviour of CFRP confined concrete RC column.
- To study the lateral behaviour of CFRP confined concrete.
- To determine the efficiency of CFRP wraps in terms of utilization of strength and deformation capacity of CFRP material.
- To study the strength of columns by wrapping using CFRP includes behaviour of linear stress with linear strain and Behaviour of linear stress with lateral strain.

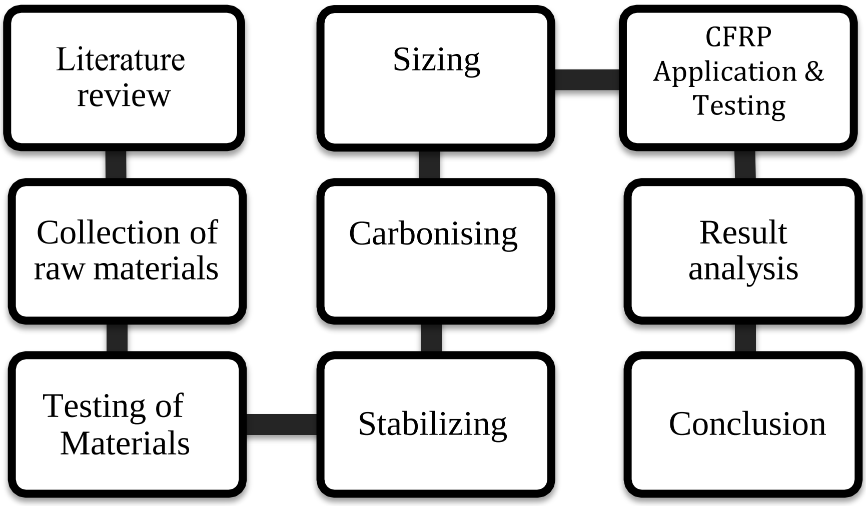
SCOPE

The objective is to increase the capacity of columns, and therefore the strengthening measures aims at enlarging the cross sectional area or at enhancing the compressive strength of concrete by applying a confining action. The present study is to investigate the performance of RC circular columns with carbon fibre reinforced polymer wraps. The influence of key parameters such as materials properties, stiffness of CFRP Wrap and concrete strength will be critically assessed. An analytical model for evaluating the structural capacity of CFRP wrapped circular column will also proposed.

FIBER REINFORCED POLYMER

FRP is a composite material generally consisting of carbon, aramid are Glass Fiber in a polymeric Matrix (Eg., Thermosetting Resin). FRP is isotropic material Characterized by high strength in the direction of the Fiber orientation. Externally Bonded FRP wraps are used to increase the strength, as well as the axial deformation.

METHODOLOGY



REVIEW OF LITERATURE

Bisby and Take (2021) using an optical measurement technique, it was found that, depending on the location of the strain measurement, the hoop strains over the surface of the FRP confined circular concrete cylinders varied by as much as 50% of the ultimate axial strain of the FRP. Although Pessiki et al. (2001) suggest that the hoop rupture strain can be related (as shown in Eqn. 2) to the ultimate strain of the FRP through an efficiency factor η, it should be noted that a thorough understanding of the strain distribution around the FRP jacket is lacking in the existing literature, which only presents isolated readings for the values for hoop strain around the circumference of the circular concrete specimens.

Guoqiang Li (2020) conducted a study on "Experimental study of FRP confined concrete cylinders". For the past decade, there has been a continuously increasing interest in the use of fiber-reinforced polymer (FRP) in the repairing, retrofitting, strengthening, rebuilding, and new construction of columns in engineering structures. The 28-day compressive strength of the unconfined concrete was determined using standard 150. 4mm by 300.8mm cylinders. A limitation with FRP confinement is that the FRP cannot effectively confine the concrete core before the unconfined concrete strength is reached due either to its higher transverse Poisson's ratio and / or to its lower axial stiffness.

Tamer EI Maaddawy (2019) a study on "Conducted post-repair performance of eccentrically loaded RC columns wrapped with CFRP composites" chloride-induced corrosion in reinforced concrete (RC) structures is a major worldwide durability problem. Reinforced concrete structures located in industrial regions are also vulnerable to carbonation-induced corrosion due to the increased concentration of carbon dioxide. Three concrete cylinders, each having a diameter of 150 mm and a length of 300 mm, were cast from the same mix used in fabrication of test specimen to determine the concrete compression strength. Structural test results showed that 4.25% steel mass loss had no noticeable effect on the strength of eccentrically loaded RC columns. AT nominal e/h of 0.3, the strength of the damaged column repaired with full CFRP wrapping system was about 40% higher than that of the control. During the post – repair corrosion phase, full FCRP wrapping system, with an effective confinement ratio of f1/ f'c = 0.2, reduced the measured current by about 25% and 12% at fixed. Applied potential of 12 and 15v, respectively relative the current of the unwrapped specimen.

MATERIAL USED

Cement, fine aggregates, coarse aggregates, reinforcing bars and CFRP are used in casting of column. The specifications and properties of these materials are as under.

Cement : Cement used for all specimens was ordinary Portland Pozzolona cement of 53 grade. This is conforming to IS 269-1976.

Fine Aggregate : The fine aggregate used for all specimens was conforming to IS-383-1970. It was sieved through 2.36mm sieve used.

Coarse Aggregate : The coarse aggregate conforming to IS: 383-1970 used in hard broken granite stone obtained from quarries in and around Chidambaram. The size of aggregate used was 12mm to 20mm.

Water : Portable water was used for mixing concrete and curing the specimens.

Steel : In all columns have the internal tensile reinforcement as 6mm and compression reinforcement as 8mm. The tension and compression reinforcement was Fe 415 grade, the clear cover of top, bottom and sides are kept as 40mm.

Carbon Fibers : Carbon fibers have high tensile strength and young's modulus, but also a high specific strength compared to steel and glass fibers. The carbon fibers are in different forms like sheets, fabrics, strips and tendons. These carbon fibers have diameters ranging from 5 to 10 micrometers and have a characteristics charcoal colour. Carbon fiber has a two dimensional atomic structure creating different properties longitudinally and transverse direction. Along the longitudinal axis of the fiber the modulus and strength are high as opposed to the transverse axis which provides little of either strength or modulus. These fibers exhibit high durability in high temperature and moisture environments when subjected to fatigue loading.

TEST SETUP

- The specimen was capped at its top and bottom and axially placed on the column testing frame.
- LVDT placed at 120 degree a part to measure the lateral deflection of the concrete specimen at its mid height.
- Three deflectometer was placed vertically over the top and bottom of the cap to measure the axial compression (change in length) and one placed in center of the specimen.
- An electrical strain gauge was placed horizontally at the mid height of the specimen to measure the lateral strain.

ANSYS MODELLING

One of the reasons for wide application of the finite element software is due to the availability of number of package programs. Today the most effective and commonly used software is ANSYS. They are mostly graphics oriented. The processor modules involve mathematical computations that requires large arithmetic operations i.e., number of crunching operations in the computer. ANSYS modeling is generally performed by mapped meshing or free meshing. Mapped mesh modeling is a procedure in which meshes are generated in even order. Free mesh modeling is the one in which the meshes are generated in random. In this thesis work, mapped mesh modeling is adopted.

METHODS OF MODEL GENERATION

Single Node and Element Generation : This technique is tedious procedure. However, it can be very effective on models with a few higher order elements.

Digitizing Input : Many users have scaled drawings of a model. Outlines of the model or node and elements can be transferred directly into the program using an electric digitizing tablet.

Pattern Generation : This is a method in which the entire model can be garneted by simply repeating the portion of the mode. Duplication can also be done in which the entire model can be translated, routed, mirrored, or scaled to generate another portion of the model. Duplication can be individually said as a method of model generation.

Region Generation : This is another type of model generation in which the nodes and elements are generated within a region bounded by previously defined lines.

Dragging Generation : This mesh generation technique is used to extrude in fixed section of elements. Dragging line creates 2D or shell element. Dragging 2D element creates 3D elements of constant cross section.

Mesh Generation : Granular type of meshing is the one in which meshes formed are close to each other leading to increase in approximation of the result. Coarse meshing is that in, which meshes formed give results approximately.

ASSUMPTIONS AND RESTRICTIONS

- Cracking is permitted in three orthogonal directions at each integration point.
- If cracking occurs at an integration point, the cracking is modeled through an adjustment of material properties which effectively treats the cracking as a "smeared band" of cracks, rather than discrete cracks.
- The concrete material is assumed to be initially isotropic
- Whenever the reinforcement capability of the element is used, the reinforcement is assumed to be "smeared" throughout the element.
- In addition to cracking and crushing, the concrete may also undergo plasticity, with the Drucker-Prager failure surface being most commonly used. In this case, the plasticity is done before the cracking and crushing checks.

TEST RESULTS

Comparison of confined and unconfined column :

Specimens	Experimental Ultimate Axial Load in KN		Experimental Deflection in mm	
Confined	0.7mm thick	0.35mm thick	0.7mm thick	0.35mm thick
	670	540	3.5	3
Unconfined	370		2.8	

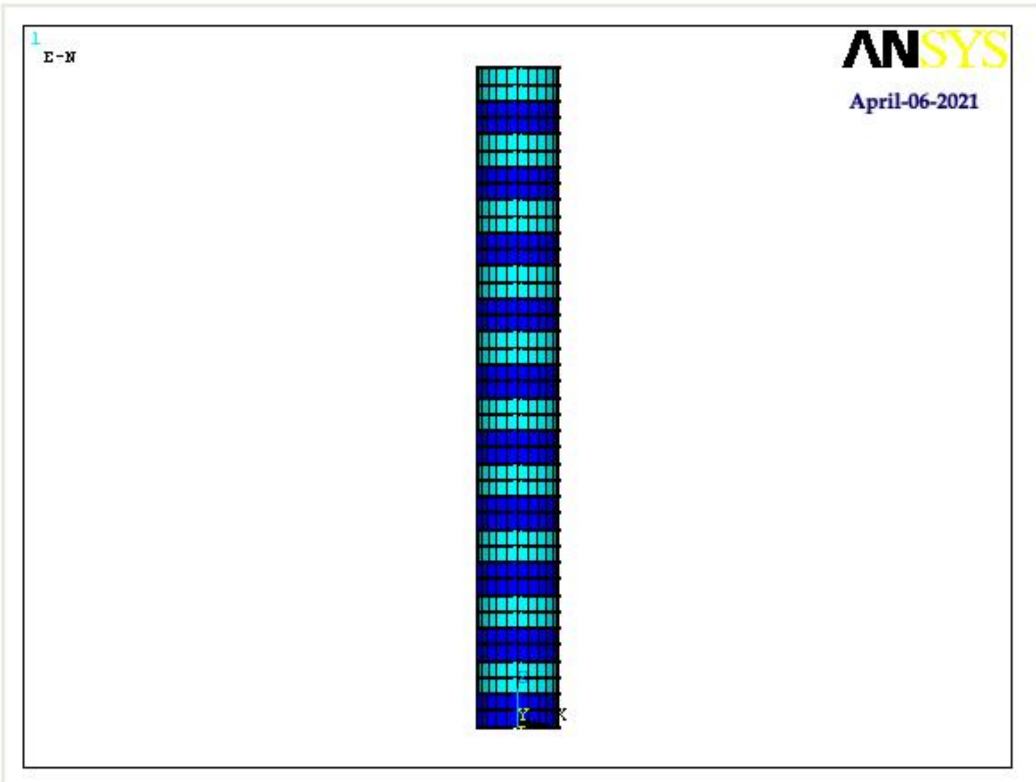


Fig.1. Generation of FRP

DESIGN OF BCJ WITH SLAB SPECIEMEN

Slab is monolithically cast with Beam Column joint in an actual structure. Under loading condition, slab acts as an integral part of the main beam, increases both the positive and negative flexural capacities of the beams. The contribution of slab to the positive capacity of the beams in terms of equivalent effective slab with, as recommended by ACI 318-83 is well accepted and is commonly used in flexural capacity of beams, i.e., when a slab is in tension, whether in terms of an effective slab width or otherwise has not yet been settle. The primary reason for this is there are no specific recommendations on the effective of slab including lack of adequate and concerns tested in the laboratory to be expected in a real building. Therefore, it was decided that three dimensional beam-column with slab to be tested under cyclic loading.

ANALYSIS AND DESIGN OF BCJ WITHOUT SLAB

In moment resisting frames, beams and columns are connected at one point which is known as beam-column, joint, here the slab may or may not be present. In RC structures, beam column joints are critical zones for transferring loads effectively between the connecting elements like bums, stabs and columns because the joints are assumed as rigid. ACI committee recommends that the non-seismic joints be provided with at least two layers of transverse retirement between the top and bottom levels of longitudinal reinforcement in the deepest beam framing into the joint. For gravity load only maximum spacing is kept to n300mm for non-seismic lateral loads.

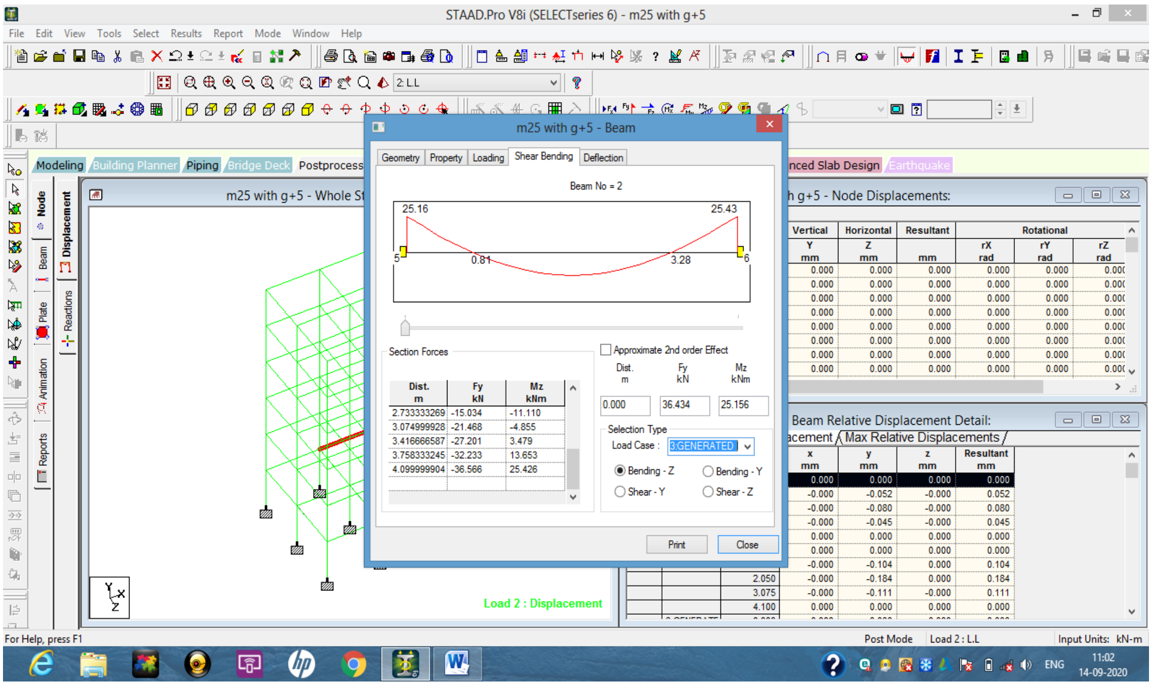


Fig.2. Analysis on STADD PRO

RESULTS AND DISCUSSION

Strengthening of RC columns using UDC-CFRP sheets exhibit higher load carrying capacity. The percentage increase in ultimate load varied from 11.96% to 45.33% for CFRP strengthened RC columns.

CONCLUSION

The percentage increase in axial deflection at ultimate stage varied from 18.23 % to 32.91% for RC columns strengthened with CFRP sheets. CFRP strengthened RC columns failed in buckling mode. The finite element models show good agreement with the experimental test results. The failure mechanism of a CFRP confined RC column is modelled quite well using ANSYS and the ultimate axial deflection predicted is very close to the experimental results.

REFERENCES

1. Abdel-Hay, Ahmed Shaban. "Partial strengthening of RC square columns using CFRP." HBRC Journal 10.3 (2021): 279-286.
2. ANSYS Manual, Version (10.0).
3. Benzaid, Riad, Nasr Eddine Chikh, and Habib Mesbah. "Behaviour of square concrete column confined with GFRP composite warp." Journal of civil engineering and management 14.2 (2020): 115-120.
4. Fitzwilliam, Jason, and Luke A. Bisby. "Slenderness effects on circular CFRP confined reinforced concrete columns." Journal of Composites for Construction14.3 (2019): 280-288.
5. Houssam A. Toutanji et al.(2018). Axial load behavior of rectangular concrete columns confined with frp composites. FRPRCS-8 University Of Patras, Patras, Greece, July, 16-18.
6. Kachlakev, D.; Miller, T.; P Yim, S.; Chansawat, K.; Potisuk, T., Finite Element Modeling of Reinforced Concrete Structures Strengthened with FRP Laminates, Oregon Department of Transportation, Research Group, 2018.
7. Manuel A.G. Silva and Carios C Rodrigues (2017). Size and relative stiffness effcts on compressive failure of concrete columns wrapped with glass FRP. Journal of Materials in Civil Engineering, ASCE. 334-342
8. Mukherjee, A., et al. "Mechanical behavior of fiber-reinforced polymer-wrapped concrete columns-complicating effects." Journal of Composites for Construction 8.2 (2016): 97-103.
9. Pham, H. B., R. Al-Mahaidi and V. Saouma Modeling of CFRP- concrete bond using smeared and discrete cracks, composite structures, 2016, volume 75, Issues 1-4, pages 145-150, Thirteen International Conference on Composite Structures – ICCS/13doi:10.1016/j.compstruct.2006.04.039.
10. Richard D. Lacobucci et al.. (2003). Retrofit of square concrete columns with carbon fibre reinforced polymer for seismic resistance. ACI Structural Journal. 100 (6). 785-794. K.