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Retrofitting Reinforced Concrete Columns using Fibre Reinforce Polymer (FRP)

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Abstract: Analysis of a Fibre reinforced concrete column to study the behavior under loading. For analysis purpose ANSYS V15.0 package program is used as a Finite Element Analysis tool. The main objective of this study was to develop three dimensional finite element modeling (3D-FEM) of Concrete column that can be used to investigate fibre wrapping design & application. The accuracy of the results obtained from analysis using ANSYS is validated by comparing it with experimental results.

Keywords: 3D-FE, static analysis,

I. INTRODUCTION

Fibre-reinforced plastic (FRP) (also fibre-reinforced polymer) is a composite material made of a polymer matrix reinforced with fibers. The fibers are usually glass, carbon, aramid, or basalt. Rarely, other fibers such as paper or wood or asbestos have been used. The polymer is usually an epoxy, vinyl ester or polyesterthermosetting plastic; and phenol formaldehyde resins are still in use. The matrix must also meet certain requirements in order to first be suitable for FRPs and ensure a successful reinforcement of itself. The matrix must be able to properly saturate, and bond with the fibers within a suitable curing period. The matrix should preferably bond chemically with the fibre reinforcement for maximum adhesion. The matrix must also completely envelop the fibres to protect them from cuts and notches that would reduce their strength, and to transfer forces to the fibres. The fibres must also be kept separate from each other so that if failure occurs it is localized as much as possible, and if failure occurs the matrix must also debond from the fibre for similar reasons. Finally the matrix should be of a plastic that remains chemically and physically stable during and after the reinforcement and moulding processes. To be suitable as reinforcement material, fibre additives must increase the tensile strength and modulus of elasticity of the matrix and meet the following conditions; fibres must exceed critical fibre content; the strength and rigidity of fibres itself must exceed the strength and rigidity of the matrix alone; and there must be optimum bonding between fibres and matrix.

II. LITERATURE REVIEW

Patil presented paper which deals with the verification of experimental results in terms of load-carrying capacity and strains, by using software. Also to check the load carrying capacity with different shapes of columns with same cross sectional area. Parameters considered are the number of composite layers and the corner radius for a square shape. The number of layers of FRP materials and the corner radius are the major parameters, having a significant influence on the behavior of specimens. The test results from preliminary testing proved that the benefit of confinement could be enhanced by increasing the stiffness of external confinement applying multiple layers and by a good corner radius for square shape.

K.P.Jaya has discussed about Seismic retrofitting of constructions vulnerable to earthquakes is a current problem of great political and social relevance. Most of the Indian building stock is vulnerable to seismic action even if located in areas that have long been considered of high seismic hazard. During the past thirty years moderate to severe earthquakes have occurred in India. Such events have clearly shown the vulnerability of the

Building stock in particular and of the built environment in general. Hence, experiments were conducted on Reinforced concrete beam-columns with and without FRP wrapping. One Specimen each was tested without GFRP and CFRP wrapping, three specimens were tested with 2 layers, 4 layers and 6 layers of GFRP wrapping and other two specimens were tested with CFRP wrapping. The specimens were tested under a constant axial load and reversed cyclic lateral loading. Experimental results indicate a significant increase of ductility and increase in energy absorption capacity of RC beam-column when strengthened by both GFRP and CFRP Jacket.

Z. Yan had studied Fiber Reinforced Polymer (FRP) composites can provide effective confinement to circular concrete columns for the purpose of seismic retrofit of bridges. However, the retrofit effectiveness of FRP confinement for square and rectangular

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columns is greatly reduced due to the flat sides and sharp corners. Shape modification is a possible approach for eliminating the effects of column corners and flat sides, thereby restoring the membrane effect and improving the compressive behavior of FRP-confined square and rectangular concrete columns. An effective method for performing shape modification with FRP composites is to use prefabricated (non-bonded) FRP composite shells with expansive cement concrete.

Seismic retrofit of non-ductile rectangular reinforced concrete columns by CFRP jacketing: In this paper, experimental results on the behavior of non-ductile rectangular columns retrofitted by carbon fiber reinforced polymer (CFRP) jackets are presented. 8 specimens constructed with low strength concrete, plain bars and without adequate transverse reinforcement were tested under constant axial and reversed cyclic lateral loads. The lap splice lengths of longitudinal reinforcement for four of the specimens were inadequate, while the longitudinal bars were continuous for the remaining four specimens. In each of these two groups; one specimen was tested as the reference specimen, 2 specimens were retrofitted with different thicknesses of transverse CFRP jackets, and one previously damaged specimen was retrofitted with CFRP jacket after repairing procedure. Test results indicated that significant ductility enhancement can be obtained for low strength brittle concrete columns retrofitted by CFRP jackets. For the specimens with inadequate lap splices, the enhancement in ductility was not as remarkable as the specimens with continuous longitudinal reinforcement.

Baris Binic has analyzed Fiber reinforced polymer (FRP) lamina have been used widely in the last decade to enhance strength and deformation capacity of deficient reinforced concrete (RC) columns. Seismic assessment and retrofit of existing columns in buildings and bridge piers necessitate accurate prediction of the available deformation capacity. In this study, a new analytical model is proposed to represent potential plastic hinge regions of RC columns prior to and after FRP retrofit. It is observed that, in estimating the response of existing deficient columns, parameters such as plastic hinge length, concrete strength and splice length are important sources of uncertainty. While for FRP-retrofitted columns, parameters such as jacket stiffness, dilatation strain at splice failure and yield strength of the reinforcing bars are more important sources of uncertainty.

III. METHODOLOGY

In this project I would be analyzing and studying the design standards provided by ACI Committee 440 (2008). Guide for the design and construction of externally bonded FRP systems for strengthening concrete structures (ACI 440.2R-08). *American Concrete Institute*, Farmington Hills, Michigan, USA.On the practical end I would be analyzing few concrete elements which would be subjected to compressive load for the elements with and without FRP.I would be analyzing six cylindrical concrete blocks which is made from a standard concrete mix design of M25 Grade. Amongst these six cylindrical blocks, three blocks would be fiber wrapped and after 7 days of fiber wrapping the average load bearing capacity of 3 fiber wrapped cylinders would be analyzed against other three cylindrical blocks which is not fiber wrapped.

IV. SCOPE OF THE PAPER

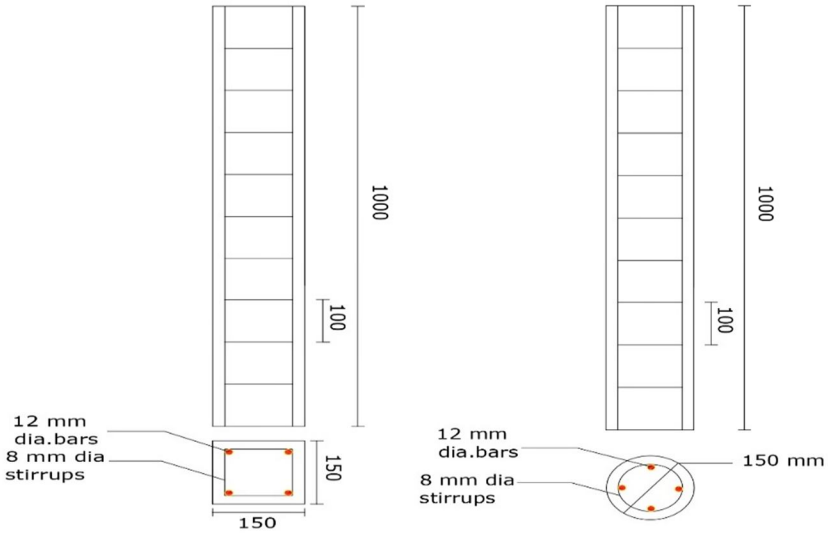
Rehabilitation and strengthening of old structures using advanced materials is a Contemporary research in the field of Structural Engineering. During past two decades, much research has been carried out on shear and flexural strengthening of reinforced Concrete beams using different types of fiber reinforced polymers and adhesives. Strengthening of old structures is necessary to obtain an expected life span. Life span of Reinforced Concrete (RC) structures may be reduced due to many reasons, such as Deterioration of concrete and development of surface cracks due to ingress of chemical Agents, improper design and unexpected external lateral loads such as wind or seismic Forces acting on a structure, which are also the reasons for failure of structural Members. In this project we would review the strength enhancement details of Glass Fiber over the existing concrete column structure.

A. Experimental Work

The ultimate compression load capacity as well as stiffness of concrete cylinder increases with the use of composite wrap technology. The percentage of the load capacity increases with increasing the number of wrapping layer and size. The compressive strength of the concrete cylinder with the use of a long bonding length and thin composite wrap is similar to that of the cylinder with a short bonding length and thick composite wrap.

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Casting of square and Circular Section

The flexural strengths of the rectangular concrete beams with and without notch formation are increased with the use of externally bonded glass–fibre composite. The shear side strengthening method is less significant in term of the flexural load capacity of the beam compared with tension surface strengthening method.

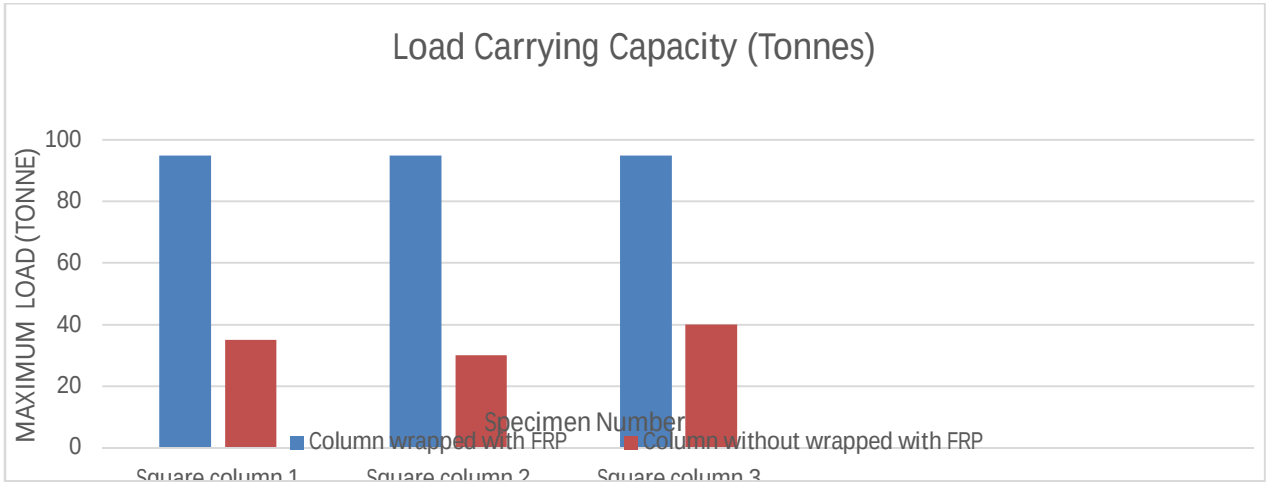


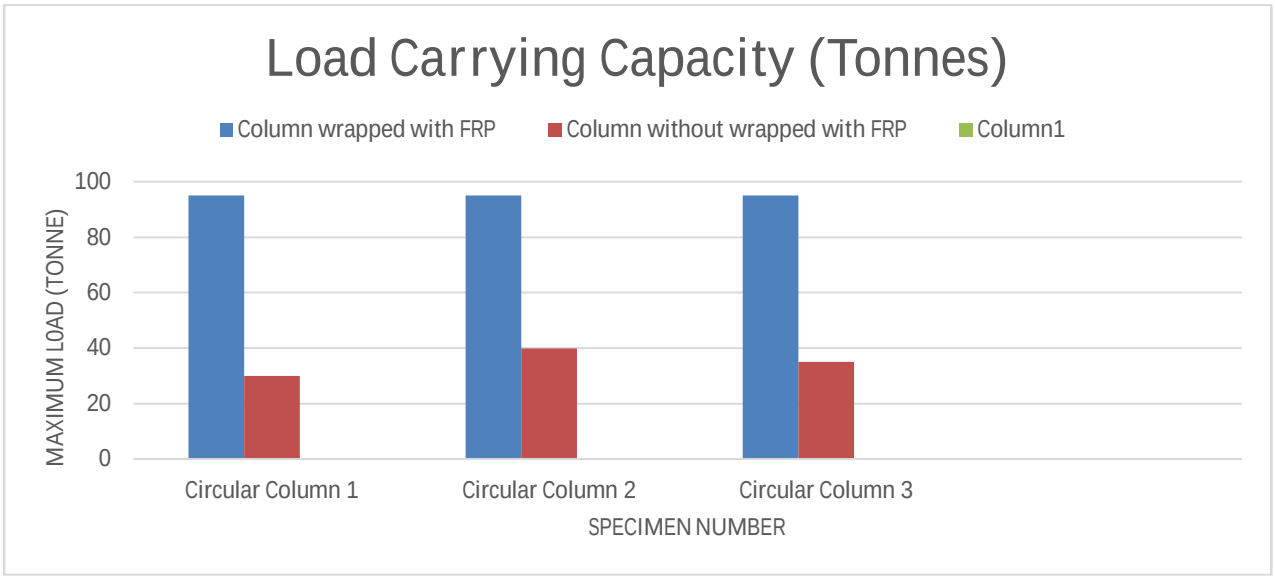
Application of Solution and FRP to Columns

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B. Experimental Results

Geometry	Group Cross Section	Specimen	Confinement condition	Maximum load (Tonne)	Crack Conditions
Circular	150 mm Dia	CC1	No wrapping	30	cracks at bottom surface
		CC2		30	cracks over entire length
		CC3		35	cracks at top surface
Circular	150 mm Dia.	CCF1	1 layer of 900 GSM GFRP	95	No any crack observed
		CCF2		95	
		CCF3		95	
Square	150X150	SC1	No wrapping	35	Bottom crack
		SC2		30	Bottom crack
		SC3		40	Top crack
Square	150X150	SCF1	1 layer of 900 GSM GFRP	95	No any crack observed
		SCF2		95	
		SCF3		95	





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C. Software Analysis

Total 12 RCC column specimens were casted. Six columns were of circular cross section and Six were of square cross section. Out of this 6 columns 3 were wrapped with FRP and other three were control specimens. Control specimens of circular and square cross section were modelled as axially loaded columns. Other 3 specimens of circular and square cross section were modeled as columns wrapped with FRP by wet-layup method and loaded axially. Concrete was modeled as SOLID 65 whereas longitudinal and transverse steel modeled as LINK 8. FRP sheets were modeled as SOLID 45.SOLID 65 was selected because this concrete material model can predict the failure of brittle material. LINK 8 was selected to model steel material to taken into account stress strain behavior of steel. Cross sectional details of each column were shown in figures below.

D. Element Type

As per aforementioned information, concrete was modeled as SOLID 65. Steel reinforcement was modeled as LINK 8 element type. The steel for the finite element model was assumed to be an elastic-perfectly plastic material and identical in tension and compression. SOLID 45 Element was used for FRP Sheets which is an 8 noded brick element having three degrees of freedom at each node translational in x,y and z directions. The finite element analysis calibration study included modelling a reinforced concrete column with the dimensions and properties corresponding to analytical column. The material type and the corresponding element type are shown in following table.

Element types for model

Material type	Element type
Concrete	SOLID 65
Reinforcing steel	LINK 8
FRP Sheet	SOLID 45

E. Material Properties

Following are the material properties entered in ANSYS

a) Concrete

Property	Value	Unit
Specific Compressive strength	25	N/mm^2
Modulus of Elasticity	2.5×10^4	N/mm^2
Poisson's Ratio	0.2	

b) Reinforcing steel

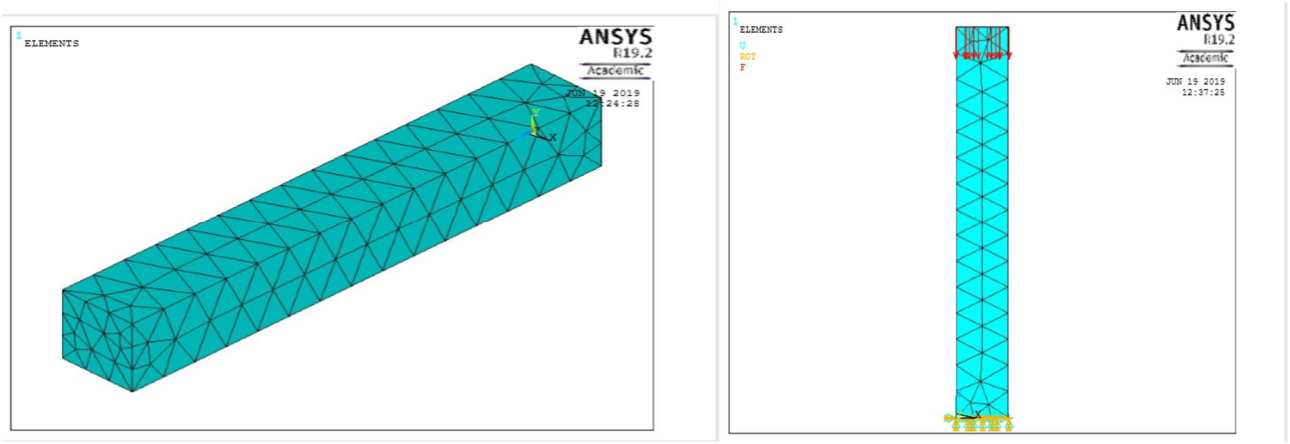
Property	Value	Unit
Yield strength	415	N/mm^2
Modulus of Elasticity	2.1×10^5	N/mm^2
Poisson's Ratio	0.2	

c) Glass Fiber sheet

Property	Value	Unit
Tensile strength	3500	N/mm^2
Modulus of Elasticity	70,000	N/mm^2
Thickness of GFRP	0.348	mm
Poisson's Ratio	0.25	

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F. Meshing



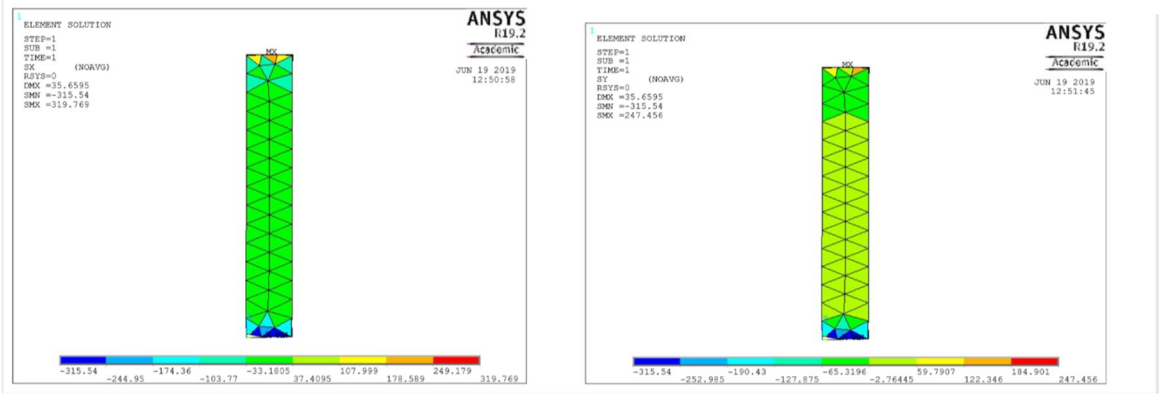
Meshing was done by setting mesh attributes under meshing option and then by using mesh tool the Column was meshed. As shown in fig

1) Support conditions In order to represent the actual behavior the column was supported and the respective boundary conditions were provided. By restraining All DOF at the base the necessary end condition was achieved.

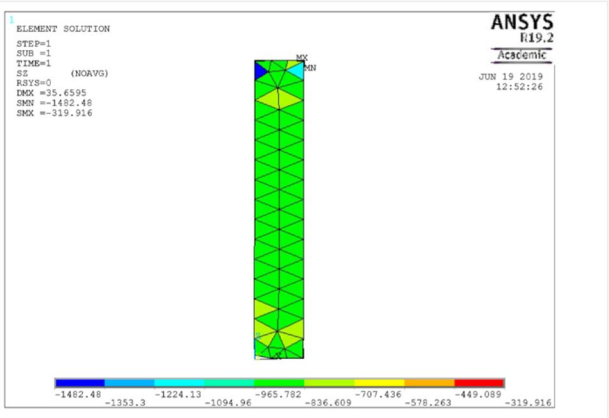
2) Loading Ultimate load bearing capacity of column specimen was calculated by using design guidelines provided IS 456-2000. This ultimate load is applied as axial load on column in order to consider behavior of Column under this load.

V. ANSYS RESULT

A. Elemental Solution



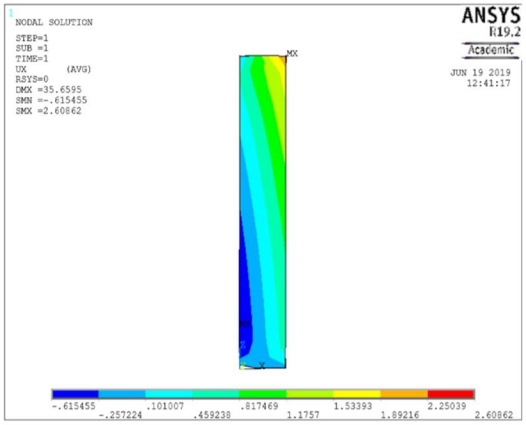
X Component Solution Y Component Solution



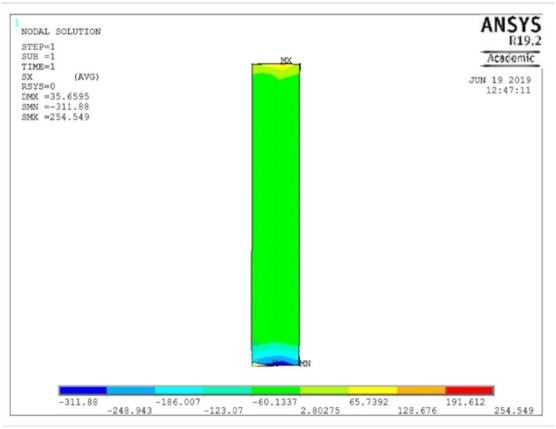
Z Component Solution

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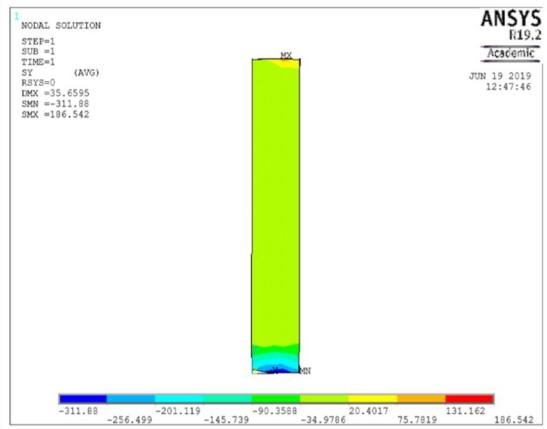
B. Nodal Solution



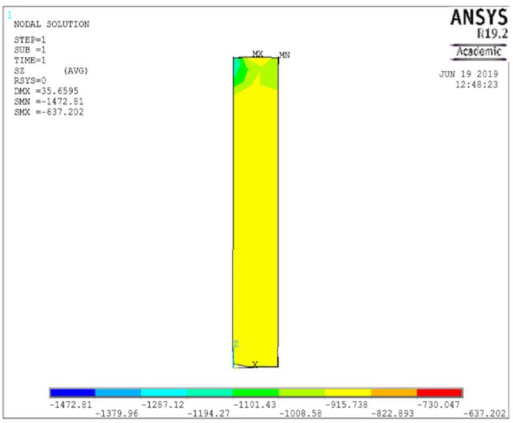
Displacement



X Component Solution

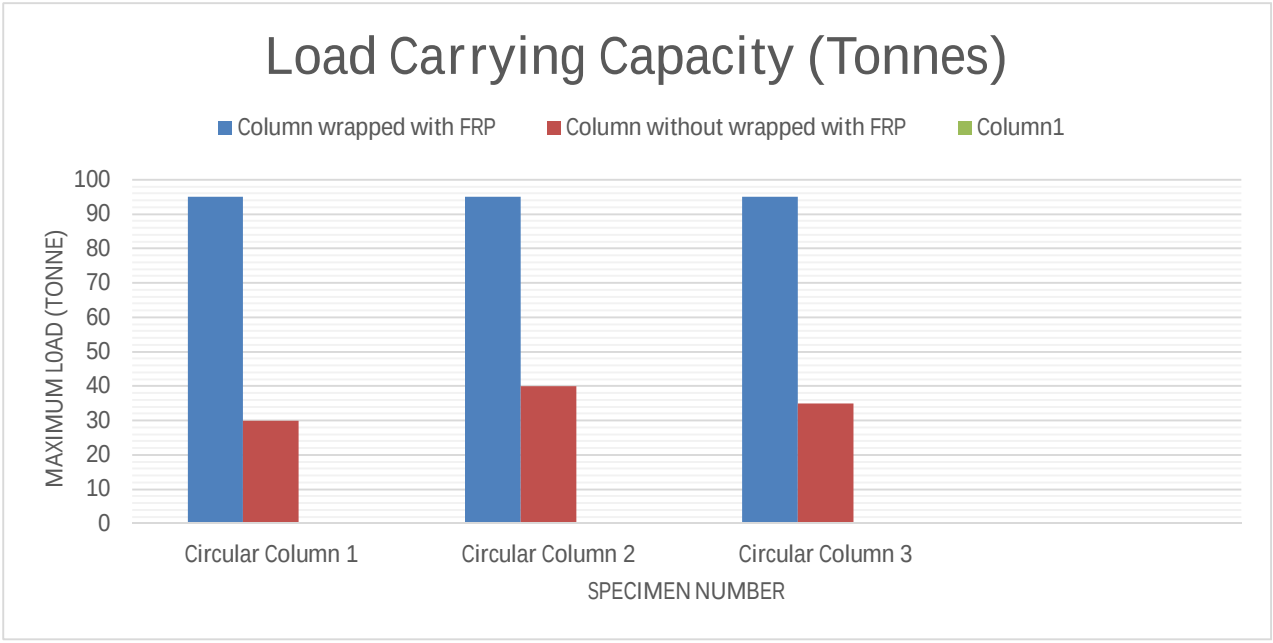


Y Component Solution



Z Component Solution

VI. COMPARISON OF EXPERIEMENTAL RESULT AND SOFTWARE RESULT.



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VII. CONCLUSION

In the present work, three dimensional finite element analysis of Fiber reinforced concrete column using commercial software ANSYS is presented. And also the experimental study is carried out from study following conclusion can be drawn
The results of the Column wrapped with FRP and Column wrapped without FRP.

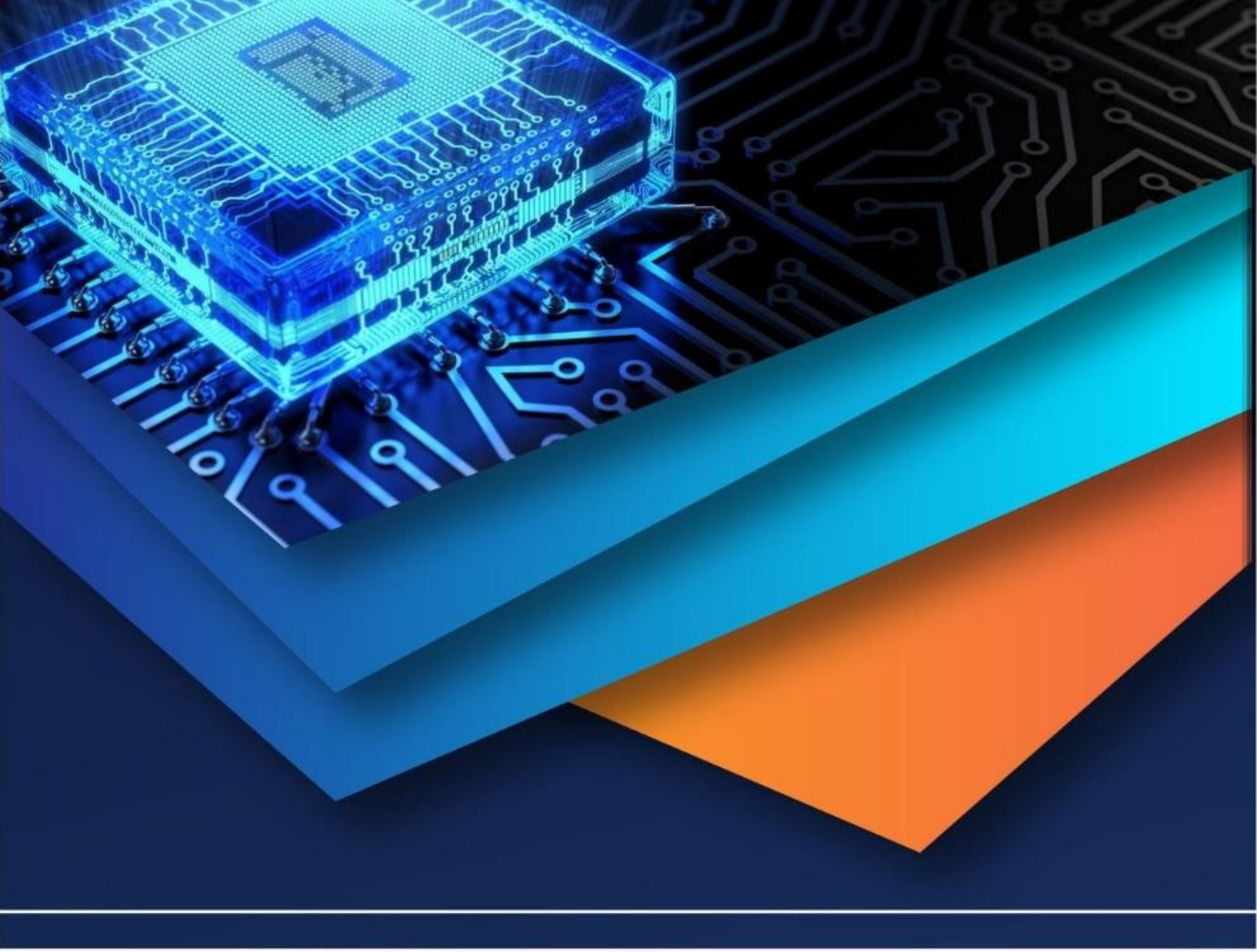
A. Results obtained for Fiber reinforced concrete column is validated by comparing it with experimental and software result. The result reveals the response obtained by Ansys are close to Experimental study for given loading condition and deflection.

B. Previous studies shows the considerable improvement in strength of column as FRP strengthening system are light weight non offsetting non corrodible strengthening techniques

REFERENCES

[1] Poonam A. Patil and Prof. G.R. Patil. "Analysis of Column Retrofitted with Fiber Reinforced Polymer in Civil Infrastructure." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684, p-ISSN: 2320–334X, PP 40-45
[2] Richelle Gallardo Zafra and Kazuhiko Kawashima. "Analysis of Carbon Fiber Sheet Retrofitted RC Bridge Columns."
[3] N.G. SHRIVE, Killam Memorial Professor, Department of Civil Engineering, University of Calgary, Alberta CANADA "Use of Fiber Reinforced Polymers to Improve Seismic Resistance of Masonry."
[4] Nicolae Ţă Ranu*, Ciprian-Ilie Cozmanciuc and Ruxandra Oltean. "Experimental Study of Reinforced Concrete Columns Confined with Composite Membranes." Buletinul Institutului Politehnic Din Iaşi, Publicat De Universitatea Tehnică, Gheorghe Asachi" Din Iaşi, Tomul Liv (Lviii), Fasc. 3, 2011 Secţia Construcţii. Arhitectură
[5] Owais Farooq & Syed Zakir Hussian. "Retrofitting of Columns Using Hybrid Fiber Reinforced Epoxy Composite Laminates (HFRECL)." Imperial Journal of Interdisciplinary Research (IJIR), Vol-3, Issue-1, 2017, ISSN: 2454-1362.
[6] Richard D. Iacobucci et.al., (2003). "Retrofit of Square Concrete Columns with Carbon Fiber-Reinforced Polymer for Seismic Resistance."
[7] H. Katsumata, et.al, "seismic retrofitting technique using carbon fibres for reinforced concrete buildings." Fracture Mechanics Of Concrete Structures, Proceedings FRAMCOS-3, AEDIFICATIO Publishers.
[8] R. Sudhakar and Dr. P. Partheeban "Strengthening of RCC Column Using Glass Fibre Reinforced Polymer (GFRP) ".
[9] Toshiyuki Kanakubo (1999) "Study on Structural Performance of Reinforced Concrete Columns with Waist-High Walls Strengthened by Carbon Fibre Reinforced Plastic Sheets."
[10] Priyanka Sarker et.al, "overview of Fiber reinforced polymers for structural retrofitting". Journal of Civil Engineering (IEB), 39 (1) (2011) 49-57.
[11] C. S. Lewangamage et.al. "Study on Reinforced Concrete Columns Partially Confined with Carbon Fibre Reinforced Polymer (CFRP)"
[12] Heang-Kilee. "Overview of Sprayed FRP Retrofitting and Strengthening of RC Structures."2007
[13] J.G Teng. " An overview on some recent research on FRP composites in structures."2009.
S.K. Sheikh. "seismic upgrade of concrete columns". CD2-KN04

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