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Non Linear Fem Analysis of Palmyra Palmfiber and Maguey Fiber Reinforced Concrete Beam Using Ansys R15.0

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ABSTRACT—

The conventional concrete is widely used construction material, which is very good in carrying compressive forces and weak in carrying tension. To enhance the concrete good in tension, discrete fibres can be included to it to some extent. Experimental based analysis has been widely used as a means to find out the response of individual elements of structure. To study these components finite element analyses are now widely used and become the choice of modern engineering tools for the researcher. In this thesis, investigation and evaluation on the use of finite element method for the analysis of Fibre Reinforced Concrete beam subjected to loading has been done. With the investigation it is found that when Borassusflabllifer (Palmyra Palm) fibre is used, the more strength to a beam is given when 1% of the fibre is added to volume fraction of beam, while when Agave Americana (Maguey) fibre is used, the more strength to a beam is given when 2% of the fibre is added to volume fraction of the beam. The finite and fibre reinforced beams were tested experimentally in the laboratory, and the analysis were carried out by ANSYS R15.0 by using the same material properties. The experimental result and analysis show that the fibre reinforced concrete beam using Palmyra Palm fibre is found to give more strength among the three reinforced concrete beams.

Keywords—FRC, Palmfibre, Maguey Fibre, Ansys R15.0.

I. INTRODUCTION

Different methods have been utilized to study the response of structural components. Experimental based testing has been widely used as a means to analyze individual elements and the effects of concrete strength under loading. While this is a method that produces real life response, it is extremely time consuming, and the use of materials can be quite costly. The use of finite element analysis to study these components has also been used. Unfortunately, early attempts to accomplish this were also very time consuming and infeasible using existing software and hardware. In recent years, however, the use of finite element analysis has increased due to progressing knowledge and capabilities of computer software and hardware. It has now become the choice method to analyze concrete structural components. The use of computer software to model these elements is much faster, and extremely cost effective. By understanding the use of finite element packages, more efficient and better analyses can be made to fully understand the response of individual structural components and their contribution to a structure as a whole.

This thesis is a study the behavior of fibre reinforced concrete Structural Beam's using finite element analysis. The main objectives of the proposed work are (i) to investigate and evaluate the use of the finite element method for the analysis of Fiber Reinforced Concrete beams, (ii) to study on behavior importance gained analytical procedures related to fibre added reinforced concrete structural beams and also the finite element modelling of that, (iii) to study experimentally on the ultimate compressive load on the reinforced concrete beam specimens, and (iv) to study the ultimate compressive strength, behavior of beams and crack pattern of Fiber Reinforced Concrete beam by means of finite element modelling using ANSYS.

II. REVIEW OF LITERATURES

Gregory Marvin Garrick B.S had presented a paper on "Analysis and Testing of Waste Tire Fiber Modified Concrete". In this project, it could find a noticeable decline inthe compressive strength of the concrete and there was an increase in the toughness of the concrete. It was concluded that waste tire fibers were more suitable as additives than waste tire chips since they produced the highest toughness. An analytical model was also performed and it was concluded that ultimate tensile strength of concrete is very important as it is the property that is responsible for the failure of concrete even in compression. This project had also done a three-dimensional finite element analysis using ANSYS. Results obtained from this analysis were used to determine the critical fiber length. The models were able to predict a value of ultimate tensile strength that was very close to the experimental result obtained. It was able to absorb more energy when loaded than the control sample. Owing to the fibers bridging over the cracks, the crack opening width can be controlled. In addition the three dimensional distribution of fibers in concrete provides the reinforced concrete with improved performance in all

directions. Waste tire modified concrete failed in a ductile manner rather than a brittle manner. The project hence states that with waste tire as fibers performed better than those with chips thus, waste tires should be used as fibers instead of chips.

MortezaNaghipour,MarziehNemati,Hossein Mohammadi -Doostdar and Reza Fooladvandhave presented a paper on Modeling and Experimental Studies on Pre-Loaded Reinforced Concrete Beams Strengthened by External

Reinforcement. In this project, in order to investigate the effect of fortification on cracked reinforced concrete beams, numbers of reinforced concrete beams were selected for testing. They have examined the strengthening by attaching external reinforcing bars on both sides of the beams, at the level of internal flexural tensile reinforcement and by means of deflectors. Here, they carried out the investigation through experimental data analysis and modeling using ANSYS finite element structural software. In this thesis, it is found that the method of fortification used has increased the flexural capacity of the beams. It has also shown that this method is suitable for strengthening of beams under their dead loads. P. Jayajothi presents the nonlinear Finite Element Analysis (FEA) that has been carried out to simulate the behaviour of failure modes of Reinforced Concrete (RC) beams strengthened in flexure and shear by Fibre Reinforced Polymer (FRP) laminates. From the analyses the load deflection relationships until failure, and crack patterns were obtained and compared with the experimental results which were available. The load deflection plots obtained from numerical studies has shown good agreement with the experimental plots reported early. There was a difference in behavior between the RC beams strengthened with and without CFRP layers. The crack patterns obtained in FEA in the beams were also presented.

Gregory Marvin Garrick had presented an experiments were conducted to determine how the properties of concrete were affected by the inclusion of waste tires. They found a noticeable decline in the compressive strength of the concrete and increase in the toughness of the concrete. It also shown a result that waste tire fibers were more suitable as additives than waste tire chips since they produced the highest toughness. An analytical model was performed to determine how properties such as the critical fiber length affect the ultimate tensile strength of the composite. This has shown that a value of ultimate tensile strength that was very close to the experimental result obtained. Using coir fibre in civil construction reduces environmental pollution factors and may also bring several improvements in concrete characteristics. Coir fibre used in cement improves the resistance of concrete from sulphate attack. Compressive strength is also improved up to certain percentage. Addition of coir fibre also arrests the micro cracks present in the concrete.

III. EXPERIMENTAL INVESTIGATION AND ANSYS 15.0 Initially, basic tests were conducted for fine aggregate,

coarse aggregate and cement to check their suitability for concrete making. The specimens were casted by adding two different fibers, viz. Palmyra Palm fiber and Maguey fiber each at various proportions of 0%, 1%, 2% to the determine mix design of grade M30 as per IS code. The various tests such as compression test, split tensile test, and flexural tests were carried out on the specimens for 28 days curing from which optimum content is derived from their mechanical properties experimentally in laboratory. Same models with same material properties are also analyzed using ANSYS

R.15. The experimental results obtained and the analysis by ANSYS is compared.

A. Experimental Investigation

Mix design is the process of selecting suitable ingredients of concrete and determining their relative proportion with the object of producing concrete of certain minimum strength and durability as economically as possible. The mix design of grade (M30) concrete were determined and the mix was designed. Trial mixes were made, tested and final mix proportion is arrived.

For obtaining flexure behavior of RC beams, beam of size 100×200×1500mm were casted in wooden moulds to maintain the dimension of the beam in the laboratory. The bottom flexural reinforcement consisted of two numbers of 12mm diameter bars providing a total cross section of 226.19mm2 and the top.

TABLE I. MIX PROPORTION

Concrete	Water	Cement	Fine Aggregate	Coarse Aggregate	Fiber
CRCB	0.428	1	1.177	2.321	0
PPFRCB -01	0.428	1	1.170	2.218	0.0095
MFRCB- 02	0.428	1	1.171	2.219	0.0089

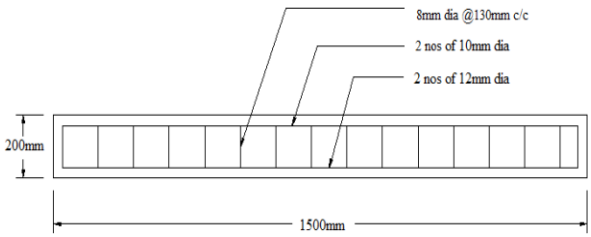

FIG I. LONGITUDINAL REINFORCEMENT OF BEAM

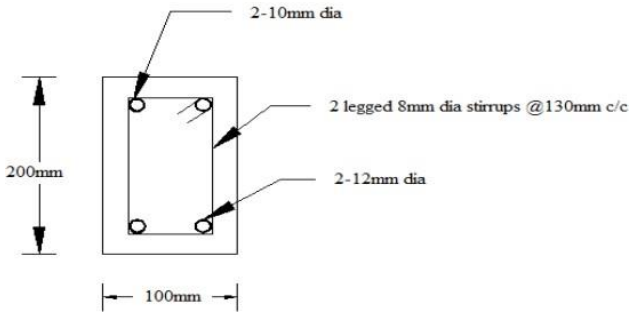

FIG II. REINFORCEMENT DETAILS FOR BEAM CROSS SECTION

B. Test Setup

• Flexural strength tests are carried out at the age of 28 days on 100 x 200 x 1500 beam specimen using 500 KN loading frame by subjecting the specimen to two point loading to determine the flexural strength.

• A total of nine beams were cast. Out, three was conventional reinforced concrete beam, three was 1% Palmyra palm fiber reinforced beam and the other three was 2% Maguey fiber reinforced beam. Each beam specimen was tested on a effective span of 1200mm under a simply supported condition. The beam was loaded by two concentrated load by means of a I section to provide a load on pure bending region in the central portion of the beam. Loading was applied by means of 40 ton hydraulic jack. Load is given at 2.45kN interval. Dial gauge of sensitivity 0.01mm were used to measure the deflection of beams at the mid span. The strain gauge was used to determine the strains at the top most concrete fiber of beam and strain at centroid

of tension steel at bottom of the beam at mid span section with sensitivity of 0.002m. The crack patterns were also recorded at every load increment. All the beams were tested up to failure.

C. Analysis trough Ansys 15.0

Investigations on compressive strength for cube, split tensile strength for cylinder and flexural strength for prism are carried out through ANSYS R.15 for comparing them with experimental values. The ultimate strength of beams, behavior of beam and crack patterns are also investigated through ANSYS R.15 for comparing ultimate strength with experimental values.

TABLE II. MIX FOR SPECIMENS OF ANSYS 15.0 MODEL OF THE SPECIMEN

CATEGORIES	***ANSYS 15.0 MODEL DETAILS***	
Types of elements		
Concrete	Solid 3D, concrete 65	
Material properties For M30 Concrete		
Specific name	**Modulus of Elasticity EC(MPa)**	**Poisson'sratio**
CC	28861.7393	0.160
PPFRC-01	31855.1408	0.190
PPFRC-02	29342.8015	0.210
MFRC-01	30182.7765	0.200
MFRC-02	30967.7250	0.220
Model descriptions		
Size of cube	150(L)x150(B)x150(H) mm	
Size of cylinder	150(D)x300(H) mm	
Size of prism	500(L)x100(B)x100(H) mm	

The compressive strength for cube, split tensile strength for cylinder and flexural strength for prism are found through ANSYS 15.0. The greatest strength is found when using the PPFRC-01 specimen. Hence,the greatest strength is found in the test models of cube, cylinder and prism when they are provided with the specimen PPFRC-01.

D. Result of Ansys 15.0

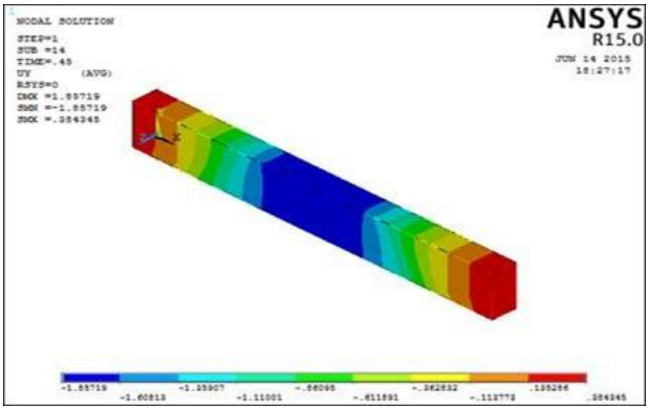

FIG III. DEFORMATION OF BEAMPPFRCB-01

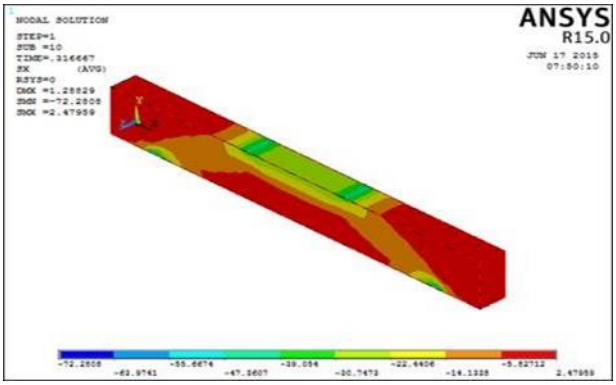

FIG IV. STRESS ALONG X DIRECTION OF PPFRCB-01

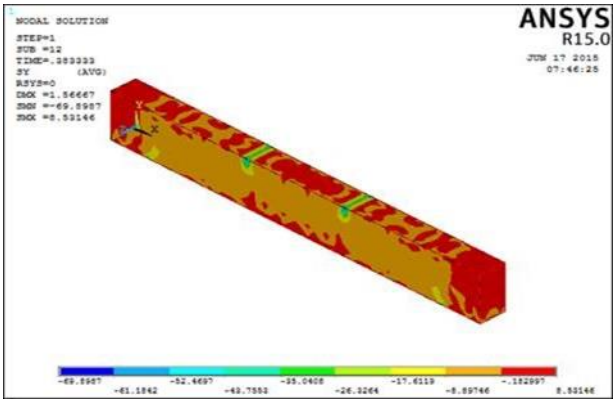

FIG V. STRESS ALONG Y DIRECTION OF PPFRCB-01

IV. DISCUSSION

The work is carried out to investigate and evaluate the use of the finite element method for the analysis of Fiber Reinforced Concrete beam subjected to loading. The result obtained experimentally is compared with that from ANSYS.

TABLE III. COMPARISON OF COMPRESSIVE STRENGTH TEST RESULTS

Specific name	**Experimental Results (MPa)**	**ANSYS 15.0 Results (MPa)**
CC	33.32	32.71
PPFRC-01	40.59	42.08
PPFRC-02	34.44	31.33
MFRC-01	36.44	33.00
MFRC-02	38.36	34.45

TABLE IV. COMPARISON OF SPLIT TENSILE STRENGTH TEST RESULTS

Specific name	**Experimental Results (MPa)**	**ANSYS 15.0 Results (MPa)**
CC	2.51	2.61
PPFRC-01	4.35	4.21
PPFRC-02	3.33	3.51
MFRC-01	2.67	2.29
MFRC-02	2.84	3.30

TABLE V.COMPARISON OF FLEXURAL STRENGTH TEST RESULTS

Specific name	**Experimental Results (MPa)**	**ANSYS 15.0 Results (MPa)**
CC	3.73	2.55
PPFRC-01	4.80	3.115
PPFRC-02	4.05	2.48
MFRC-01	2.66	2.78
MFRC-02	3.84	3.13

TABLE VI. COMPARISON OF ULTIMATE STRENGTH TEST RESULTS

Specific name	**Experimental Results (MPa)**	**ANSYS 15.0 Results (MPa)**
CRCB	56.41	58.80
PPFRCB-01	71.94	69.89
MFRCB-02	65.67	63.06

The important observations made through the experimental and non-linear analysis carried are highlighted below:

- The reinforced concrete with 1% volume fraction of the fiber added specimen is found to give more compressive, split tensile and flexural strength among the test specimens made with Palmyra Palm fiber.
- The reinforced concrete with 2% volume fraction of the fiber added specimen is found to give more compressive, split tensile and flexural strength among the test specimens made with Maguey fiber.
- The reinforced concrete with 1% volume fraction of Palmyra Palm fiber added is found to give ultimate load strength among all the test beams.

A. Scope for Future Research

The present study can be extended for future research with consideration to the following points:

- More accurate results can get by increasing the meshing.
- Modeling for other additives can also done by changing its material properties using ANSYS.
- Wrapping for other models can also done by changing wrapping materials by giving as input.

- Palmyra Plam Fiber is a new find to concrete, and hence it can be studied further by blending it with other natural and synthetic fibers forming hybrid fibers.
- The durability of Palmyra Plam fiber can be studied.

V. CONCLUSION

The optimum fiber content for Palmyra Palm Fiber was 1% by the weight of cement.

- Due to the crack resistance and brittle resistance of fiber, the strength of concrete tends to increase
- From the test results, it was found that as the volume of fiber increases, the strength parameters of concrete is also increased.

The ultimate strength is found to be more when Palmyra Palm fiber with 1% by the weight of cement was used for making beam..

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REFERENCES

1. Bathe.K.J (1995), 'Finite Element PrCCedures in Engineering Analysis', Prentice Hall.
2. Rao.S.S (1999), 'The Finite Element Method in Engineering', Pergamon Press.
3. Moaveni.S (1999), 'Finite Element Analysis – Theory and Application', Prentice Hall.
4. P.Seshu (2004), 'Finite Element Analysis', Prentice Hall of India Pvt. Ltd., New Delhi.
5. Antonio F. Barbosa and Gabriel O. Ribeiro (1998), „Analysis of reinforced concrete structures using ansys nonlinear concrete model', Federal University of Minas Gerais.
6. P. Fanning (2001), „Nonlinear models of reinforced and post- tensioned concrete beams', Electronic Journal of Structural Engineering, University College Dublin Earlsfort Terrace, Dublin 2, Ireland.
7. Gregory marvingarrick, b.s., louisiana state university (2001), 'analysis and testing of waste tire fiber modified concrete'
8. MortezaNaghipour, MarziehNemati,HosseinMohammadi-Doostdar and Reza Fooladvand, (2013), 'Modeling and Experimental Studies on Pre-Loaded ReinforcedConcrete Beams Strengthened by External Reinforcement'
9. F. A. Fathelbab , M. S. Ramadan and A. Al-Tantawy (2011), 'Finite Element Modelling of Strengthened Simple Beams using FRP Techniques: A parametric Study'
10. Sreeja . M.D (2013), 'Behaviour of Steel Fibre Reinforced Concrete Beam under Cyclic Loading'.
11. R. Balamuralikrishnan and C. Antony Jeyasehar (2009), 'Flexural Behavior of RC Beams Strengthened with Carbon FiberReinforced Polymer (CFRP) Fabrics'
12. R. Srinivasan and k. Sathiya (2010), 'Flexural Behavior Of Reinforced ConcreteBeams Using Finite Element Analysis (Elastic Analysis)'.
13. Haider M. Abdul Hussein, Ahmed N. Mohammed(2013), 'Nonlinear Finite Element Analysis of ConcreteFilled Steel Tubes'
14. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
15. M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.