International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

COPY RIGHT

IJIEMR Transactions, online available on 4th Sept 2019. Link :http://www.ijiemr.org/downloads.php?vol=Volume-08&issue=ISSUE-09

Title **EXPERIMENTAL INVESTIGATION ON TENSILE STRENGTH OF EPOXY POLYMER COMPOSITE WITH FLY ASH AND FIBRES**

Volume 08, Issue 09, Pages: 1–9.

Paper Authors

MURALI SAGAR VARMA SAGI, K.VENKATESH

M.V.G.R. College of Engineering (Autonomous), Vizianagaram-535005 (A.P), India

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

EXPERIMENTAL INVESTIGATION ON TENSILE STRENGTH OF EPOXY POLYMER COMPOSITE WITH FLY ASH AND FIBRES

MURALI SAGAR VARMA SAGI (PH.D)[1], K.VENKATESH[2]
[1]Assistant professor, Department of Civil Engineering, M.V.G.R. College of Engineering (Autonomous), Vizianagaram-535005 (A.P), India. Mobile no: +919676918761,
[2]Post Graduate Student of Engineering, Department of Civil Engineering, M.V.G.R. College of Engineering (Autonomous), Vizianagaram-535005 (A.P), India. Mobile no: +918096276245s
[1]muralisagariitr@gmail.com,[2]venkatesh.kanakala111@gmail.com

ABSTRACT
The fiber reinforced polymer composite played a dominant role gives the strength and modulus of the structure. Many experimental works done on the addition of fibers to the epoxy polymer composite to enhance the mechanical properties, so that their practical applications will increase. CONCRIX fibers are special type of synthetic fibers with high bonding tensile strength. The present investigation is aimed at determining the effect of addition of CONCRIX fibers to the epoxy resin composite on tensile strength. In order to reduce the cost of the composite material, attempted to replace some amount of epoxy with flyash.It is observed that,Addition of CONCRIX fiber to the epoxy resin mixture showed increase in the tensile strength of the composite. 58.14% increase in tensile load carrying capacity is observed at 5% Volume fraction of thefibers. Similarly, displacement at peak load increased by 54.06% at 10% volume fraction of the Concrix fiber. It is concluded that, method of preparation of polymer composite has significant impact on the behaviour of the material.This work can be further extended by changing the method of sample preparation to avoid micro voids in the material which may be the reason for little improvement in the tensile strength of the composite.
Keywords: Concrix fiber, Polypropylene fiber,Epoxy and Hardener,Hybrid composites.

1. INTRODUCTION

The advantage of composite materials over conventional materials are having high specific strength, stiffness and fatigue characteristics of the structural design to be more versatile. By definition, composite materials are having two or more constituents with physically separable phases. Composites are the materials that comprise strong load carrying material imbedded in weaker material. Reinforcement provides strength and rigidity for helping structural load. Composites are proven that these are weight-saving materials. The reinforcement may be platelets, particles or fibers are usually added to improve the mechanical properties

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

such as stiffness, strength and toughness of the material. Popular fibers available as continuous filaments for use in high performance concrete are glass and carbon fibers.

2. LITERATURE REVIEW

M. Boopalan et al., (2013)studied the properties of epoxy composite reinforced with jute and banana fiber. The tensile, flexure and thermal tests are carried out using hybrid composites. From the study, the addition of banana fibers in jute fibers composite up to 50% weight will increase the mechanical and thermal properties of the material.

N. Venkateshwaran et al., (2012) studied the tensile strength and modulus of short, randomly oriented hybrid-natural fiber composite was found out experimentally and also predicted using the rule of hybrid mixture. Hybrid composites were prepared using banana/sisal fibers of different ratios, while overall fiber volume fraction was fixed as 0.4 of volume fraction. From the study, it was observed that the RoHM equation predicted tensile properties of hybrid composites are little higher than the experimental values. The change of formation of micro voids between fiber and matrix during the preparation of composites greatly influence the tensile properties.

Jingjing He (2018) studied the uniaxial tensile test of basalt/epoxy composite for different fiber volume fractions and different fiber orientations. It is observed that increasing the fiber angle reduces the performance of the material. Also found that, for a fixed orientation, tensile properties of the material increase with increase in fiber volume.

3. Objectives of the Work

The main objective of the work is to evaluate the tensile strength of fiber reinforced epoxy polymer composite with different types and different proportions of fibers.

TABLE-1

Basic parameters of polypropylene & Concrix fibers.

PARAMETERS	POLYPROPYLENE FIBERS	CONCRIX FIBERS
Specification	Microfiber	Bi-component macrofiber
Length	12mm	50mm
Tensile strength	392 N/mm^2	590 N/mm^2
Density	0.91 gm/c.c	0.91 gm/c.c
Colour	White	Yellow

3.1 Fabrication of specimen

Mould used in this work is made of well-seasoned teak wood of required dimensions. The fabrication of the composite material was carried out through hand lay-by technique. The moulds are cleaned and to avoid sticking of the material to the edges of the mould, polythene sheet is placed around the mould. After the mould is ready, the required materials are mixed in a bowl in required proportions and poured in the mould. Care has been taken to place the mixture in the mould within 15 minutes after adding all the ingredients.A weight is placed on top of the mould for one day. The sample is removed from the mould after 24 hours of

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

placing and cured for in air for another 7 days. The specimen is then tested in UTM by applying axial tension. The specimen failed in the gauge length only.

3.2 Testing of composite specimen

After preparation of the sample tensile test was conducte as per ASTM D638. A 20KN capacity UTM is used to apply axial tensile load on the specimen to test the tensile strength of the composite. The prepared sample before testing is shown in Fig.1

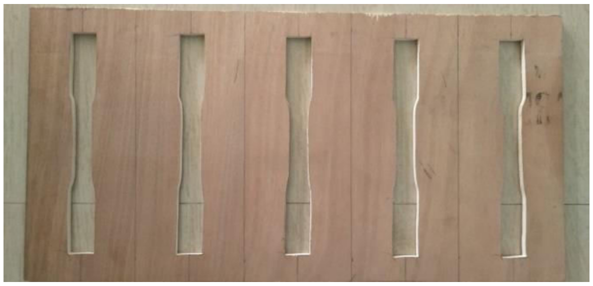


Figure 1 Dog-Bone shaped or dumbbell shaped specimen of 8mm thickness.

Figure 2 Actual dimension of the specimen

3.3 Sample calculation for material proportions

Proportions are calculated by two methods

- ➢ By weight
- ➢ By Volume

Calculations by weight proportions

Let us take the weight of the Mix be = W g.

Epoxy & Hardener should be in the ratio of 1:0.8

Total epoxy and hardener are 1+0.8=1.8

Weight of Epoxy to be added $=\frac{1}{1.8}\times W = 0.55\,W$g.

Weight of Hardener to be added $= \frac{0.8}{1.8} \times W$ =0.45 W g.

If you want to prepare mix for 30% Fly ash and 70% Epoxy hardener,

Weight of Epoxy to be added $=\frac{1}{1.8}\times W \times 0.7 = \ 0.38\,W$g.

Weight of Hardener to be added $= \frac{0.8}{1.8} \times W \times 0.7 = 0.32$ W g.

Weight of Fly ash to be added = 0.3 W g.

Calculations by the volumeproportions

Let the volume of the specimen is = V = 47.872cm^3

Increase 20% to account for losses (V) =1.2x47.872=57.45cm^3.

Let the percentage volume fraction of the fiber be V_f

Weight of the fiber to be mixed = W_f = $V_f \times V \times D_f/100$

Density of CONCRIXfibers(γ_f) =0.91gm/cc.

Calculation of Weights of Epoxy and Hardener

Density of Epoxy (γ_{epoxy}) = 1.17gm/cc.

Density of Hardener ($\gamma_{hardener}$) = 0.92gm/cc.

Ratio of Weight of Epoxy and Hardener is 1:0.8

Volume of Epoxy + Hardener = V-V_f

Let Volume of Epoxy be V_e

Volume of Hardener be $V_h = (V-V_f)- V_e$

Weight of Epoxy = $W_e = V_e/\gamma_e$

Weight of Hardener= $W_h = V_h/\gamma_h$

$W_e/W_h = 1/0.8$

$$\frac{\frac{V_e}{\Upsilon e}}{\frac{(V-Vf)-Ve}{\Upsilon h}} = \frac{1}{0.8}$$

$$Ve = \frac{\Upsilon e[V - V_f}{[\Upsilon_e - 0.8\Upsilon_h}$$

Weight of the Epoxy (W_e) = $\frac{(V_e)}{\Upsilon_e}$

Weight of the Hardener (W_h) = $\frac{(V_h)}{\Upsilon_h}$

4. RESULTS AND DISCUSSION

4.1 RESULTS SUMMARY

S.No	Specimen Category	Specimen Nomenclature	Peak Load (N)	Peak Stress (N/mm^2)	Max. Disp. At Peak Load (mm)	% Strain at Peak Stress
1.	A-1	A1-E	3927	20	7.14	19.875
2.	A-2	A2-EF-30-70	3060	6.5	3.6	7.20
		A2-EF-40-60	3070	9.4	4.4	8.55
		A2-EF-50-50	3110	13.5	5.5	29.00
		A2-EF-60-40	3310	16.5	6.5	5.625
		A2-EF-70-30	3320	16.80	10.1	6.60
3.	A-3	A3-EFI – 2.5%	5450	30.00	6.7	15.25
		A3-EFI - 3.75%	6320	30.00	7.2	13.40
		A3-EFI – 5%	6690	32.50	9.7	14.40
4.	A-4	A5-ECFI-5%	6210	29.25	10.4	20.30
		A5-ECFI-10%	5790	28.00	11	21.75
		A5-EPPFI-5%	2340	11.25	9.7	19.125
		A5-EPPFI-10%	3150	6.90	2.8	5.50
		A5-ECPPFI-5-5%	4380	21.25	10.3	20.625

A1, A2, A3, A4- Categories of Different Specimens

Where

A-1 - Pure Epoxy specimen

A-2 - Epoxy with different percentages (in weight) of Fly Ash

A-3 - Epoxy with Fibers placing parallel to mould in different amounts

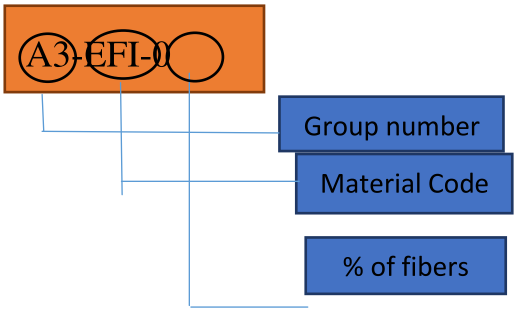
A-4 - Epoxy with CONCRIX fibers, Poly propylene fibers and Hybridization of fibers in volume fractions

Material Code

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

EFI – Epoxy and Fiber

Nomenclature of the specimens



E - Epoxy

EF - Epoxy with Fly ash

EFI - Epoxy with Fibers

ECFI Fibers - Epoxy with CONCRIX

EPPFI Fibers - Epoxy with Polypropylene

ECPPFI - Epoxy with CONCRIX and Polypropylene Fibers

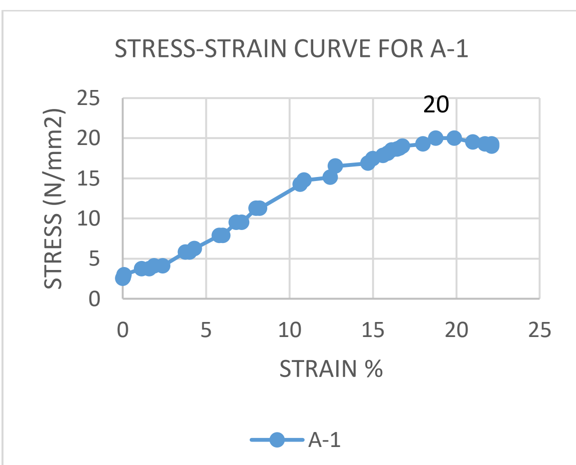


Figure 3 Pure epoxy without adding fiber

4.2 Comparison between A1 and A2 to check the effect of adding Fly ash in the mixture of Epoxy resin

Stress – Strain curve

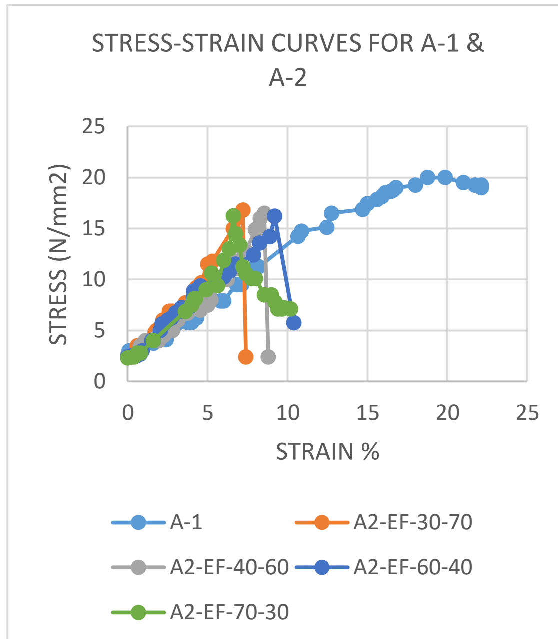


Figure 4 Stress-Strain curves for A-1 & A-2

From the stress strain curve shown in Fig 4, it is observed that, Specimen with pure epoxy resin showed ductile failure. Addition of higher amount of fly ash to the mixture, load carrying capacity reduced and also the failure pattern changes from ductile to brittle. Therefore, addition of fly ash to reduce the cost of polymer composite is not good idea.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

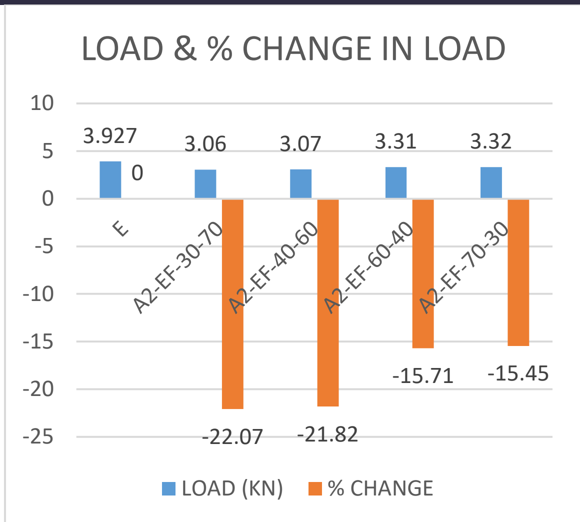


Figure 5 Load and % Change in Load for A-1 & A-2

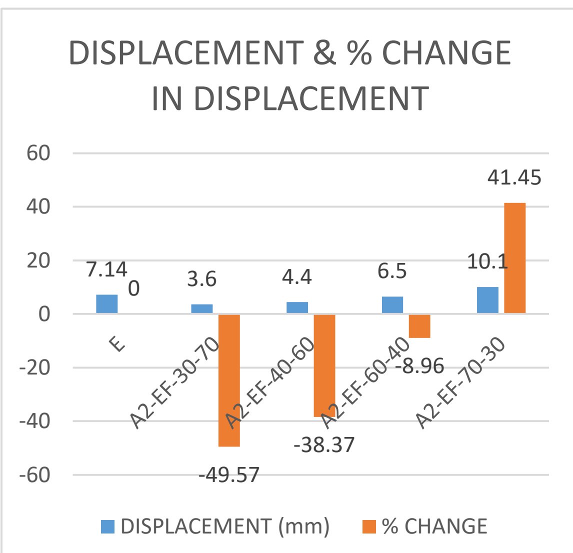


Figure 6 Displacement and % Change in Displacement for A-1 & A-2

It is observed that, load carrying capacity and displacement at peak load also reduced with increase in the fly ash content in polymer mix.

4.3Comparison between A1 and A3 to check the effect of adding Fibers in the mixture of Epoxy resin

Stress – Strain curve

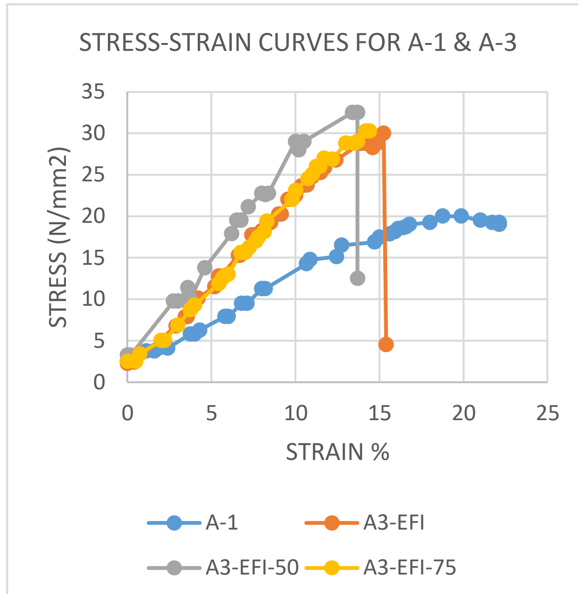


Figure 7 Stress-Strain curves for A-1 & A-3

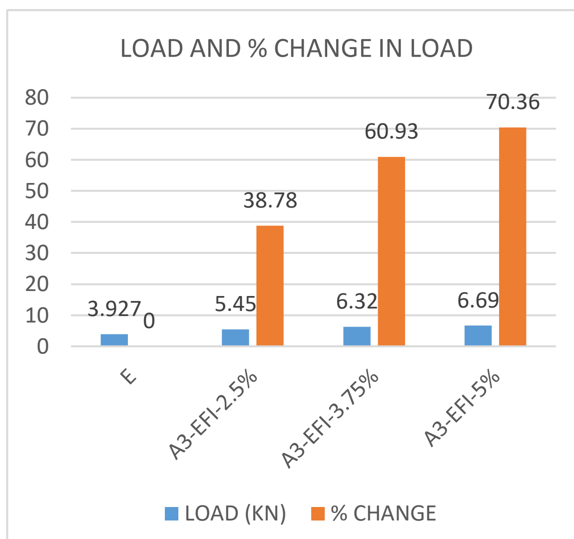


Figure 8 Load& % Change in Load for A-1 & A-3

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

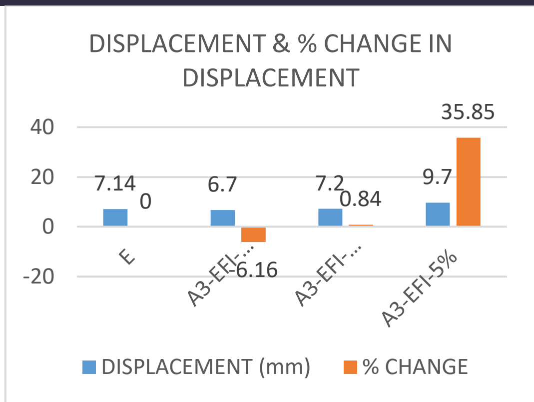


Figure 9 Displacement and % Change in Displacement for A-1 & A-3

In this group of specimens, fiber are placed physically at two levels in the entire thickness. As the fibers placed parallel to the axis of the specimen, load carrying capacity has increased with increase in fiber area in the cross section. The stress strain curve in the Fig.7 showed that, specimens with fibers failed suddenly after the peak load, while pure epoxy specimen showed ductile failure. This may be due to sudden transfer of the load from epoxy to fibers and failed after the peak load.

4.4-Comparison between A1 and A4 to check the effect of adding Fibers in different proportions of the mixture of Epoxy resin

Stress – Strain curve

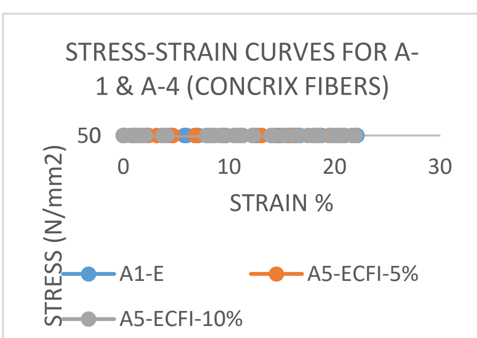


Figure 10 Stress-Strain curves for A-1 & A-4 (Concrix Fibers)

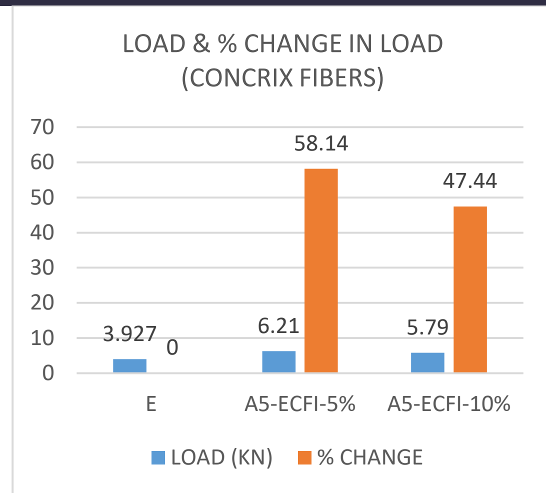


Figure 11 Load and % Change in Load for A-1 & A-4 (Concrix fiber)

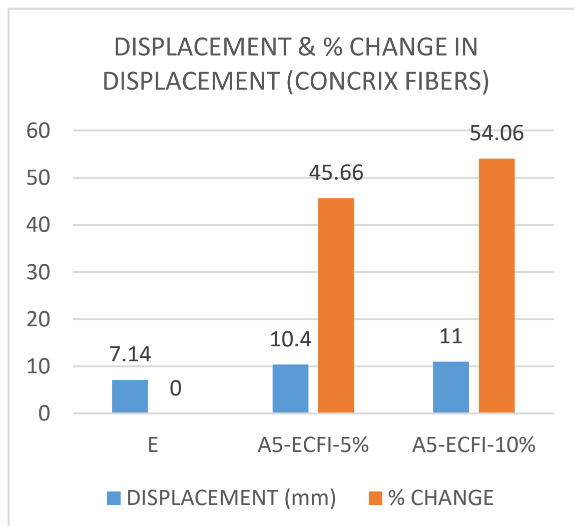


Figure 12 Displacement and % Change in Displacement for A-1 & A-4 (Concrix Fiber)

Fibers are mixed along with epoxy resin and cast the specimen in the same way as that of pure epoxy. It is observed that, addition of CONCRIX fibers to the mixture, the load carrying capacity and also peak displacement increased significantly.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

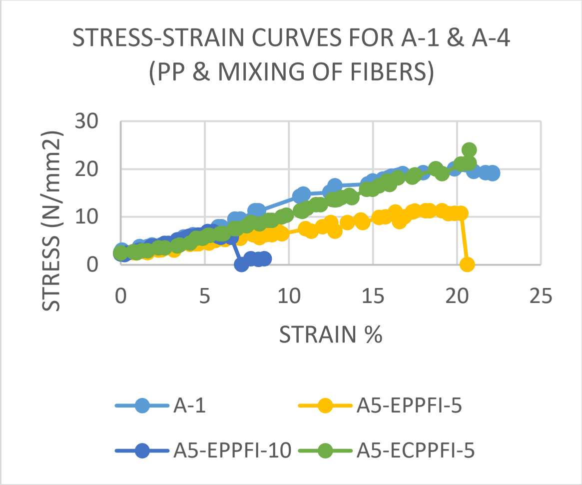


Figure 13 Stress-Strain curves for A-1 & A-4 (PP & Mixing of Fibers)

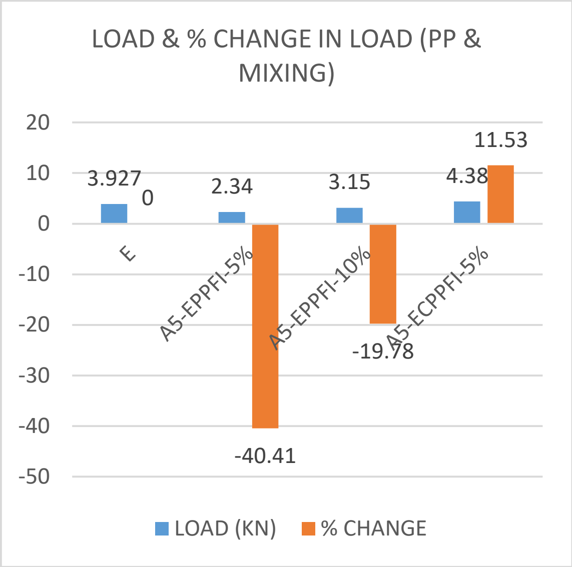


Figure 14 Load and % Change in Load for A-1 & A-4 (PP & Mixing of Fibers)

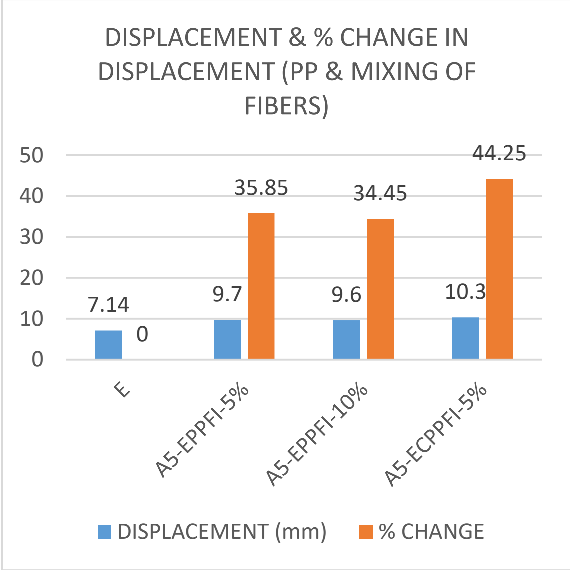


Figure 15 Displacement and % Change in Displacement for A-1 & A-4(PP & Mixing of Fiber)

It is observed that, addition of micro polypropylene fibers did not help in increasing load carrying capacity and also displacement.

Hybridization of CONCRIX macro and PP micro fibers showed better performance compared to mono fibers in the polymer composite.

5. CONCLUSIONS

1. The method of casting has vital role in the mechanical properties of polymer composites. In the present study, the mixture of epoxy resin was placed into the mould without any compaction. This leads to many pores in the specimen.

2. Placing of fibers parallel to the specimen axis improved load carrying capacity by 70.36% at 5% fiber area in the cross section. Increase in the displacement at the peak load is observed to be 35.85% at 5% fiber area in the cross section.

3. Cost of the epoxy resin composite can be reduced by adding flyash to the mixture and compensate the reduction in the tensile strength by adding fibers. It is observed that, 30% epoxy can be replaced by fly ash without loosing much of the tensile strength.

4. Addition of CONCRIX fiber to the epoxy resin mixture showed increase in the tensile strength of the composite. 58.14% increase in tensile load carrying capacity is observed at 5% Volume fraction of the the fibers. Similarly, displacement at peak load increased by 54.06% at 10% volume fraction of the Concrix fiber.

5. Addition of micro poly propylene fibers to the polymer composite reduced the tensile strength of the material. Hybridization of the macro CONCRIX and micro Polypropylene fibers showed 11.53% improvement in the tensile load carrying capacity.

6. Similar study can be carried out by changing the method of specimen preparation to avoid voids. Application of the above composite can be studied for retrofitting of the RC members.

REFERENCES

1. L. Laxmana Naik, Kavya H.M., K. Gopalakrishna, B.Yogesha, Tensile property evaluation of Sisal-Glass fiber reinforced polymer based composites, composite materials (2017).
2. Begum K. and Islam M.A. Natural fiber as a substitute to synthetic fiber in polymer composites: A Review, vol.2 (3), 46-53, April (2013).
3. S. L. BAI, R. K. Y. LI, L. C. M. WU, H. M. ZENG, Y. W. MAI, Tensile failure mechanism of sisal fibers in composites, Journal of material science letters 17 (1998).
4. P. J. Herrera-Franco, A.Valadez-Gonzalez, Mechanical properties of the continuous natural fibre-reinforced polymer composites: Part a 35 (2004) 339-345.
5. M. Boopalan, M. Niranjanaa, M.J. Umapathy, Study on the mechanical properties and thermal properties of jute and banana fiber reinforced epoxy hybrid composites: Part B 51(2013).
6. N. Venkateshwaran, A. Elayaperumal, G.K. Sathiya, Prediction of tensile properties of hybrid-natural fiber composite: Part B 43 (2012).
7. Jamal Mirbagheri, Mehdi Tajvidi, John C. Hermanson, Ismaeil Ghasemi, Tensile properties of wood flour/kenaf fiber polypropylene hybrid composites (2007).
8. Jingjing He, Junping Shi, Xiaoshan Cao and Yifeng Hu, Tensile mechanical properties and failure modes of a basalt fiber epoxy resin composite material: Reseach article (2014).
9. P. Dilleswara rao, D.Venkata rao, A. Lakshumu Naidu, MVA Raju Bahubalendruni, Mechanical properties of the banana fiber reinforeced composites and manufacturing techniques: A Review
10. H. Ku, H. Wang, N. Pattarachaiyakoop, M. Trada, A Review on tensile properties of natural fiber reinforced polymer composites/; Part B 42 (2011).