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Mechanical Characterization of Fiber Reinforced Glass Epoxy Hybrid Composite

[1] Naveen Kumar.A , [2] V.M.Mahesh, [3] G.Mallesh
[1] Assistant Professor, Department of Mechanical Engineering , BITS College , Narsampet, Warangal , Telangana, [2][3]Assistant Professor, Department of Mechanical Engineering , SJCE , Mysore , Karnataka .

Abstract: **-- This paper presents the study of mechanical properties of the composite reinforced with the slag and coconut shell powder. Composites have been developed by hand lay-up technique with different weight fractions of 0%,3%,6%,9%,12% of slag and coconut shell powder separate composite plates.9% of Coconut shell powder reinforced composite shows better tensile strength results when compared with the slag reinforced composite. From the XRD results, it is noticed that carbon content will be more of Coconut shell powder then slag. The flexural strength tends to increase up to 9% of reinforcement beyond the 9% material tends to exhibit brittleness. The addition slag exhibits higher impact strength when compared with coconut shell powder. Hardness number of composites increases with the addition of reinforcement.**

Index Terms - E-glass, Coconut shell powder (CSP), Slag

INTRODUCTION TO COMPOSITE

Composite is defined as "An anisotropic, heterogeneous medium, made by combining two or more materials with different properties. Composite properties are different they do not merge completely with each other and it is identified by physically interface between them. The properties of the interface also contribute to the properties of the composite". Composite - with light weight, low density, high strength to weight ratio, stiffness property and corrosion resistance have come a long way in replacing the conventional materials such as steel, aluminium, timber, etc. Now a day's composite are being used for the manufacturing of prefabricated, portable and modular buildings as well as for exterior cladding panels, which can simulate masonry or stone. In interior applications composites are used in the manufacturing of the shower enclosures, trays, bath, sinks, troughs and spas. Cast composites products are widely used for the production of vanity units, bench tops and basins. Owing to their good combination of properties, recently composites are widely used in automotive and aircraft industries in the manufacturing of Spaceships, sea vehicles,etc.

EXPERIMENTAL DETAILS

Fiber reinforced composites are composed of fibers and a matrix. Fibers are the reinforcement and the main source of strength while the matrix 'glues' all the fibers together in shape and transfers stresses between the reinforcing fibers. Fillers are added for the manufacturing composite material, to improve the properties of the material and to reduce the product cost by saving the matrix.

Materials Used

SI NO	CONTENT	MATERIAL
1	Reinforcement	E-Glass
2	Matrix	Epoxy LY- 556 with Hardner
3	Fillers	CSP, Slag

Sample Preparation

In the present work a composite sheet of 400 mm X 400 mm X 3 mm thick is fabricated using hand layup and bag molding process for different weight fractions of slag and coconut shell powder reinforced with glass fiber, epoxy resin. Mass of glass fiber, epoxy resin and mass of the fillers were calculated using equations as per their volume and density(Table 1, Table 1.1, Table 1.2).

Table: 1. Mass of glass, Epoxy and slag

Materials	Density	Volume	0%	3%	6%	9%	12%
			Mass (gm)	Mass (gm)	Mass (gm)	Mass (gm)	Mass (gm)
Glass Fiber	2.54	144	365.76	365.76	365.76	365.76	365.76
Epoxy Resign	1.15	336	386.4	369.84	353.28	336.72	320.16
Slag	2.8	-	0	40.32	80.64	120.96	161.28

Table: 1.1. Mass of glass, Epoxy and Coconut shell powder

Materials	Density	Volume	0%	3%	6%	9%	12%
			Mass (gm)	Mass (gm)	Mass (gm)	Mass (gm)	Mass (gm)
Glass Fiber	2.54	144	365.76	365.76	365.76	365.76	365.76
Epoxy Resign	1.15	336	386.4	369.84	353.28	336.72	320.16
CSP	0.7	-	0	10.08	20.16	30.24	40.32

Table: 1.2. Density of different materials used for manufacture of FRP composites.

Materials	Density (ρ) kg/m^3
E- glass	2.54
Slag	2.8
Coconut shell powder	0.7

List of Equations

Volume (v) = Length × Breadth × Thickness = 480000 mm^3

Volume of glass fiber (v_g) = $\frac{V}{100}$ × % of glass fiber

Volume of epoxy resin (v_s) = $\frac{V}{100}$ × % of epoxy resin

Volume of Filler (v_f) = $\frac{V}{100}$ × % of fille

Mass = Density × Volume = ρ× v = grams

Sample Calculation for the 3% of Slag

Volume v = 400×400×3 = 480000 mm^{3} = 480 cm^3

Volume of glass fiber (v_g) = $\frac{480}{100}$ × 30 = 144 cm^3

Volume of epoxy resin (v_s) = $\frac{480}{100}$ × 67 = 321.6 cm^3

Volume of Filler (v_f) = $\frac{480}{100}$ × 3 = 14.4 cm^3

Mass of glass fiber m_g = 2.54× 144 = 365.76 gm

Mass of epoxy resin m_s = 1.15×321.6 = 369.84 gm

Mass of filler m_f = 2.8×14.4 = 40.32 gm

Fabrication method

In this techniquefibers and resin are pre-mixed with curing agent are manually placed againstthe molding surface. While fabricating composite products with long fibers, reinforcing fibers in form of mats placed layer-by-layer over the surface, to ensure appropriate stackingsequence, as well as requisite thickness of the final product. Once a particular layer offiber is placed, it is coated with a layer of resin either through a spray gun, or through abrush. Care has to be taken to ensure that resin is devoid of air bubbles, as it is applied to reinforcing fibers. For this, serrated rollers may be used, which helps to remove air bubbles,as well as ensure increased wetting of fibers.

In this process the composite product is covered with a thin layer of randomly oriented fibers, known as surfacing mat. This layer provides a better surface finish to the product, and may also protect inside of composite against corrosion.

In this process, layers of fibers, impregnated with uncured resin, are laid on top of a mold, layer-by-layer. Once the layup is complete, the overallfiber stack up is covered with a flexible bag or diaphragm. The overall assembly is next subjected to external pressure andtemperature for purposes of reliably curing the resin in relatively shortperiod of time. Once curing is complete, constituent materials become one integratedmass in desired shape. They can subsequently trim, and finished.

Mechanical Properties

All the mechanical tests are conducted on the manufactured composite material as per the ASTM standards. The tensile test was conducted according to the ASTM 790 standard on computerized universal testing machine INSTRON H10KS. Flexural test were performed using 3-point bending test method according to ASTM D790-03.Impact strength determined by Izod impact test according to ASTM D 256. Shore- Durometer (Shore-D) instrument is used to determine the hardness of composite as the ASTM D2240 standard.

RESULTS AND DISCUSSION

In the results and discussion the mechanical properties are determined for both the composite material reinforced with the different fillers of slag and CSP. The results are compared and discussed with the Graphs and charts.

Tensile test

A series of tensile test were conducted as per the ASTM standards for the different weight fractions of slag and CSP, the results are recorded and discussed.

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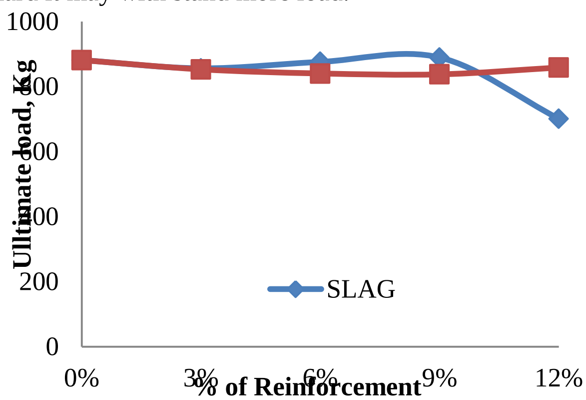
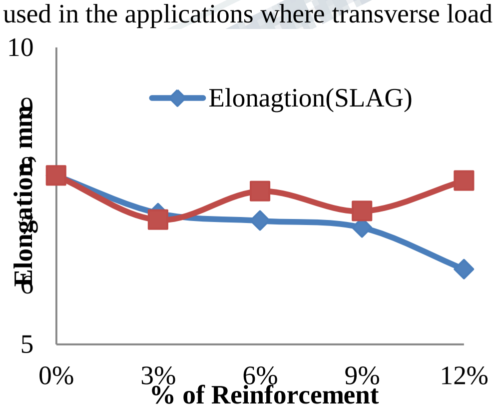
Maximum load carrying capacity of different weight fractions of slag and coconut shell powder is as shown in figure . It is observed that load carrying capacity increases with increase in the percentage of reinforcement of both slag as well as coconut shell powder up to 9%. Further load carrying capacity increases with addition of the coconut shell powder because from the XRD results it was noticed that percentage of carbon content is more when compared to slag hence coconut shell powered reinforced composite becomes hard it may with stand more load.

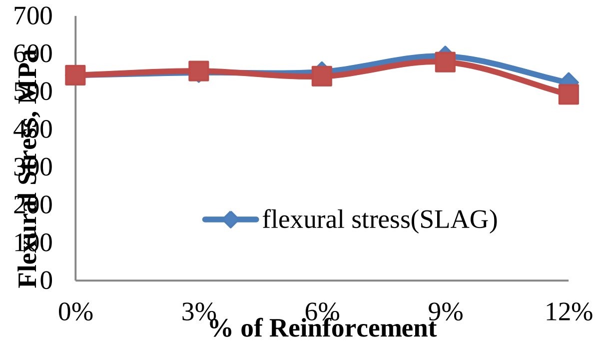


Flexural strength
Maximum bending load carrying capacity of different weight fractions of slag and CSP reinforced composite and it is noticed that load carrying capacity increases with increase in the percentage of reinforcement of both slag as well as coconut shell powder up to 9%.

The transverse deformation of different weight fractions of slag and CSP composite and observed that deformation in a CSP reinforced composite increases with increase in the content of the fillers. Similarly with increase in the percentage of slag, deformation decreases as compared to coconut shell powder hence slag filled composites can be used in the applications where transverse load is acting.

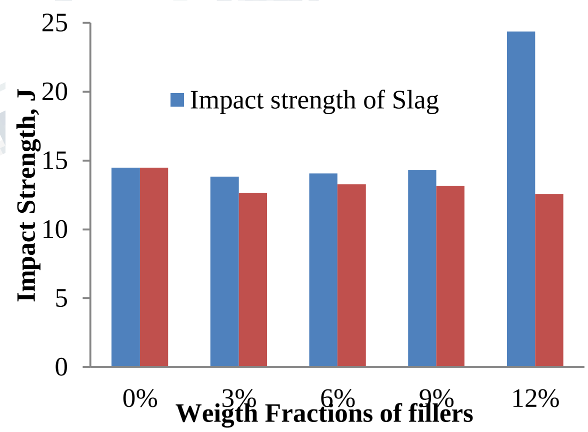


The comparison of flexural strength for different weight fraction of slag and coconut shell powder. The results revealed that as the percentage of reinforcement increases flexural strength also increases. The flexural strength tends to increases up to 9% of reinforcement beyond 9% the material tends to exhibit brittleness.



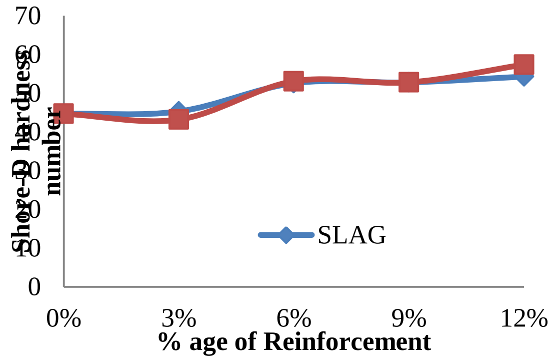
Impact Strength

Composite material exhibits higher impact strength when compared to unreinforced material. This clearly shows that better bonding strength was established when reinforcing material was added to the composite system. The addition of slag exhibits higher impact strength when compared with coconut shell powder.



Hardness strength

It is noticed that hardness number of slag compared to the coconut shell powder reinforced composites were enhanced with the addition of fillers this may be due to uniform dispersion of slag particles and decrease in inter particle distance in the matrix which results in increase of resistance of composites against indentation.



CONCLUSIONS

It is concluded that glass-epoxy composite reinforced with different weight fractions slag and coconut shell powder with a size of 400 mm X 400 mm X 3 mm plate were manufactured using hand layup and bag molding techniques with established literature survey. Composite plates were cut using electric hacksaw machine to conduct tensile, flexural, impact and hardness as per ASTM standards to study the mechanical characteristics of the composite fabricated Stress-strain variations of unreinforced composite and different weight fractions of slag and coconut shell powder were studied and inferred that as the reinforcement increases the resistance to the load is also increases for both slag and coconut shell powder. The flexural strength results revealed that as the percentage of reinforcement increases flexural strength also increases and noticed that in both the cases up to 9% of reinforcement beyond 9% the material exhibit brittleness phase. Composite Material exhibits higher impact strength when compared to unreinforced material. This clearly shows that better bonding strength was obtained when reinforcing material was added to the composite system. The addition of slag exhibits higher impact strength when compared with coconut shell powder. Hardness number of the composite increases with addition of reinforcement. Optimum hardness result obtained was for the coconut shell powder while compared with slag this is due to the fact that due to higher percentage of carbon content in the coconut shell powder.

REFERENCE

[1]. Bernd Wetzela, Frank Hauperta, Ming Qiu Zhangb "Epoxy Nano composites with high mechanical and Tribological performance" Composites Science and Technology 63 (2003) 2055–2067.

[2]. Kazuya Okubo, Toru Fujii, Yuzo Yamamoto"Development of bamboo-based polymer composites and their mechanical properties"K. Okubo et al. / Composites: Part A 35 (2004) 377–383378.

[3]. Feng-Hua Su , Zhao-Zhu Zhang , Wei-Min Liu "Tribological and mechanical properties of Nomex fabric composites filled with polyfluo 150 wax and nano-SiO2" Composites Science and Technology 67 (2007) 102–110

[4]. X.F. Yao , D. Zhou , H.Y. Yehb "Macro/microscopic fracture characterizations of SiO2/epoxy Nano composites" Aerospace Science and Technology 12 (2008) 223–230.

[5]. Manoj Singlal ,Vikas Chawla "Mechanical Properties of Epoxy Resin – Fly Ash Composite" Vol. 9, No.3, pp.199-210, 2010.

[6]. C.M. Manjunatha , A.C. Taylor , A.J. Kinloch , S. Sprenger "The tensile fatigue behaviour of a silica nanoparticle-modified glass fibre reinforced epoxy composite" Composites Science and Technology 70 (2010) 193–199.

[7]. M. Lai , K. Friedrich , J. Botsis , T. Burkhart "Evaluation of residual strains in epoxy with different Nano/micro-fillers using Embedded fiber Bragg grating sensor" Composites Science and Technology 70 (2010) 2168–2175

[8]. Sandhyarani Biswas, Alok Satapathy Amar Patnaik "Effect of Ceramic Fillers on Mechanical Properties of Bamboo Fiber Reinforced Epoxy Composites: A Comparative Study" Advanced Materials Research Vols. 123-125 (2010) pp 1031-1034.

[9]. Dr.G. Ramachandra Reddy , Dr.M. Ashok Kumar , K.V.P.Chakradhar "Fabrication and performance of hybrid Betel nut (Areca catechu) short fibre/ Sansevieria cylindrical (Agavaceae) epoxy composites" International Journal of Materials and Biomaterials Applications 2011; 1 (1): 6-13.

[10]. Goulart, S.A.S, Oliveira, T.A. Teixeira, Miléo, P.C. Mulinari, D. R. "Mechanical Behaviour of Polypropylene Reinforced Palm Fibers Composites" Procedia Engineering 10 (2011) 2034–2039

[11]. Sandeep Kumar, Bhabani K. Satapathy , Amar Patnaik "Thermo mechanical correlations to erosion performance of short glass/carbon fiber reinforced vinyl ester resin hybrid composites"Computational Materials Science 60 (2012) 250–260.

[12]. Ch.Ramesh , N.Jeevan Kumar, Malaga.Anil Kumar "Fabrication and Mechanical Properties of Iron Slag Matrix

Composite Materials" International Journal of Engineering Research and Development e-ISSN: 2278-067X, Volume 5, Issue 4 (December 2012), PP. 34-46 .

[13]. Wasim Akram, Sachin Kumar Chaturvedi,Syed Mazhar Ali "Comparative Study of Mechanical Properties Of E-Glass/Epoxy Composite Materials With Al2O3, CaCo3, SiO2 and PBO Fillers" International Journal of Engineering Research & Technology Vol. 2 Issue 7, July – 2013 ISSN: 2278-018

[14]. TimoJ. Lehtonenn, Jukka U.Tuominen, Elina Hiekkanen "Dissolution behaviour of high strength bioresorbable glass fibres manufactured by continuous fibre drawing" journal of the mechanical behaviour of biomedical materials 20 (2013) 376 -386.

[15]. R.Satheesh Raja, K.Manisekar , V.Manikandan "Effect of fly ash filler size on mechanical properties of polymer matrix composites" International Journal of Mining, Metallurgy & Mechanical Engineering (IJMMME) Volume 1, Issue 1 (2013) ISSN 2320–4060.

[16]. C.Chaithanyan, H.Venkatasubramanian, Dr. S.Raghuraman, T. Panneerselvam "Evaluation of Mechanical Properties of CoirSisal Reinforced Hybrid Composites Using Isophthalic Polyester Resin" IJIRSET Vol. 2, Issue 12, December 2013.

[17]. Sudeep Deshpande, T Rangaswamy "Effect of Fillers on E-Glass/Jute Fiber Reinforced Epoxy Composites" Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 8(Version 5), August 2014, pp.118-123.

[18]. RafahA.Nasif "Study the Effect of Fillers on the Glass Fiber Reinforced Composites" Engineering & Technology . Journal, Vol 32, Part(B), No.1,2014.

[19]. Ramesh K. Nayak, Alina Dash and B.C.Ray "Effect of epoxy modifiers (Al2O3/SiO2/TiO2) on mechanical performance of epoxy/glass fiber hybrid composites" Procedia Materials Science 6 (2014) 1359 – 1364.

[20]. Md Nadeem M , K Chandrashekara , Yathisha N, Rudramurthy "Study Of The Effects Of Carbon And Glass Fibre Reinforcement And Other Fillers On Elevated Temperature Resistant Properties Of Er Matrix Composites" International Journal of Research in Engineering and Technology eISSN:2319-1163 pISSN: 2321-7308 Volume: 03 Issue: 10 (Oct 2014).

[21]. S. Rajesh , B. Vijaya Ramnath, C.Elanchezhian, N.Aravind, V.Vijai Rahul, S. Sathish "Analysis of Mechanical Behaviour of Glass Fibre/ Al2O3- SiC Reinforced Polymer composites" Procedia Engineering 97 (2014) 598 – 606.

[22]. Arpitha G R, Sanjay M R, L Laxmana Naik, B Yogesha "Mechanical Properties of Epoxy Based Hybrid Composites Reinforced with Sisal/SIC/Glass Fibers" International Journal of Engineering Research and General Science Volume 2, Issue 5, ISSN 2091-2730,August-September, 2014.

[23]. Bhadrabasol Revappa Raju1, BheemappaSuresha, Ragera Parameshwarappa Swamy, Bannangadi Swamy Gowda Kanthraju "Investigations on Mechanical and Tribological Behaviour of Particulate Filled Glass Fabric Reinforced Epoxy Composites" Journal of Minerals and Materials
Characterization and Engineering, 2014, 1, 160-167.

[24]. Iskender Ozsoy1,Askin Demirkol, Abdullah Mimaroglu1 ,Huseyin Unal1, Zafer Demir "The Influence of Micro- and Nano-Filler Content on the Mechanical Properties of Epoxy Composites" Journal of Mechanical Engineering 61(2015)10, 601-609.

[25]. Vinay Kumar Patel, Anil Dhanola, "Influence of CaCO3,Al 2O3, and TiO2 micro fillers on physico-mechanical properties of Luffa cylindrical/polyester composites", Engineering Science and Technology, an International Journal (2015), doi: 10.1016/j.jestch.2015.10.005

[26]. Nikoloz M. Chikhradzea,b, Fernand D.S. Marquisc, Guram S. Abashidzeb "Hybrid fiber and Nano powder reinforced composites for wind turbine blades" jmaterres techno l .2015;4(1):60–67

[27]. B.Venkatesh "Fabrication and Testing of Coconut Shell Powder Reinforced Epoxy Composites" International Journal of Advance Engineering and Research Development (IJAERD) Volume 2, Issue 2, February -2015, e-ISSN: 2348 - 4470, print-ISSN: 2348-6406.

[28]. C. Venkateshwar Reddy , R.Ramnarayanan, P.Ramesh Babu "A Study On Effect Of Filler (Sio2) On Mechanical Properties Of Glass/Epoxy (Ht Cure) Composite" IJRET: Volume: 04 Special Issue: 08 | TIAMTE-2015 | Aug-2015.

[29]. Volkan Arikan , Onur Sayman “Comparative study on repeated impact response of E-glass fiber reinforced polypropylene & epoxy matrix composites” Composites Part B 83 (2015) 1e6

[30]. Vijay Baheti , Jiri Militky , Rajesh Mishra , B.K. Behera “Thermo mechanical properties of glass fabric/epoxy composites filled with fly ash” Composites Part B 85 (2016) 268e276.

[31]. Muruganantham. S, Chandramohan. V, Sankar. N “Experimental Analysis of Mechanical Properties in E-Glass Fiber Pipe” IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 08 | February 2016.