International Conference on Advances in Materials, Computing and Communication Technologies
In Association withInternational Journal of Scientific Research in Science and Technology
Volume 9 | Issue 1 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Coir Fibre & Glass Fibre Reinforced Epoxy Based Hybrid Composite

Akhil A[1], Anandu P R[1], V Ramkumar[2], Dr.V Manikandan[3]

[1]BE student, Department of Mechanical & Automation Engineering, PSN College Of Engineering & Technology, Tirunelveli, Tamil Nadu, India

[2]Professor, Department of Mechanical & Automation Engineering, PSN College Of Engineering & Technology, Tirunelveli, Tamil Nadu, India

[3]Principal, Department of Mechanical & Automation Engineering, PSN College Of Engineering & Technology, Tirunelveli, Tamil Nadu, India

ABSTRACT

Fibre reinforced polymer composites has been used in a variety of application because of their many advantages such as relatively low cost of production, easy to fabricate and superior strength compared to neat polymer resins. Reinforcement in polymer is either synthetic or natural. The objective of the project work is to study the physical and mechanical behaviour of coir/glass fibre reinforced epoxy-based hybrid composites. The project focuses on the effect of variation in the arrangement of fibre layers on the mechanical properties of the fabricated composites. Specimen is prepared with coir fibre and glass fibre as reinforcing material and epoxy resin as a matrix in the polymer composite. The arrangement of the coir fibre and glass fibre layers were changed and moulding was done by hand lay-up technique, keeping the mould closing as constant. The specimens were subjected to tensile strength, flexural strength and impact strength test and the failure of the composite was examined.

I. INTRODUCTION

A composite material (also called a composition material or shortened to composite, which is the common name) is a material which is produced from two or more constituent materials. These constituent materials have notably dissimilar chemical or physical properties and are merged to create a material with properties unlike the individual elements. Within the finished structure, the individual elements remain separate and distinct, distinguishing composites from mixtures and solid solutions. There are various reasons where new material can be favoured. Typical examples include materials which are less expensive, lighter or stronger when related to common materials. More recently researchers have also begun to actively include sensing, actuation, computation and communication into composites, which are known as Robotic Materials.

Composite materials are generally used for buildings, bridges, and structures such as boat hulls, swimming pool panels, racing car bodies, shower stalls, bathtubs, storage tanks, imitation granite and cultured marble sinks and countertops.

Concrete is the most common artificial composite material of all and typically consists of loose stones (aggregate) held with a matrix of cement. Concrete is an inexpensive material, and will not compress or shatter even under quite a large compressive force.

Epoxy Resin:

Epoxy Resin is used for the matrix of the composite. Epoxy resin is a low temperature curing resin. It consists of mainly two parts, the resin and the hardener. They are mixed at 2:1 weight ratio to obtain the optimum hardness once it is cured. The epoxy resin is clear resin and cures within 24 to 48 hours. Once the resin and hardener are mixed, an approximate time of 30 to 40 minutes is available for working before the resin starts curing. To prevent the resin from sticking on the mould, wax or plastic or certain chemicals have to be used. Thin plastic sheets are effective for this purpose and hence they are used.

Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols (usually called mercaptans). These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing.

The applications for epoxy-based materials are extensive and include coatings, adhesives and composite materials such as those using carbon fibre and fibreglass reinforcements (although polyester, vinyl ester, and other thermosetting resins are also used for glass-reinforced plastic). The chemistry of epoxies and the range of commercially available variations allows cure polymers to be produced with a very broad range of properties. In general, epoxies are known for their excellent adhesion, chemical and heat resistance, good-to-excellent mechanical properties and very good electrical insulating properties.

Fibre Reinforcement:

Fibre reinforced composites can be classified into four groups according to their matrices: metal matrix composites (MMCs), ceramic matrix composites (CMCs), carbon/carbon composites (C/C), and polymer matrix composites (PMCs) or polymeric composites. Matrix, which has the primary role of holding the reinforcement together, is considered also as resin especially in the case of polymers. PMCs, which distinguish from other types especially because of their light weightness, are further classified as thermoset, thermoplastic, and elastomeric composites. Thermosets have crosslinked polymer chains at the cure stage, which at the end leads to a rigid product that cannot be reshaped. Thermoplastics, unlike thermosets, can be further heated and remelted, which allows them to be reshaped as a new product and therefore recycled more broadly when compared to thermosets.

E-Glass fibres

Coir Fibre

II. EXPERIMENTAL TESTS:

A composite material made from two or more constituent materials like reinforcement (fibres, particles, flakes, and or fillers) and matrix (polymers, metals, or ceramics). Reinforcement in polymer is either synthetic or natural. Synthetic fibre such as glass, carbon etc. has high specific strength but their fields of application are limited due to higher cost of production. Recently there is an increase interest in natural fibre-based composites due to their many advantages, mainly cost of production.

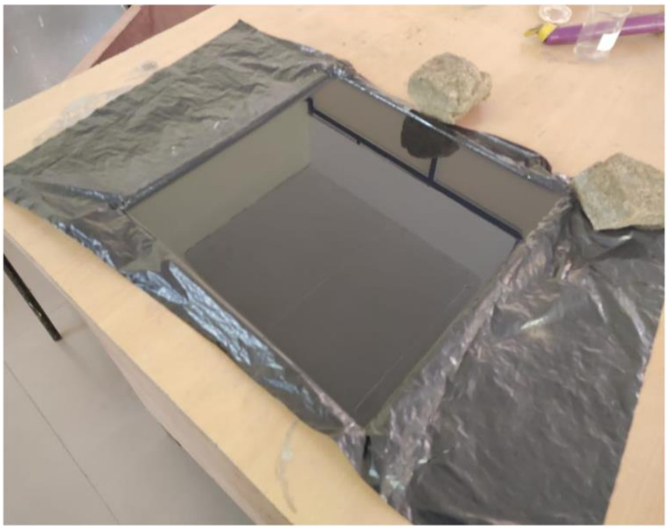
Among all reinforcing fibres, natural fibres have increased substantial importance as reinforcements in polymer matrix composites. Studies on cements and plastics reinforced with natural fibres such as coir, sisal, bamboo, jute, banana and wood fibres have been reported. The natural fibre coir is pull out from the husk of coconut and is mixed with E-glass fibres and Epoxy resin to make a composite.

The short coir fibre is collected from local sources and E-glass fibres and Epoxy resin is purchased from market is used for fabrication of composite. The low temperature curing epoxy resin and corresponding hardener are mixed in a ratio of 2:1 by weight as recommended. A mould of dimension 300 x 300 x 6mm is used for casting the composite slabs. The composites are prepared with three different layer compositions using simple hand lay-up technique. The mixture is poured into various moulds conforming to the requirements of various testing conditions and characterization standards.

As per test ASTM standards the tensile test of composites is done using Universal Testing Machine (ASTM D638). Impact test is done using IZOD impact test (ASTM D256). Flexural test is done using UTM (ASTM D790-98).

Fabrication:

A mould of dimension 300 x 300 x 6mm is used for casting the composite slabs. The mould is made of 3mm glass and 6mm wooden spacers. Polyethylene glycol or plastic sheets had to be used to prevent the epoxy resin from bonding with the glass plate. The fibres and the resin are sandwiched between the glass plates and a particular amount of load is applied for the compression of the fibres.



Mould

III. METHODOLOGY:

- Resin and hardener is weighed and mixed in the 2:1 ratio.
- The fabricated specimen has been made without adding any fibres and the weight of the resin has been calculated as 450 gms.
- A specimen is made by mixing the coir and glass fibre in a random manner along with the resin at

the calculated weight ratio of 90 wt% resin and 10 wt% of fibre.

- A specimen is fabricated by arranging 3 layers of fibres with the epoxy resin. Here a layer of coir fibre is sandwiched between two layers of glass fibres (G-C-G) at 90 wt% resin and 10 wt% fibre.
- A specimen is fabricated by arranging 3 layers of fibres with the epoxy resin. Here a layer of glass fibre is sandwiched between 2 layers of coir fibre(C-G-C) at 90 wt% resin and 10 wt% fibre.
- The fabricated specimens then have to be cut according to the ASTM standards with specific dimensions for various tests.

1. Neat resin specimen:

The first specimen to be fabricated is with neat resin. The resin and hardener are measured in a ratio of 2:1 by their weight. The hardener is mixed in a beaker using a glass rod without the formation of air bubbles. The mixture is heated with a heat gun to remove excess air bubbles.

Resin Mixture And Weighing of resin in the required ratio

The resin mixture is poured into the mould without adding any fibre and is allowed to cure for 24 hours. The cured specimen is collected by carefully removing the plastic cover and the wooden spacers without damaging the resin plate and the mould. The weight of the neat resin specimen is calculated as 450 grams.

Neat resin specimen

2. Coir-glass fibre random mixture:

The specimen is prepared by mixing coir fibre and glass fibre in a random arrangement with the resin. The resin and fibres are taken at a weight ratio of 90% to 10% respectively. 405 grams of resin is taken and 22.5 grams of both coir fibre and glass fibre are taken. The fibres are mixed in a random manner and resin is poured into the mould along with the fibre. The fibre is sandwiched between the glass plates of the mould and a heavy load is applied until the specimen is cured. This specimen is allowed to cure for 24 hours. The cured specimen is collected by carefully removing the plastic cover and the wooden spacers without damaging the resin plate and the mould.

Coir glass fibre random mixture specimen

3. Coir-Glass fibre in C-G-C Arrangement:

The specimen is prepared by sandwiching a layer of e-glass fibre in between two layers of coir fibre. The resin and fibres are taken at a weight ratio of 90% to 10% respectively. 405 grams of resin is taken and 22.5 grams of both coir fibre and glass fibre are taken. 11.25 grams of coir fibre are used on both the top and bottom layers. The resin mixture is poured on to the fibre and it is sandwiched between the glass plates of the mould and a heavy load is applied until the specimen is cured. This specimen is allowed to cure for 24 hours. The cured specimen is collected by carefully removing the plastic cover and the wooden spacers without damaging the resin plate and the mould.

Coir-Glass fibre in C-G-C Arrangement

4. Coir glass fibre in G-C-G Arrangement:

The specimen is prepared by sandwiching a layer of coir fibre in between two layers of glass fibre. The resin and fibres are taken at a weight ratio of 90% to 10% respectively. 405 grams of resin is taken and 22.5 grams of both glass fibre and coir fibre are taken. 11.25 grams of glass fibre are used on both the top and bottom layers. The resin mixture is poured on to the fibre and it is sandwiched between the glass plates of the mould and a heavy load is applied until the specimen is cured. This specimen is allowed to cure for 24 hours. The cured specimen is collected by carefully removing the plastic cover and the wooden spacers without damaging the resin plate and the mould.

Coir glass fibre in G-C-G Arrangement

Experimental tests:

Tensile strength:

Tensile strength is a measurement of the force required to pull something such as rope, wire, or a structural beam to the point where it breaks. Tensile strength of an can be measured by testing it with an Universal Testing Machine (or UTM). It is a versatile machine that can be used to measure tensile and compression tests on materials, components, and structures. Hence the part “universal” is attached to this machine.

A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a tensometer. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures (in other words, that it is versatile).

A material can withstand the maximum stress while being stretched or pulled before necking. This test was done with universal testing machine (UTM) according to ASTM standards(D638). The fabricated composite slabs were cut according to the above mentioned standard. i.e, 200mm x 20 mm x 6mm.

Flexural strength:

Bend testing (also flex or flexural testing) is commonly performed to measure the flexural strength and modulus of all types of materials and products. This test is performed on a universal testing machine (tensile testing machine or tensile tester) with a 3 point or 4point bend fixture.

The key analysis when performing bend testing are:

Flexural Modulus – This measures the slope of a stress / strain curve and is an indication of a material's stiffness.

Flexural Strength – This measures the maximum force that a material with withstand before it breaks or yields. Yield is where you have pushed a material past its recoverable deformation and it will no longer go back to the shape it once was.

Yield Point – The yield point is the point where the material essentially "gives up" or the point where if you were to continue to bend the product, the force will not continue to increase and will then start to decrease or break.

The flexure test method measures behaviour of materials subjected to simple beam loading. The 3-point bending test is used to find the flexural modulus, flexural strength and strain at break of the Basalt fibre reinforced polymer composites. Flexural test is conducted on Universal Testing machine with cross head speed of 2 mm/min according to ASTM D790-98. The sample dimensions are 127 mm×13 mm×6 mm. The span length of 100 mm is maintained.

Impact strength:

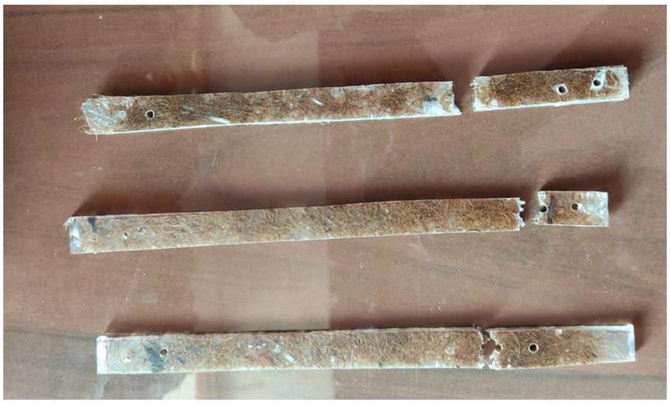
The Izod impact strength test is an ASTM standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific height (constant potential energy) and then released. The arm swings down hitting a notched sample, breaking the specimen. The energy absorbed by the sample is calculated from the height the arm swings to after hitting the sample. A notched sample is generally used to determine impact energy and notch sensitivity.

The test is similar to the Charpy impact test but uses a different arrangement of the specimen under test. The Izod impact test differs from the Charpy impact test in that the sample is held in a cantilevered beam configuration as opposed to a three-point bending configuration.

Impact test is used to determine the amount of impact energy that

was required to break the specimen. An un-notched Izod Impact test is conducted to study the impact energy according to ASTM D256. The un-notched specimens are kept in a cantilever position, and a pendulum has swung around to break the specimen. The impact energy (J) is calculated using a dial gauge that is fitted on the machine. Five samples were taken for each test, and the results are averaged.

IV. RESULTS AND DISCUSSION:

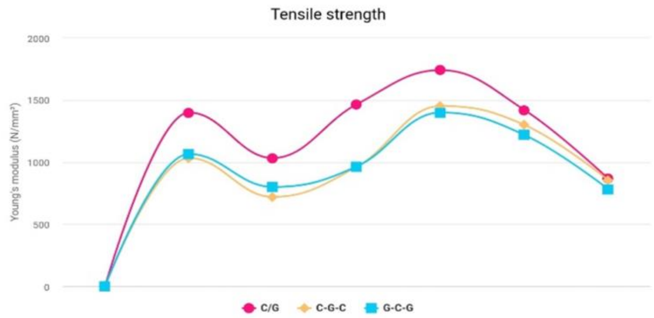


Specimen after tensile test

Specimen after impact test

Specimen after flexural test

Tensile strength:

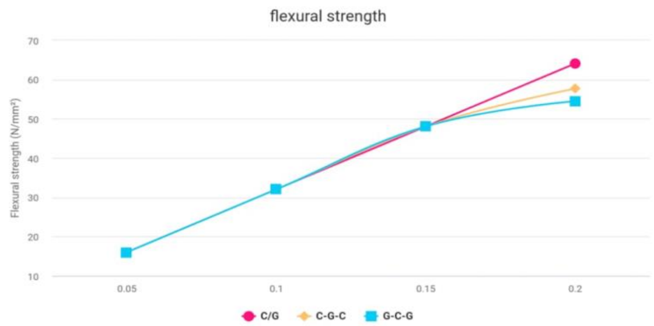


Tensile strength of composites

The figure shows the tensile strength of the composite with variation in arrangement of fibre layers. From the figure it is clear that the random mixture of fibres has an improved tensile strength. The Coir-Glass fibre random mixture has a higher strength and the composites with fibre arrangement C-G-C & G-C-G have similar tensile strength.

In the random mixture of coir and glass fibres, the fibres are bonded to each other as well as to the epoxy resin. Whereas in the case of C-G-C & G-C-G arrangements, the bond between the coir fibres and the glass fibres is very low. Hence a lower tensile strength is observed.

Flexural Strength:

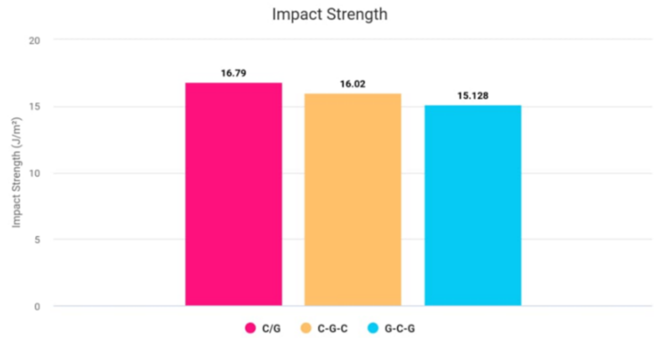


Flexural strength of composites

The flexural properties of coir fibre and glass fibre reinforced epoxy-based hybrid composite under various layer arrangement is given in the figure.

The flexural strength was found to remain constant up to a certain limit and then vary. The highest flexural strength was observed in the coir-glass fibre random mixture composite specimen. The lowest flexural strength was observed in G-C-G fibre arrangement. The higher bonding between the coir fibre and glass fibre along with the epoxy resin results in the higher flexural strength of the coir-glass random mixture composite.

Impact Strength:



Impact Strength of composites

Impact strength of a composite is nothing but the ability of the material to resist fracture failure under sudden applied high speed and is interrelated to the toughness. The impact test of Coir fibre and glass fibre reinforced epoxy-based hybrid composite was done under varying layer arrangement of fibres. Fig 3.26 shows the variation in impact strength with the variation in fibre layer arrangement.

The Impact strength of the composite under multiple layer arrangement is relatively similar to each other. The composite specimen having the coir and glass fibre in random arrangement has the relatively higher impact strength. The lowest impact strength is observed from the G-C-G fibre arrangement.

V. CONCLUSION

Coir fibre and Glass fibre reinforced epoxy-based hybrid composites have been investigated with various fibre layer arrangements and the following conclusion were drawn. The characterization of the composite reveals that the variation in the arrangement of fibre layers have a significant effect on the mechanical properties of the composite. From the investigation we have found that the tested mechanical properties are higher in the specimen having a random arrangement of coir and glass fibres. The specimens with the fibre arrangements in the order C-G-C & G-C-G have relatively lower values in the tested mechanical properties.

The Tensile strength of the coir and glass fibre reinforced epoxy-based hybrid composite revealed that the coir and glass fibre random arrangement exhibit better properties than other fibre layer arrangements. Flexural strength of composites also shows better properties than other layer arrangements. The bonding between the fibres and the epoxy resin has a significant impact in the mechanical properties. The impact strength of the composites was quite similar and the differences are negligibly small. Still the coir-glass random fibre mixture has a relatively higher impact strength.

APPLICATIONS

- Building and construction industry: panels for partition and false ceiling, partition boards, wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in times of natural calamities such as floods, cyclones, earthquakes, etc.
- Storage devices: (post-boxes, grain storage silos, bio-gas containers, etc.)
- Furniture: (chair, table, shower, bath units, etc.),Electric devices: (electrical appliances, pipes, etc.)
- Everyday applications:(lampshades, suitcases, helmets, etc.)
- Transportation: (automobile and railway coach interior, boat, etc.).
- The reasons for the use of natural fibres in the automotive industry Include: Low density: which may lead to a weight reduction of 10 to 30%, acceptable mechanical properties, good acoustic properties, favorable processing properties, for instance low wear on tools, options for new production technologies and materials, Favorable accident performance, high stability, less splintering, occupational health benefits compared to glass fibres during production.

VI. REFERENCES

[1]. Tiesong Lin, Dechang Jia, Meirong Wang, Peigang He, Defu Liang // Bull. Mater. Sci. 32 (1) (2009) 77.

[2]. Shao-Yun Fu, Bernd Lauke // Composites Science and Technology 56 (1996) 1179.

[3]. G. Zak, M. Haberer, C.B. Park, B. Benhabib // Composites Science and Technology 60 (2000) 1763.

[4]. Junzhi Zhang, Huating Liu, Yandong Zhu, Zhaoqi Fu, Jing Zhao // Advanced Materials Research 261-263 (2011) 407. 0

[5]. Weimin Li, Jinyu Xu // Materials Science and Engineering 505 (1-2) (2009) 178.

[6]. J.L. Thomason, M.A. Vlug // Composites Part A: Applied Science and Manufacturing 28 (1997) 277.

[7]. Xinrui Zhang, Xianqiang Pei, Qihua Wang // Journal of Applied Polymer Science 111 (2009) 2980.

[8]. M. Botev, H. Betchev, D. Bikiaris, C. Panayiotou // Journal of Applied Polymer Science 74 (1999) 523.

[9]. Shao-Yun Fu, Yiu-Wing Mai, Emma Chui-Yee Ching, Robert K.Y. Li // Composites Part A: Applied Science and Manufacturing 33 (2002) 1549. 116 P. Amuthakkannan, V. Manikandan, J.T. WinowlinJappes, M. Uthayakumar

[10]. Jinxiang Chen, Sujun Guan, Shunhua Zhang, Jingjing Zheng, Juan Xie, Yun Lu // Advanced Materials Research 189-193 (2011) 4043.
[11]. S.-Y Fu, B. Lauke, E. Mäder, C.-Y. Yue, X. Hu // Composites Part A: Applied Science and Manufacturing 31 (2000) 1117.
[12]. A. Bernasconi, P. Davoli, A. Basile, A. Filippi // International Journal of Fatigue 29 (2007) 199.
[13]. Hui Zhang, Zhong Zhang, Klaus Friedrich // Composites Science and Technology 67 (2007) 222.
[14]. Nevin Gamze Karsli, AyseAytac, Veli Deniz // Journal of Reinforced Plastics and Composites 31 (2012) 1053.
[15]. Bin Yang, Jinhua Leng, Bobing He, Heng Liu, Yu Zhang, Zhaohua Duan // Journal of Reinforced Plastics and Composites 31 (2012) 1103.
[16]. Sultan Ozturk // Journal of Composite Materials 44 (2010) 19.
[17]. K.J. Wong, Umar Nirmal, B.K. Lim // Journal of Reinforced Plastics and Composites 29 (2010) 3463.
[18]. Y.J. Phua, Z.A. Mohd Ishak, R. Senawi // Journal of Reinforced Plastics and Composites 29 (2010) 2592.
[19]. P.T. Curtis, M.G. Bader, J.E. Bailey // Journal of Material Science 13 (1978) 377.
[20]. Laly A. Pothan, Sabu Thomas, N. R. Neelakantan // Journal of Reinforced Plastics and Composites 16 (1997) 744.
[21]. N. Dayananda Jawali, Siddaramaiah, B. Siddeshwarappa, JoongHee Lee // Journal of Reinforced Plastics and Composites 27 (2008) 313.