Jupiter Publications Consortium

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in

International Journal of Research in Mechanical, Mechatronics and Automobile Engineering (IJRMMAE)

Study on Jute and Glass Fiber Reinforced Polymer Composites

(Review Paper)

M. Balaji[1] and Dr. K. Nirmalkumar[2]

[1]Student of Final Year M.E. Structural Engineering
Kongu Engineering College, Perundurai
[2]Professor, Department of Civil Engineering
Kongu Engineering College, Perundurai
Erode, Tamil Nadu, India.
[1]balaji0694@gmail.com, [2]nirmalkavi1979@gmail.com

Received 25, November 2016 | Accepted 30, November 2016

Abstract-This paper provides the reason for hybridising the organic (natural) and inorganic (synthetic) fibre. The incorporation of several different types of fibres into a single matrix has led to the development of hybridfibre composites. Hybrid composites are the materials consists of two different elements at microscopic level but the traditional composites are at macroscopic level. Most probably, one of the elements in composite are of organic and the other is of inorganic nature. Mixing of these different materials at microscopic scale results in the formation of highly homogenous material which possess the new property or the property between two these materials at its new phase. By using these type of hybridised material, the disadvantages in one material is overcome by the other one and thereby increasing the strength of product .The properties of a hybrid composite mainly depend upon the fibre content, length of individual fibres, orientation, extent of intermingling of fibres, fibre to matrix bonding and arrangement of both the fibres. The strength of the hybrid composite is also dependent on the failure strain of individual fibres. The selection of the components that make up the hybrid composite is determined by the purpose of hybridization, requirements imposed on the material or the construction being designed.

Keywords- Hybrid Fiber Composite, Homogenous, Intermingling, Hybridization, Construction.

I.INTRODUCTION

The incorporation of different types of fibres into a single matrix has led to the development of hybrid fibre composites (Maya Jacob John et al (2016)).Hybrid composites are the materials consists of two different elements at microscopic level but the traditional composites are at macroscopic level. Most probably, one of the elements in composite are of organic and the other is of inorganic nature.There are several types of hybrid composites characterized as:

(1) Interply or Tow-by-Tow
(2) Sandwich Hybrids or Core-Shell
(3) Interplyor Laminated

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in

International Journal of Research in Mechanical, Mechatronics and Automobile Engineering (IJRMMAE)

(4) Intimately Mixed Hybrids
(5) Reinforced with Ribs, Pultruded Wires, Thin Veils OfFiber or combinations of the above.

Development of polymer composites with natural fibres and fillers as a sustainable alternative material for some engineering applications, particularly in aerospace applications and automobile applications are being developed. Some of the natural fibres (organic) are sisal, Jute, hemp, coir, bamboo, etc. These fibres possess superior mechanical properties such as stiffness, flexibility and modulus compared to glass fibres. The premier advantages are: low cost, light weight, easy production. abundance and renewability, non-abrasiveness, simple process, non-toxicity, high flexibility, acoustic insulation, low density and friendly to environment. Hydrophilic nature of the natural fibre is the major disadvantage. To overcome this drawback synthetic fibres (GFRP) is used, because of its hydrophobic property. Glass Fibre Reinforced polymer is the best example of an inorganic (synthetic) fibre. It is made up of plastic matrix reinforced by fine fibres of glass. The advantages of the synthetic fibres arestretching, waterproofing and stain resistance. At same time the synthetic fiber dose not undergo bio-degradation.The properties of a hybrid composite mainly depend upon the fibre content, length of individual fibres, orientation, extent of intermingling of fibres, fibre to matrix bonding and arrangement of both the fibres. The strength of the hybrid composite is also dependent on the failure strain of individual fibres. The hybridised composite is also used for strengthening the RC elements (column, Beam, Slab, etc.,) To avoid the failure and cracking of the structure due to load greater than the ultimate load after the construction has completed, warping of the RC elements by hybrid fibre composite plate (flexible). By warping the RC elements with hybrid fibre composite, the ductility and strength are improved.Fibre that have chosen for the hybridisation should be light weight, better mechanical properties and possess the better tenacity when compared to others.

II. SELECTION OF JUTE FIBRE

Tossa raw jute and white jute are the two main types of jute fibers next to cotton in the world. Usually the stem of the jute plant grows about six to ten feet. The stem of the jute plant contains fibers (Muthuvelet al (2013)). After attaining the entire growth, the jute plants are cut, tied p and kept in water for certain days to achieve the fermentation. Once the fermentation was achieved those jute are tied off and dried under sunlight. After drying up the fibers are drawn from the stem of the plant. Hemicellulose are the type of polysaccharides present in all type of plants responsible for bonding. Hemicellulose are hydrophilic in nature and have lower molecular masses than both cellulose and lignin. Hemicellulose are classified into two types namely Xylans and Glucomannans. Lignin is the type of polymer with high molecular weight and of amorphous structure. Lignin is thermoplastic in nature (i.e., at temperatures around 900 C it starts to soften and at temperatures around 1700C it starts to flow. Jute fiber possess high specific strength and stiffness. The properties of fibers depend on size, maturity and processing methods adopted for the extraction of the fiber. Properties such as density,electrical

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in
International Journal of Research in Mechanical, Mechatronics and Automobile Engineering (IJRMMAE)

resistivity, ultimate tensile strength and initial modulus are related to the internal structure and chemical composition of fiber.

Table 2.1 chemical composition

Substances	Weight percent (%)
Cellulose	61 – 71.5
Hemicellulose	13.6 – 20.4
Pectin	0.2
Lignin	12 – 13
Moisture content	12.6
Wax	0.5

Fig 2.1 Jute fiber obtained from stem of Jute plant (Muthuvel et al (2013)).

III. SELECTION OF GLASS FIBRE

Aluminized glass fiber composites have the notable properties such as improved electrical and thermal conduction, impact and fatigue properties. Epoxy resins are used in the production of glass fiber composites because of its wetting power and adhesion to glass fiber, low setting shrinkage, cohesion strength and adequate dielectric characteristics. The limit of epoxy-based composites are also very high. Glass fiber manufactured from silicon with additional oxides possess the high strength, good corrosion resistance and low price. It is classified in to two main types namely E-Glass and S-Glass. The former one possess good electrical properties whereas the second one possess the good stiffness and temperature resistance.

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in

International Journal of Research in Mechanical, Mechatronics and Automobile Engineering (IJRMMAE)

Table 3.1 Properties of Glass Fiber

Property	Glass Fiber
Density (gms./cc)	2.55
Elongation Break (%)	4.8
Tensile Strength (Mpa)	2000
Young's Modulus (Gpa)	80

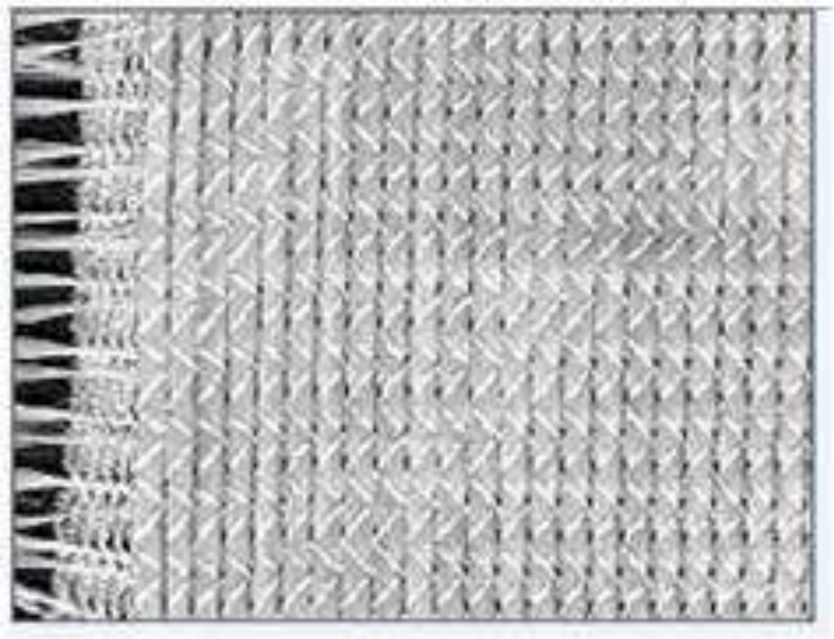


Fig 3.1 Glass Fiber

IV. CHARACTETERISTICS OF HYBRID FIBER COMPOSITES

A. Jute/Glass Fibre-Reinforced Polyester Hybrid Composites (Carlo Santulli et al (2013)

The mechanical properties of pultruded jute and jute/glass hybrid reinforced unsaturated polyester composites have the effect of water absorption for long time immersion at room temperature (up to 4076 hours). Due to the addition of glass fibers increases the moisture resistance of the composite which leads to the deviation from Fickian behavior. At same time the diffusion coefficient was found to be depend on the fiber content and stacking sequence. When the composite is subjected to an aqueous environment, there is a notable decrease in the flexural and the tensile properties with high retention of the mechanical properties. This loss is mainly due to the fiber/matrix interface weakening induced by the water ageing. Hence the hybrid composite shows the better strength and the modulus of reaction at higher temperature in comparison with the jute composites. From this durability of natural Fibre composites can be tailored by a proper hybridization with Synthetic fibres in order to find a suitable cost-performance balance, meanwhile reducing the environmental impact of thematerial.

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in

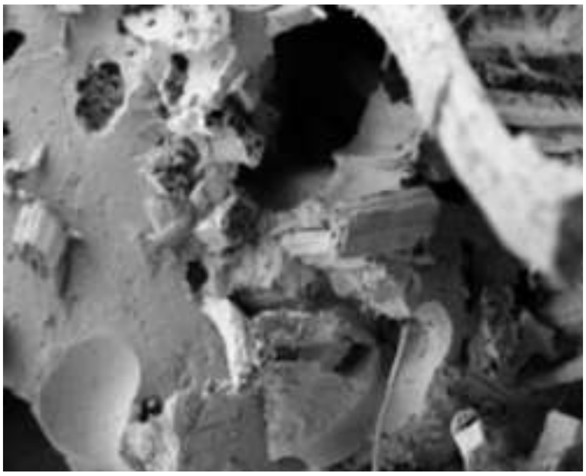
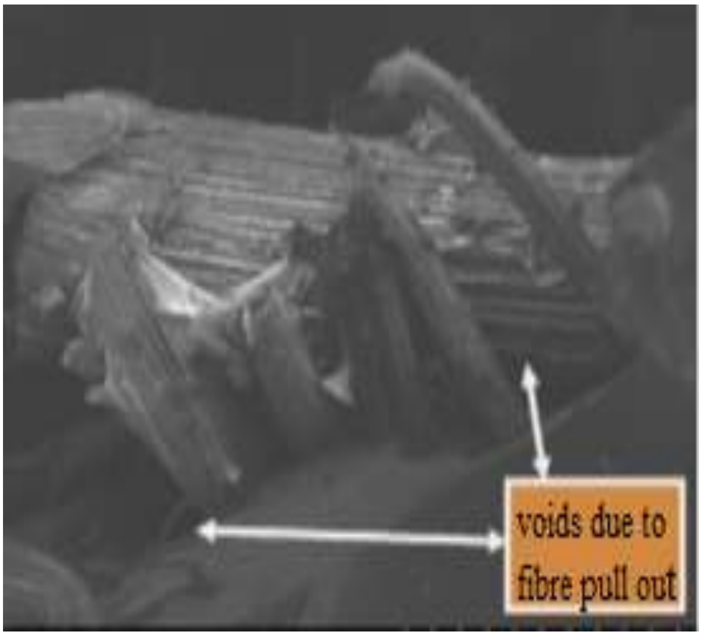


Fig 4.1SEM micrographs showing details of the fractured surface of aged pultruded composites.

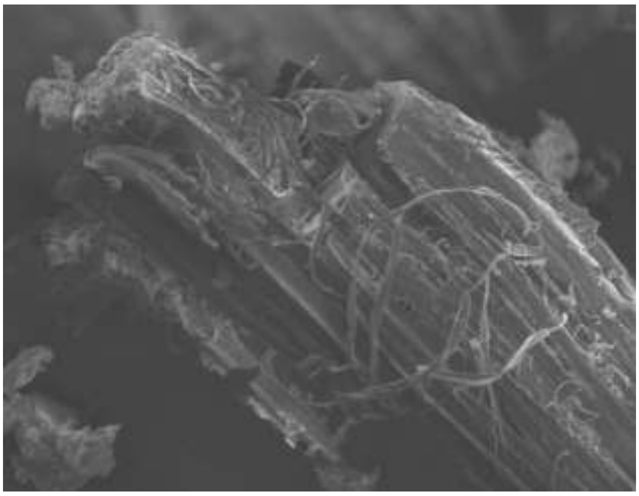
B. Jute/Banana Fibre Reinforced Epoxy Hybrid Composites (Boopalan et al (2012)).

The mechanical properties such as tensile strength, flexural strength and impact strength of the Jute/Banana Fibre Reinforced Epoxy Hybrid Composite is maximum at 50/50 weight ratio. The tensile strength of the hybrid composite is increased to 44% at 50/50 weight ratio when compared to the palmyar/polyester composite. Different weight ratios (25/75, 50/50, 75/25) of jute and banana fiber is studied for both thermal and water absorption characteristics. It possess the better thermal properties and less water absorption capacity at 50/50 weight ratio. Due to the addition of banana fiber, the tensile strength is increased to 17%, flexural strength is increased to 4.3% and impact is increased to 35.5%.

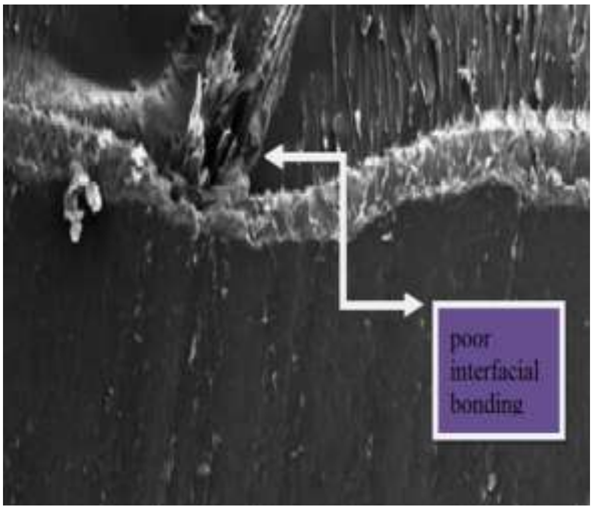


i. Fractured Specimen of Tensile Test

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in
International Journal of Research in Mechanical, Mechatronics and Automobile Engineering (IJRMMAE)



ii. Fractured Specimen of Flexural Test



iii.fractured specimen of impact test

Fig 4.2 SEM image of fractured specimen for 50:50 hybrid composites (Boopalan et al (2012)).

C. Hybrid Fibre Reinforced Concrete Beams With GFRP Wrappings

Beams of 700mm × 150mm ×150mm were used. The mix design procedure using Indian Standard code of practice for M 30 grade of concrete yielded a proportion of 1:1.21:2.15 by weight with water – cement ratio of 0.42. The ingredients of concrete were weighed accordingly and dry mixed. Calculated quantity of hybrid fibers were added to the ingredients and the mass was thoroughly mixed. Next, approx., 80% of the calculated quantity of water was added while continuing the mixing. Finally, super plasticizer (1% by weight of cement) was added with the remaining water and the concrete was homogeneously mixed. The beam specimens were kept under wet gunny bags of 24 hours and then demoulded and cured for 28 days under water. The wrapping was done on three sides of the beams following the procedure of hand lay-up. To secure a proper bond between concrete and GFRP, steel plates smeared with releaser were kept over the beams. The plates were removed after setting of GFRP was achieved. The wrapped beams were further air cured for one day before testing. A load controlled universal testing machine was used to test the beams using two point loading as shown. The mid span deflection was recorded

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in

International Journal of Research in Mechanical, Mechatronics and Automobile Engineering (IJRMMAE)

using a dial gauge having least count of 0.01mm. The load deflection curve was plotted. Flexural strength corresponding to the maximum load was calculated from the curve. In general, it can be concluded that the hybrid fibres can be effectively used in beams to drive additional benefits. It can also be concluded that GFRP wrapping (either single wrapping or sandwich wrapping) of beams offer an effective confinement system which enhances the strength characteristics, and energy absorption characteristics.

V. CONCLUSION

On combining two different types of fibers to get a better quality in mechanical, chemical and physical properties rather than optimizing the hybrid effect. On other hand the natural fiber composites deals with random mats and short fibers, which make hybrid effects more difficult to predict (YentelSwolfs (2014)). Hybrid effects under complex loading conditions such as flexure, impact and fatigue tests are not well explained. The durability properties of natural Fibre composites can be tailored by a proper hybridization with Synthetic fibres in order to find a suitable cost-performance balance, meanwhile reducing the environmental impact of the material.More research is needed to fully exploit the potential of metallic and polymer fibres. Processes such as tow spreading and comingling have reached a certain maturity for non-hybrid composites, and open new opportunities for hybrid composites. It is expected that this will further widen the applicability of hybrid composites.

References

[1] Valadez-Gonzalez A, Cervantes-Uc JM, OlayoR, Herrera-Franco PJ. Effect of fiber surface treatment on the fiber–matrix bond strength of natural fiber reinforced composites. Compos B Eng 1999;30:309–20.
[2] Mehta G, Drzal LT, Mohanty AK, Misra M. Effect of fiber surface treatment on the properties of biocomposites from nonwoven industrial hemp fiber mats and unsaturated polyester resin. J ApplPolymSci 2006;99:1055–68.
[3] Stamboulis A, Baillie CA, Garkhail SK, van Melick HGH, Peijs T. Environmental durability of flax fibres and their composites based on polypropylene matrix. Appl Compos Mater 2000;7:273–94.
[4] Springer GS. Environmental effects on composite materials. Lancaster (PA): Tecnomic; 1988.
[5] Rao RMVGK, Balasubramanian N, Chanda M. Moisture absorption phenomenon in permeable fiber polymer composites. J ApplPolymSci 1981;26:4069–79.
[6] Espert A, Vilaplana F, Karlsson S. Comparison of water absorption in natural cellulosic fibres from wood and one-year crops in polypropylene composites and its influence on their mechanical properties. Compos A ApplSciManuf2004;35:1267–76.
[7] Zhou J, Lucas JP. The effects of a water environment on anomalous absorptionbehavior in graphite/epoxy composites. Compos SciTechnol 1995;53:57–64.
[8] American Society for Testing and Materials - ASTM. Norma ASTM D570. Standard test method for water absorption of plastics. Philadelphia: ASTM; 1998.

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in

International Journal of Research in Mechanical, Mechatronics and Automobile Engineering (IJRMMAE)

[9] American Society for Testing and Materials - ASTM. Norma ASTM D792. Standard test methods for density and specific gravity (relative density) of plastics by displacement. Philadelphia: ASTM; 1998.

[10] American Society for Testing and Materials - ASTM. Norma ASTM D3039. Standard test method for tensile properties of polymer matrix composite materials. Philadelphia: ASTM; 2003.

[11] American Society for Testing and Materials - ASTM. Norma ASTM D256. Standard test methods for determining the izod pendulum impact resistance of plastics. Philadelphia: ASTM; 2004.

[12] AnshidaHaneefa,Panampilly0Bindu, IndoseAravind and Sabu Thomas, Studies on tensile and flexural properties of short banana/glass hybrid fiber reinforced polystyrene composites, Journal of Composite Materials 2008, 42, 1471-1477

[13] ASTM Standard, D638-03, D256- 06, D790-07, D579- 98(05).

[14] Dabade.B.M, RamachandraReddy.G, Rajesham.S and UdayaKiran.C, effect of fiber length and fiber weight ratio on tensile properties of sun hemp and palmyrafiber reinforced polyester composites,Journal of Reinforced Plastics and Composites 2006, 25, 1733-1738.

[15] Chabba, S., Matthews, G.F., Netravali, A.N., Green composites using cross-linked soy flour and flax yarns, journal of the royal society of chemistry, 2005, 7, 576- 581.

[16] Jamal Mirbagheri,MehdiTajvidi,John C. Hermanson,IsmaeilGhasemi,Tensile Properties of Wood Flour/KenafFiber Polypropylene Hybrid Composites,105, 2007, 3054–3059.

[17] John, K. and Venkata Naidu, S., Sisal Fiber/Glass Fiber Hybrid Composites: The Impact and Compressive Properties, 23, 2004, 1253-1258.

[18] John, K. and Venkata Naidu, S., Tensile Properties of Unsaturated Polyester-Based Sisal Fiber–Glass Fiber Hybrid Composites, 23, 2004, 1815-1819.

[19] Kalaprasad, G., Joseph, K. and Thomas, S. Theoretical Modeling of Tensile Properties of Short Sisal Fiber – Reinforced Low Density Polyethylene Composites, 3.

[20] M.M Thwe., K Liao. (2003) Comp. Sci. Tech,, 63 ,375

[21] M.S Sreekala., J.George, M.G Kumaran., S. Thomas (2002)Comp. Sci. Technol.62 339

[22] R Burguen˜o., M.J Quagliata., Mohanty A.K., Mehta G., Drzal L.T., Misra M(2005) Composites: Part A 36 581.

[23] A.K Mohanty., L.T Drzal. M Misra. (2002) J. Adhesion Sci. Technol. 16 999

[24] B Singh., M Gupta., A Verma (1995) Const. Build. Mater., 9 39

[25] D Ray., J Rout (2005) , Natural Fibers, Biopolymers and Bio composites Editedby Mohanty A.K., Misra M., Drzal L.T., CRC Press 347

[26] A Bakar., A Hariharan., Abdul Khalil (2005) H.P.S J. Comp. Mater. 39 8 663

[27] H Anuar., S.H Ahmad. R Rasid., N.S Nik Daud. (2006) Polymer – Plastics Technology and Engineering 45 9 1059- 1063

[28] R Burguen˜o., M.J Quagliata., A.K Mohanty., G Mehta., L.T Drzal., M Misra. (2005) Composites: Part A 36 581.

[29] Carlo Santaulli, FabrizioSarasini, Jacopo Tirillio (2013), "Environmental Effects on the Mechanical Behaviour of Pultruded Jute/Glass Fiber –Reinforced Polyester Hybrid Composites", composites science and technology, Vol.94, PP 62-70.

Vol. 2 Iss.3, pp. 7-15, 30th November, 2016
ISSN Print : 2454-1435 © 2016 IJRMMAE
ISSN Online : 2454-1443 © 2016 IJRMMAE
http://www.ijrmmae.in

International Journal of Research in Mechanical, Mechatronics and Automobile Engineering (IJRMMAE)

[30] M.Muthuvel, G.Ranganath, K.Janarthanan, K.Srinivasan (2013), “Characterization Study Of Jute And Glass Fiber Reinforced Hybrid Composite Material”,IJERT Vol.2, pp.53-65

[31] Maya Jacob John, Rajesh D.Anandjiwala, Sabu Thomas (2016), “Hybrid Composites”, Research Gate.