© 2018 IJSRSET | Volume 4 | Issue 1 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

Study on Mechanical Properties of Natural/Synthetic Fibre Reinforced Polymer Hybrid Composite : A Review

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ABSTRACT

Composites consist of two different materials, one is base matrix material and another one is reinforcement material. Composites give unique properties than individual matrix material. Composites are gaining the demands in various applications because of its distinct properties such as higher tensile strength, higher fatigue strength, better impact strength, good flexural strength and better strength to weight ratio. In present paper a review is carried out on identifying the effect on mechanical properties of hybrid fibre reinforced polymer matrix composites. Present study focus on the combination of the natural/synthetic fibre mixed with each other. Hybrid polymer matrix composites show better mechanical properties than single fibre reinforced polymer matrix composites. Due to its good properties and cost effective nature hybrid polymer matrix composite are used in automotive industry, biomedical industry, air craft and aerospace industry, house hold applications etc.

Keywords: Hybrid polymer matrix composites, Natural fibre, Synthetic fibre, Mechanical Properties

I. INTRODUCTION

A composite is a structural material that consists of two or more combined constituents that are not soluble in each other. In the composite material one constituent is called the reinforcing phase and another which is embedded is called a matrix. Composite material have found better properties such as higher tensile strength, fatigue strength, better impact properties, flexural properties and thermal properties etc. Natural fibres are better as compare with synthetic fibre due to advantages over such as lower cost, higher flexibility; biodegradability, higher strength, and modulus also lower density [1-7]. Apart from these advantages, natural fibre composite have some limitations like lower impact strength, and higher moisture properties. These limitations can be reduced by use of hybrid fibre composites.

Hybrid fibres have increased the mechanical properties due to following two reasons. First in hybrid composites, two or more fibre has same length but with different diameters provide better advantage over the use of single fibre. Second in polymer matrix composites variety of diameter increased the effective area for matrix adhesion so uniformly transfer of stresses could take place [8]. In recent the Natural fibre polymer matrix composites are used in Building materials, automobile parts, and industrial purpose [9-14].The main use of natural fibre polymer matrix composites in the packaging industries due to higher strength and longer durability [15]. Synthetic Fibre polymer matrix composites are widely used in Aerospace applications in place of metal or ceramic composite due to lighter in weight. Thermoset polymers are better than the thermoplastic for polymer matrix composites and improvement in mechanical properties [7]. Composites are classified based on two types: one which is based on matrix

material and another which is based on reinforcement material.

The Classification of composites based on matrix material such as,

- ✓ Polymer matrix composites(PMCs)
- ✓ Metal matrix composites(MMCs)
- ✓ Ceramics matrix composites(CMCs)
- ✓ Carbon and Graphic matrix composites(CGMCs)

Classification based on reinforcement materials such as, Laminar Composites, Particulate Composites, Continuous Fibre Composites, Planner (Flaks) Composites. Fabrication of composites are done by various methods, Hand lay-up technique, Compression moulding , Injection moulding, Pultrusion method and vaccum moulding etc.

II. EFFECT ON MECHANICAL PROPERTIES OF HYBRID FIBRE REINFORCED POLYMER MATRIX COMPOSITES

Many researchers have studied the effects of fibre loading on mechanical properties of hybrid fibre PMCs. Khanam et al. [16] investigated the tensile properties, flexural properties and chemical resistance properties of sisal/carbon hybrid fibre reinforced epoxy composites. They concluded that addition of more percentage of carbon fibre in hybrid composite improvement in flexural modulus, flexural strength, tensile modulus and tensile strength. Ramesh et al. [17] studied on the mechanical properties of glass/sisal/jute fibre hybrid polyester composites. They concluded that more improvement in mechanical properties when addition of glass fibre with sisal and jute fibre reinforce hybrid composites. Jute/glass shows the maximum tensile strength, glass/jute/sisal shows the maximum flexural strength and glass/sisal shows the maximum impact strength. Ramnath et al. [18] investigated the mechanical properties of glass/abaca/jute fibre epoxy composites.

They reported that the combination of glass/abaca/jute composite shows the maximum value of tensile strength, tensile modulus and flexural modulus as well as the composite glass/abaca/epoxy shows maximum impact and flexural strength.

Kuma et al. [19] studied the mechanical properties of banana and glass fibre polypropylene hybrid composite. They concluded that improvement in mechanical properties of glass/banana fibre hybrid composite due to addition of glass fibre in to polypropylene matrix that gives positive effect of hybridization. Tensile strength is maximum with 7.5% weight of fibre and flexural as well as impact strength is maximum with 10% weight of fibre. Shanmugam et al. [20] analysed the mechanical properties of unidirectional palm stalk fibre/jute fibre reinforced polyester composite. They observed that due to incorporation of jute fibre into palm fibre increased the mechanical properties. A1Maadeed et al. [21] investigated that date plam wood flour/glass fibre reinforced polypropylene hybrid composites. They found that increase the tensile strength when addition of 5% fibre content of glass with 18% date palm polypropylene composites.

Venkateshwaram et al. [22] investigated the mechanical properties of woven jute and banana fibre reinforced hybrid composites. They concluded that the maximum tensile strength and flexural strength is better in the hybrid composite than the individual composite. Boopalan et al. [23] studied the mechanical properties of banana and jute fibre reinforced epoxy hybrid composite. They found that banana and jute fibre composite with various weight ratios gives better mechanical properties. The maximum value is observed with 50/50 percentage of weight for tensile, flexural and impact properties. Venkateshwaram et al. [24] investigated mechanical properties of banana/sisal fibre reinforced epoxy composite. They observed that 30% by weight of total fibres in each composite increased the tensile, flexural and impact properties. Srinivasan et al. [25] studied on mechanical properties of flax and banana fibre reinforced epoy hybrid composite. They show that

hybrid composite has better flexural and impact properties.

Asaithambi et al. [26] investigated the mechanical properties of banana/sisal fibre reinforced polylactic hybrid composite. They found that combination of high strength sisal fibre with banana fibre composite shows better mechanical properties as compare to single banana and polylactic acid composite. Guermazi et al. [27] analysed the effect of carbon/glass fibre reinforced epoxy hybrid composite. They observed that carbon/glass fibre hybrid composite do not shows better mechanical properties rather than other composite. Dong et al. [28] investigated study on E glass and T55S carbon fibre reinforced epoxy hybrid composite. They found that hybridization of E glass and T77S carbon fibre hybrid composite does not show better flexural properties. Sanchezet et al. [29] investigated the effect of combination of carbon and carbon nano tube epoxy composite on flexural properties. They found that use of carbon nanotube as reinforcement gives superior flexural strength and modulus.

Laly A. Pothan et al. [30] investigate the role of fibre/matrix interactions in chemically treated banana fibre composites by using dynamic mechanical analysis and compared with those of untreated fibre composites. They concluded that Chemical treatment improved the storage modulus of banana fibre reinforced polyester composites. With NaOH maximum increase of modulus values were observed. Laly A. Pothan and Sabu Thomas [31] investigated that to improve the adhesion between the fibre and matrix, chemical treatment was suggested. The effect of chemical treatment on the dynamic mechanical properties of banana fibre reinforced polyester composites has been analysed to investigate the interfacial properties. They concluded that composites with better modulus and low damping ideal for use as a substitute for building material can be developed from banana fibre and polyester resins by the judicious control of the interphase chemistry.

Maries Idicula et al. [32] optimised the relative volume fraction of banana and sisal (1:1). Different volume ratios of the fibres by keeping 0.04 the total fibre volume fraction hybrid composites were prepared. Sisal/polyester composite showed maximum damping behaviour and highest impact strength as compared to banana/polyester as well as hybrid composites. They concluded that by hybridising banana/sisal, better stiffness and damping behaviour were obtained. V.S. Srinivasan et al. [33] investigated on hybrid composite made of natural fibres namely, Banana, Flax fibres and combination of both fibres. They concluded that the values obtained in double shear test, the ultimate shear strength of banana/flax composite was greater than flax fibre and banana fibre composites.

From the Table 1 it is found that mechanical properties of Natural fibre composites increase due to inter corporation of synthetic fibre.

Table 1. Mechanical Properties of Hybrid Fibre reinforced polymer matrix composites

Sr. No.	Fibres	Matrix	Tensile Strength (MPa)	Flexural Strength (MPa)	Impact Energy (Jule)	Method of Manufacturing	Ref
1	Sisal/Jute/Glass	Epoxy	68.55	-	-	Hand lay-up	[17]
2	Abaca/Jute/Glass	Epoxy	70.25	3.864	796.66	Hand lay-up	[18]
3	Banana/Glass	Polypropylene	24.59	270.86	29.37	Injection Moulding	[19]
4	Jute/Banana	Epoxy	54.76	91.66	106.67	Hand lay-up	[22]
5	Banana	Epox	104	192	13.	Com	[24]

	/Sisal/ Glass	y			3	press ion Moul ding	
6	Jute/Gla ss	Epox y	56.6 8	28.8 1	5.4 9	Hand lay-up	[34]
7	Banana/ Glass	phen ol form aldeh yde	42	55	-	Hand lay-up	[35]
8	Banana/ Sisal	Epox y	32.5	320. 62	-	Hand lay-up	[36]
9	Kenaf/ Glass	Poly ester	39.2 8	453. 22	146 .04	Com press ion Moul ding	[37]
10	Sisal/Ca rbon	Poly ester	122. 11	176. 53	-	Hand lay-up	[38]

III. CONCLUSION

Following conclusions can be derived from above study.

- ✓ Natural and Synthetic fibres are used as reinforcement in different form like unidirectional, woven, bidirectional and randomly oriented. The composites are prepared by different fabrication methods with various volume and weight fraction of fibres.
- ✓ Mechanical properties like Tensile, Impact and flexural property of Hybrid fibre composites are showing better performance than the single fibre composites and reducing the limitations of single fibre composites.
- ✓ The chemically treated composites show the more strength compared to untreated composites.
- ✓ Mechanical properties of natural fibre reinforced polymer composites are found to be maximum due to combination of either synthetic fibre or natural fibre having higher elongation.

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