International Journal on Recent Researches in Science, Engineering & Technology (IJRRSET)
A Journal Established in early 2000 as National journal and upgraded to International journal in 2013 and is in existence for the last 10 years. It is run by Retired Professors from NIT, Trichy. Journal Indexed in JIR, DIIF and SJIF.
Research Paper
Available online at: www.jrrset.com

ISSN (Print) : 2347-6729
ISSN (Online) : 2348-3105
Volume 7, Issue 9
September 2019.
JIR IF : 2.54
SJIF IF : 4.334
Cosmos: 5.395

Received on: 04.09.2019 Published on: 22.09.2019 Pages : 1 - 10

MECHANICAL PROPERITIES OF HYBRID WASTE FILLER REINFORCED WITH POLYMER COMPOSITES

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ABSTRACT

The mechanical properties of hybrid fillers reinforced polymer composite is presented in this project work. This project work deals with the usage of hybrid fillers as reinforcement in vinyl ester composites. The composite plates have been fabricated by compression molding machine with hybrid fillers of varying wt% from 5 to 50 as reinforcement material, and their properties such as tensile, flexural, and impact properties are studied. The mechanical properties of hybrid fillers reinforced VE composites are optimum at 30 wt% filler. The tensile strength and flexural strength of TSF-VE composites are estimated to be around 40.3 and 149MPa respectively. The better impact strength of TSF-VE composites is found to be 17.03 kJ/m^2.

I. INTRODUCTION

General:

Economic and environmental concerns are stimulating research in the development of new raw materials for automotive industries. Particularly composite are the new materials in which a good part is based on natural renewable resources, preventing further stresses on the environment. The composite material scientists all over the world focused their attention on natural composites reinforced with jute, sisal, coir, pineapple etc. primarily to cut down the cost of raw materials. The hybrid fillers coir, sisal, jute have been used for hundreds of years for many applications such as ropes, beds, bags etc.. Sisal filler is one of the most widely used natural fillers in yarns, ropes, twines, cords, rugs, carpets, mattresses, mats, and handcrafted articles. During the past two decades sisal fillers have also been used as reinforcement in cement and polymer based composites. The sisal reinforcement can be used as short randomly distributed fillers, long oriented fillers.

The use of waste hybrid fillers in wax provides an exciting challenge to the automobile industry, particularly in developing countries, since they are an economic and readily available kind of reinforcement, require only a low degree of industrialization for their processing and, in comparison with an equivalent weight of the most common synthetic reinforcing fillers, the energy required for their production is small and hence, the cost of fabricating these composites is also low. Waste hybrid fillers have the potential to be used as reinforcement to overcome the inherent

Deficiencies in wax materials. In recent years, there has been sustained interest in utilizing waste hybrid fillers in wax composites and in manufacturing products based on them with a view to have alternate of artificial filler materials, which are energy-efficient, economical and eco-friendly.

Wax composites place a major role as polymer materials. There has been a growing interest in utilizing waste hybrid fillers as reinforcement in wax composite for making low cost materials in recent years. Waste hybrid fillers composite continues to be an active area of composite research. Concerning the above, this project deals with waste hybrid filler reinforced polymer composites. The main objective of this project is to fabricate the waste hybrid filler reinforced polymer composites and analyzing the mechanical properties of the fabricated composite.

I. COMPOSITE MATERIAL

Composite materials, often shortened to composites or called composition materials, are engineered or naturally occurring materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct at the macroscopic or microscopic scale within the finished structure.

The very common example would be disc brake pads, which consists of hard ceramic particles embedded in soft metal matrix. Those composites closest to our personal hygiene form our shower stalls and bathtubs made of filler glass. Imitation granite and cultured marble sinks and countertops are widely used. The most advanced examples perform routinely on spacecraft in demanding environments.

A composite is created by combining different materials to create a new one. A rudimentary example would be mixing mud and straw and forming it into a brick shape to make adobe bricks. It takes two materials which, by themselves wouldn't usually be used for the same purpose as they are when combined into a composite material for building. In construction trades, concrete would be a slightly more complex composite of stone mixed with cement. If you add re-bar (strong steel rods), it becomes a three-phase composite that adds both strength and flexibility. In engineering, an engineer may design something that is under certain stresses that require the uses of a material that is a composite (either because conventional material can't meet the stress demands or could be too heavy for the purpose it has been designed)

ADVANTAGES OF COMPOSITE

Summary of the advantages exhibited by composite materials, which are of significant use in aerospace industry are as follows:

- High resistance to fatigue and corrosion degradation.
- High ‘strength or stiffness to weight ratio. As enumerated above weight savings are significant ranging from 25-45% of the weight of conventional metallic designs.
- Due to greater reliability, there are fewer inspections and structural repairs.
- Directional tailoring capabilities to meet the design requirements. The filler pattern can be laid in a manner that will tailor the structure to efficiently sustain the applied loads.
- Filler to filler redundant load path.
- Improved dent resistance is normally achieved. Composite panels do not sustain damage as easily as thin gage sheet metals.

REINFORCEMENTS

Reinforcements for the composites can be filler, fabrics particles or whiskers. Fillers are essentially characterized by one very long axis with other two axes either often circular or near circular. Particles have no preferred orientation and so does their shape. Whiskers have a preferred shape but are small both in diameter and length as compared to fillers.Reinforcing constituents in composites, as the word indicates, provide the strength that makes the composite what it is. But they also serve certain additional purposes of heat resistance or conduction, resistance to corrosion and provide rigidity. Reinforcement can be made to perform all Rice flour:

Rice flour was employed as filler in

or one of these functions as per the requirements.

A reinforcement that embellishes the matrix strength must be stronger and stiffer than the matrix and capable of changing failure mechanism to the advantage of the composite. This means that the ductility should be minimal or even nil the composite must behave as brittle as possible.

II. MATERIALS AND METHODOLOGY

WASTE HYBRID FILLERS:

In this project we used waste hybrid filler, there are;

- Sawdust
- Rice flour
- block copolymer polypropylene (PPB)

in order to prepare polymer based reinforced composites. Four coupling agents were selected to modify the surface of the rice husk in the composite materials, including two types of functionalized polymers and an elastomeric styrene-ethylene-butadiene- styrene triblock co-polymer grafted with MA and two bi-functional organ metallic coupling agents.

SAWDUST:

Sawdust or **wood dust** is a by-product or waste product of woodworking operations such as sawing, milling, planning, routing, drilling and sanding. It is composed of fine particles of wood. These operations can be performed by woodworking machinery, portable power tools or by use of hand tools.

COMPRESSION MOULDING:

Compression Moulding is a method of moulding in which the moulding material, generally preheated, is first placed in an open, heated mould cavity. The mould is closed with a

top force or plug member, pressure is applied to force the material into contact with all mould areas, while heat and pressure are maintained until the moulding material has cured. The process employs thermosetting resins in a partially cured stage, either in the form of granules, putty-like masses, or preforms.

Compression molding is a high-volume, high- pressure method suitable for molding complex, high-strength fillerglass reinforcements.

Advanced composite thermoplastics can also be compression molded with unidirectional tapes, woven fabrics, randomly oriented fiber mat or chopped strand. The advantage of compression molding is its ability to mold large, fairly intricate parts. Also, it is one of the lowest cost molding methods compared with other methods such as transfer molding and injection molding; moreover it wastes relatively little material, giving it an advantage when working with expensive compounds.

However, compression molding often provides poor product consistency and difficulty in controlling flashing, and it is not suitable for some types of parts. Fewer knit lines are produced and a smaller amount of filler-length degradation is noticeable when compared to injection molding. Compression-molding is also suitable for ultra- large basic shape production in sizes beyond the capacity of extrusion techniques. Materials that are typically manufactured through compression molding include: Polyester filler glass resin systems (SMC/BMC), Torlon,Vespel, Poly(p- phenylene sulfide) (PPS), and many grades of PEEK.Compression molding is commonly utilized by product development engineers seeking cost effective rubber and silicone parts. Manufacturers of low volume compression molded components include Print Form, 3D, STYS, and Aero MFG.

Compression molding was first developed to manufacture composite parts for metal replacement application compression molding is typically used to make larger flat or moderately curved parts. This method of molding is greatly used in manufacturing automotive parts such as hoods, fenders, scoops, spoilers, as well as smaller more intricate parts.

FABRICATION WORK:

The following steps are followed during fabrication process:

1. Prepare the binding mixture in a proper proportion. For 170ml of Vinyl ester Resin, 8ml of Accelerator and 8ml of Catalyst are mixed together.
2. Apply wax on the MS plate and allow it to dry.
3. Place the rectangular die with size 200mm x200mm x 3mm on the MS plate for preparing the composites.
4. Apply binding mixture inside the die, which acts as polyester resin matrix.

5. In compression moulding the upper jaw are moves downward and press the binding mixture to spread into the die.
6. Then pumping and increase the pressure and temperature.
7. After 15 minutes then release the pressure.
8. Remove the composite plate form the die.
9. Again the step to be followed.

10. Allow it to dry for 3 to 5 hours.

III. MECHANICAL TESTING Loading Characteristics of Composites

There are four main direct loads that any material in a structure has to withstand

1. Tension
2. Flexural
3. Impact

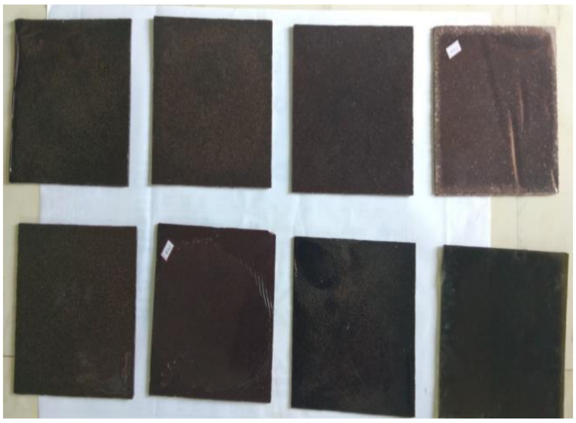
Tension

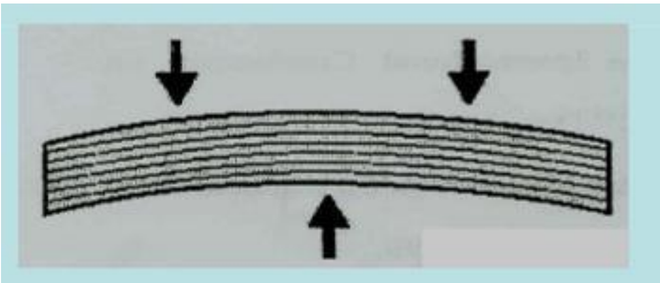
The response of the composite materials to tensile loads depends on the tensile stiffness and strength properties of the reinforcement's filler. These are far higher for filler compared to the resin systems.

Flexural

Flexure loads are a combination of tensile, compressive and shear loads

- The upper face experience compression
- the lower face experience tension and
- Central portion of the laminates experiences shear





Impact

Izod impact testing is an ASTM standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific height 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.

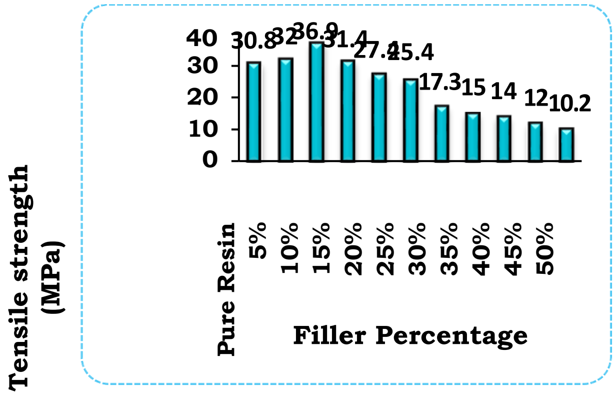
I. RESULT AND DISCUSSION Mechanical Properties

Tensile Strength.

The different weight percentages of the waste hybrid reinforced composite specimens are tested on a digital universal testing machine, and the specimen is left to break until the ultimate tensile strengths occur. The tensile strength of waste hybrid composites. The tensile strength increases from 30.8 to 32 MPa, when the filler content is increased from 0 to 5%. The poor dispersion of waste hybrid with the matrix initially decreases the strength, but then for 10%, the content accumulation is more in the waste hybrid composites, and it increases the tensile strength from 32 to 36.9 MPa between 5 to 10 wt%. The percentage of improvement in tensile strength in the present case filler is 13.27%. In the present work, the ultimate tensile strength of waste hybrid composites exhibits 31.4 MPa for filler content of 15 wt%, due to the mixing of waste hybrid and the distribution of filler content is even in the composite specimen. This could lead to more

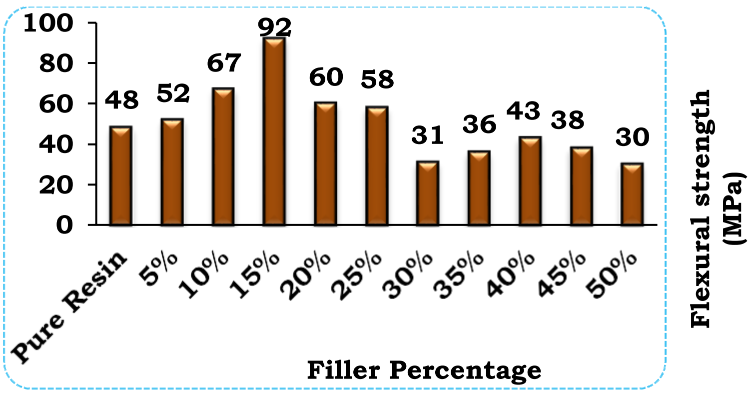
		Tensile	Tensile	Elongation
Sl.No	Filler Percentage	trength (MPa)	Tensile modulus (GPa)	Elongation at break (%)
1.	**Pure Resin**	30.8	1.38	2.2
2.	**5%**	32	1.39	2.3
3.	**10%**	36.9	2.23	1.65
4.	**15%**	31.4	1.92	1.63
5.	**20%**	27.4	1.97	1.39
6.	**25%**	25.4	2.11	1.2
7.	**30%**	17.3	1.71	1.01
8.	**35%**	15	1.76	0.85
9.	**40%**	14	2.20	0.612
10.	**45%**	12	2.22	0.54
11.	**50%**	10.2	1.60	0.625

Efficient stress transfer from the matrix to the filler under tensile loading, which is important in obtaining the highest possible tensile strength. The tensile modulus and elongation of waste hybrid composites. The ultimate tensile modulus of waste hybrid composites is 1.92 GPa, when the filler content is at 15 wt%. The maximum elongation (1.63%) is obtained at 15 wt%.It is clearly visible that elongation increases from 2.1 to 3.24%, due to the addition of TSF in composites. The elongation at break in filler content of 25 wt% is higher than that of pure resin. It changes the nature of the material from brittle to ductile. The tensile strength of the waste hybrid composite is higher than that of (36%) sawdust reinforced polyester composites, (36%) rice husk reinforced polyester composites, and (48%) red mud polyester reinforced composites decreases up to 58 MPa at 25 wt% and 31 MPa at 30 wt% due to good wet ability of hybrid waste filler and distribution of more amount of hybrid waste filler uniformly with VE resin.



Flexural Strength.

In structural applications, one of the ultimate and universally measured properties of the composite material is flexural strength. The effect of different weight percentages of the waste hybrid composite on the values of flexural strength and flexural modulus. The waste hybrid composite manifests clearly high flexural strength of 92 MPa at 15 wt%. The percentage of improvement in flexural strength between the pure resin and 15 wt% of waste hybrid composite is 47.82%.This result indicates that increase of filler matrix interaction also enables higher stress to be transferred from the matrix to the waste hybrid filler during external loading. For 5%, the flexural strength of waste hybrid composites is found to be 52 MPa which is comparatively 7.69% higher than the pure VE resin. Waste hybrid composites increase the flexural strength from 52 to 67 MPa between 5 and 10 wt%. For 20%, the tensile strength of waste hybrid composites suddenly decreases from 60 to 58 MPa, due to poor packing between filler and matrix. Compared to the pure VE, the optimum percentages of flexural strength from different wt% of waste hybrid composites is obtained at 15, 25, and 58wt %. Again, the flexural strength rapidly



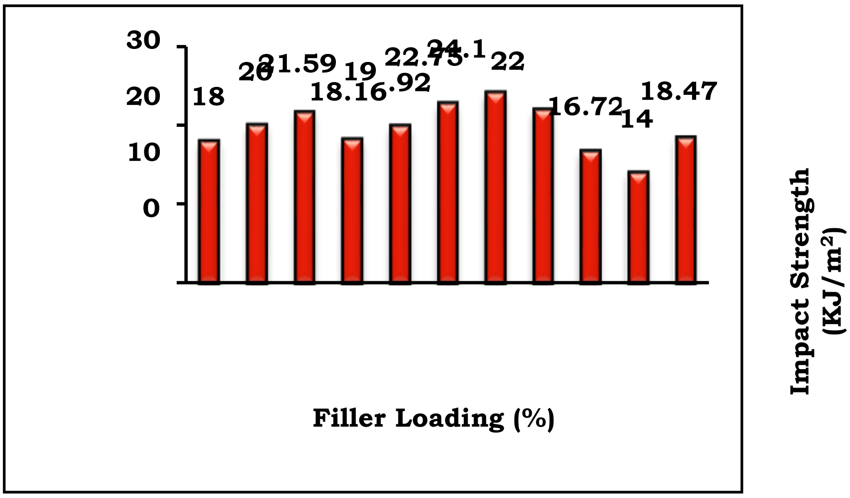
Sl.No	Filler Percentage	Flexural trength (MPa)	Elongation at break (%)
1.	**Pure Resin**	48	2.14
2.	5%	52	1.52
3.	10%	67	1.21
4.	15%	92	1.53
5.	20%	60	1.66
6.	25%	58	1.07
7.	30%	31	1.04
8.	35%	36	1.57
9.	40%	43	0.98
10.	45%	38	1.18
11.	50%	30	1.17

Impact Strength.

The weight percentage of the waste hybrid composite increases, the value of impact strength

Increases. The composite with 30 wt% of filler has

24.12 kJ/m^2, which is higher than that of pure Vinylester matrix. The impact strength increases by 25.37% for the waste hybrid reinforced composite. It is noted that the addition of waste hybrid reinforced increases the strength of 30 wt% and for the remaining weight percentages, low impact values are obtained due to poor dispersion of the TSF in the matrix. In addition to that less VE content in the highest hybrid waste filler-filled composites has caused a reduction in the ability of the composites to absorb the impact energy.



Sl.No	Filler Percentage	Impact strength (kJ/m²)
1.	0%	18
2.	5%	20
3.	10%	21.59
4.	15%	18.16
5.	20%	19.92
6.	25%	22.75
7.	30%	24.12
8.	35%	22
9.	40%	16.72
10.	45%	14
11.	50%	18.47

IV. CONCLUSION

In this work, the mechanical of hybrid waste filler composites are successfully studied. From the observed results, the following points are drawn:

First, the tensile, flexural, and impact properties of hybrid waste filler composites are found to be dependent on the filler weight percentage, by which indicates an optimum filler weight percentage of 30, respectively. The tensile strength of waste hybrid composites exhibits good tensile properties, which are relatively higher than that of reinforced polymer composites. The elongation at break occurs between 1.55 and 3.25%.Flexural tests reveal that the flexural strength is approximately 149 MPa, and the impact strength is estimated to be around 17.03 kJ/m^2. Additionally, mechanical and thermal properties test results of this study have proved that hybrid waste composite can be used to fabricate the products such as wheel hubcap of heavy-duty buses, bus seat backrest cover, and silencer guard for motorcycle at minimum cost with high toughness, high rigidity, and low heat absorption.

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