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MECHANICAL TESTING OF POLYMER COMPOSITE MATERIAL

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Abstract- High rigidity and a high strength to weight ratio are benefits of polymeric materials reinforced with synthetic fibers like glass, carbon, and aramid over traditional building materials like steel, concrete, and wood. Despite these benefits, synthetic fiber-reinforced polymer composites are becoming less and less common due to their high starting prices, inefficient structural forms, and—most importantly—disastrous environmental effects. On the other hand, one of the key reasons to investigate the possibility of employing natural fibers as reinforcement for polymers is the growing interest in using them as reinforcement in plastics to replace traditional synthetic fibers in several structural applications. Due of this, scientists have concentrated on studying natural fiber composites, also known as bio-composites, which are made of natural or synthetic resins and reinforced with natural fibers. Because renewable raw materials are healthy and do not harm the environment, researchers from all over the globe have been pursuing the production of high-performance engineered materials from renewable resources.

Key words: Composite materials, Polymer composite material, tensile test, impact test etc.

1. INTRODUCTION

A composite is mixture of two materials in which one of the materials, known as the reinforforcing phase, is in the structure of fibers, sheets, or particles, and is embedded in the other materials known as the matrix phase. The reinforcing fabric and the matrix material can be meta l, ceramic, or polymer. Composites usually have a fiber or particle segment that is stiffer and more suitable than the continuous matrix segment and serve as the primary load carrying m embers. The matrix acts as a load switch medium between fibers.. The matrix is greater ductile than the fibers and thus acts as a source of composite toughness. The matrix additionally serves to guard the fibers from environmental damage before, for the duration of and after composite processing. When designed properly, the new mixed material reveals higher strengthh than would each character material. Composites are used now not only for their structural properties, however additionally for electrical, thermal, tribological, and environmental applications.

1.1. CLASSIFICATION OF COMPOSITES

Composite materials are commonly classified at following two distinct levels

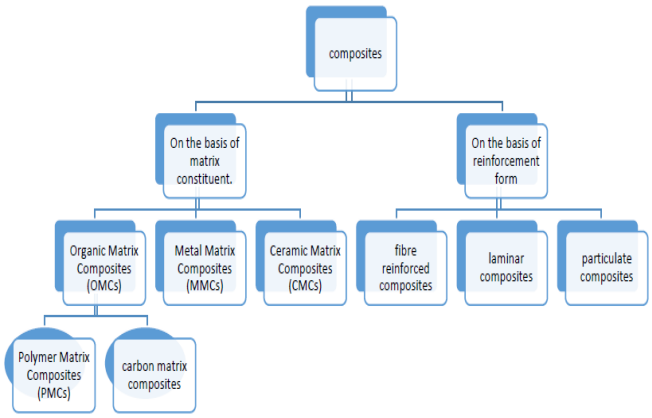

Fig.1.1- Classification of composite materials

1.2. OBJECTIVE OF THE STUDY

The main objective is to study and evaluate the mechanical and physical properties of polycarbonate granules as a reinforcement material in the epoxy resin matrix. A series of composite material will be developed by varying the weight% of polycarbonate granules that is 2%, 3%, 4% & 5%. And testing will be performed in order to analyze the mechanical properties of the developed material. The various tests include tensile test, impact test & bending test,

- To develop a series of polymer composite material by varying percentage of polycarbonate granules.
- To evaluate the physical mechanical characterization for the developed composite materials.
- Based on the strength of the composites suitable application will be predicted for automobile applications.

2. METHODOLOGY AND EXPERIMENTATION

2.1. MATERIAL SELECTED

a. Polycarbonate:

Polycarbonates (PC) are a crew of thermoplastic polymers containing carbonate agencies in their chemical structures. Polycarbonates used in engineering are strong, challenging materials, and some grades are optically transparent. They are without difficulty worked, molded, a nd thermoformed. Because of these properties, polycarbonates discover many applications.

Fig. 2.1- Polycarbonate granules

Properties of Polycarbonate:-

Physical properties-

- Density-1.2- 1.22 g/cc
- Refractive index- 1.584-1.586

Mechanical properties :

- Young's modulus- 2.0-2.4 Gpa
- Tensile strength- 55-75 Mpa

Thermal properties :

- Melting temperature- 155 degrees
- Thermal conductivities- 0.19- 0.22 W/(m-K**)**

b. Epoxy:

Epoxy may be a term used to denote each the fundamental parts and therefore the cured finis h products of epoxy resins, further as a conversational name for the epoxide functional group. Epoxy resins, additionally called poly epoxides area unit a category of reactive pre- polymers and polymers that contain epoxide teams. Epoxy resins are the foremost ordinarily used resins. they're low relative molecular mass organic liquids containing epoxide groups. Epoxide has 3 members in its ring: one atomic number 8 and 2 carbon atoms. The reaction of epichlorohydrin with phenols or aromatic amines makes most epoxies and fillers are supplemental to provide epoxies with a large vary of properties of consistence, impact, degradation, etc. the room temperature properties of a typical epoxy. though epoxy is costlier than different polymer matrices, it's the foremost common PMC matrix. over two- thirds of the compound matrices utilized in region applications are epoxy based mostly.

Properties of epoxy:

- Better adhesive properties
- Superior mechanical homes (strength and stiffness)
- Improved resistance to fatigue and micro-cracking
- Highly water resistant
- Increased resistance to osmosis
- No unstable products & exothermic response
- Due to polarity of aliphatic hydroxyl crew and ether group promotes electromagneticbonding
- High strength

c. Epoxy hardener (Araldite HY 951):

Hardener is used as solvent .in this project EH-9510 hardener is used. Hardeners are Substances that are added to polymers for aiding in curing of composites. Hardeners are use d to enhance the physical properties of epoxy resins such as adhesion, impact strength and toalter the viscosity of the polymer matrix. It also improves the life, lower exothermic and reduce shrinkage.

Applications of epoxy hardeners –

- Solvent free, high coatings.
- Pipeline & tank coatings.
- Adhesives
- Surface tolerant primers for metallic substrate.
- Marine & industrial coatings.

d. Filler:

Fillers are the particles added to materials to:

- Lower the consumption of expensive binder material.
- Better the properties of the mixture material.
- Filler has two types:

Natural filler: Sugarcane – Rice husk, wheat husk, coconut coir.

Synthetic filler: Glass, carbon

Advantages of natural filler over synthetic filler:

- Availability of renewable natural resources
- Satisfactory high specific strength and light weight
- Low cost and bio-degradability
- Eco-friendly

e. Sugar cane waste:

Sugar will used filler material. Sugarcane trash (or cane trash) is a wonderful biomass resource in sugar- producing

countries worldwide. the number of cane trash manufacture depends on the plant selection, age of the crop at harvest and soil and weather. Cane waste bin doubtless be reborn into heat and electricity. This trash contains twenty eight.6%- organic carbon, 0.35 to 0.42% N, 0.04 to 0.15% phosphorus, 0.50 to 0.42% atomic number 19. The sugarcane trash incorporation within the soil influences physical, chemical and biological properties of the soil.

2.2. CALCULATIONS

- Volume of specimen = 25 x 20 x 0.4 cc
- Density of natural fiber = 0.904 gm/cc
- Density of epoxy = 1.2 gm/cc
- Density of polycarbonate = 1.8 gm/cc
- Volume of specimen = 25x20 x .4 cc
- Density of natural fiber = 0.904 gm/cc
- Density of epoxy = 1.2 gm/cc
- Density of polycarbonate = 1.8 gm/cc

2.2.1. Table of calculation:

The following table represents the percentage composition of material taken for the p reparation of the different samples

Table 0-1- PercentageComposition

Sample No	Epoxy	Natural fiber	Polycarbonate
1	83%	15 %	2%
2	82%	15 %	3%
3	81%	15 %	4%
4	80%	15 %	5%

The following four table represents the mass of the different material taken for the preparation of the different specimen (calculated according to their density and percentage composition)

Table 2-MassCalculationForDifferentSamples

SAMPLE NO- 1

	Epoxy	Natural fiber	Polycarbonate	methyl chloride
Volume (cc)	166	30	4	50 ml
Mass (gm.)	199.7	27.12	7	
Mass with allowance (10%)	219.12	29.83	7.92	

SAMPLE NO- 2

	Epoxy	Natural fiber	polycarbonate	methyl chloride
Volume (cc)	164	30	6	50 ml
Mass (gm.)	196.8	27.12	10.8	
Mass with allowance (10%)	216.48	29.93	11.89	

SAMPLE 3

	Epoxy	Natural fiber	polycarbonate	Methylchloride
Volume	162	30	8	50 ml
Mass	194.4	27.12	14.4	
Mass with allowance (10%)	213.84	29.83	15.84	

SAMPLE NO-4

	Epoxy	Natural fiber	polycarbonate	methyl chloride
Volume	160	30	10	50 ml
Mass	192	27.12	18	
Mass with allowance (10%)	211.2	29.83	19.8	

3. FABRICATION OF COMPOSITE

- Compression moulding process
- Hand lay-up method

3.1. Compression moulding process

Compression molding is a method of moulding in which the moulding material, usually preheated, is first positioned in an open, heated mold cavity. The mold is closed with a t op pressure or plug member, pressure is applied to pressure the material into contact wit h all mould areas, while heat and stress are maintained until the molding material has cured.

3.2. Mold Preparation

- We have prepared a mold ofi25x20x0.4 cc
- We took a smooth tile and placed OHP sheet on that tile and draw a margin ofi25x20on the sheet and used 2mm thick double sided tape to provide thickness ofi4mm.

Figure 3.1- Mold preparation

3.3. Sheet Preparation:

- We took 50ml of methyl chloride and added mass of polycarbonate according to ourcalculations
- Then kept it for 30 minutes so that pc granules could dissolve in methyl chloride.
- Then we took epoxy natural fiber and previously dissolved pc granules in a beaker and mixed them with the help of blender.
- We put this mixture in mold that we had already prepared with appropriate dimensionns.
- With the help of roller, we spread the mixture into the mold properly and took care of bubble formation.

Figure 3.2- Mixing of Epoxy polycarbonate

3.4. Curing Time:

- After preparing the mold we put it under room temperature up to 48 hours with someweight over weight it.
- After 48 hours it becomes flexible sheet and then we put it under furnace about 3 hours under temperature 65 degree Celsius.

Figure 3.3- Sample sheet

3.5. CUTTING OF SAMPLE IN DESIRED DIMENSION:

A Rack saw blade was used to cut each laminate into smaller pieces, for various experiments
Tensile test sample details:

- Sample was cut into dog bone shape (17x2x2) cm

Figure 0.5- Dog -bone shape

3.6. Tensile test :

The tensile strength of a material is that the most quantity of tensile stress that it will take before failure. The usually used specimen for tensile check is that the dog-bone kind. throughout the check a uniaxial load is applied through each the ends of the specimen. The dimension of specimen is (17x2x2)cm. Typical purposes of interest once testing a material include: final durability (UTS) or peak stress; offset yield strength (OYS) that represents a degree simply on the far side the onset of permanent deformation; and therefore the rrupture (R) or fracture point wherever the specimen separates into pieces. The tensile check i s performed within the universal testing machine (UTM) Instron 1195 and results are analyzed to calculate the tensile strength of composites.

4. RESULTSANDDISCUSSION

4.1. TENSILE TEST RESULTS

ASTM D638 is one of the most common plastic strength specification and cover the tensile properties of

unreinforced and reinforced plastic this test approach uses wellknown "dumbbell" Or "d g bone" shape. A widespread checking out m/c is needed to perform this test.

Table 0-1-TensileTestsResults

S.No.	Samples developed depending on percentage of Polycarbonate	Test Result (N/mm^2)			Aggregate Result
		Specimen 1	Specimen 2	Specimen 3	
1	Sample 1 (2%)	21.88	18.21	18.12	19.40
2	Sample 2 (3%)	19.05	18.48	13.72	17.08
3	Sample 3 (4%)	21.14	20.48	20.85	20.82
4	Sample4 (5%)	17.45	18.22	12.83	16.16

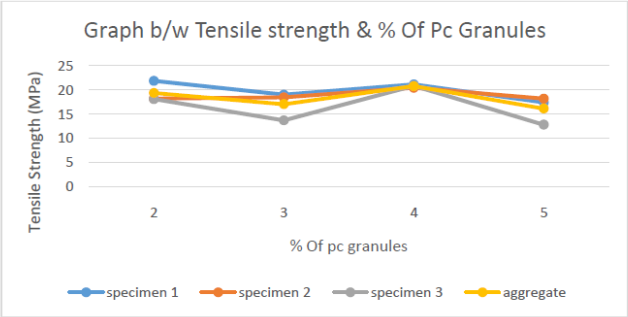

Figure 4.1- Graph between tensile strength & "percentage of pc granules"

4.2. FLEXURAL STRENGHT TEST RESULT

Bend test (also flex or flexural testing) is commonly performed to measure the flexural strength .this test is performed on universal testing m/c with a 3 point or 4 point bend fixture.

Table 0-2 – Flexural test Results

S.No.	Samples developed depending on percentage of Polycarbonate	Test Result (N/mm^2)			Aggregate Result
		Specimen 1	Specimen 2	Specimen 3	
1	Sample 1 (2%)	66.27	57.10	39.84	54.40
2	Sample 2 (3%)	38.38	38.91	34.02	35.44
3	Sample 3 (4%)	40.11	30.09	28.00	24.06
4	Sample4 (5%)	35.76	38.18	36.95	36.96

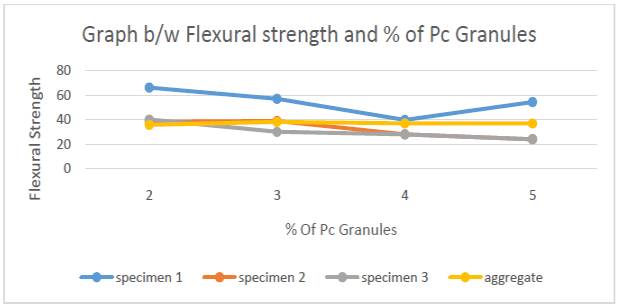

Figure 4.2- Graph between flexural strength and % of pc granules

4.3. IMPACT TEST RESULT:

Izod Impact is single point test that measure a substances resistance to have an effect on fro m a swinging pendulum. Izod influence is defined as the kinetic energy needed to initiate fracture and continue the fracture till the specimen is broken. Izod specimen are notched to pre vent deformation of the specimen upon impact. This check can be used as a quick and easy quality manage test to determine if a material meets specific impact residences or to evaluate materials for ordinary toughness.

Table 0-3- Impact Test Results

S.No.	Samples developed depending on percentage of Polycarbonate	Test Result Joules / M			Aggregate Result
		Specimen 1	Specimen 2	Specimen 3	
1	Sample 1 (2%)	6.2	6.1	8.2	6.83
2	Sample 2 (3%)	5.4	7.2	12.5	8.36
3	Sample 3 (4%)	13.1	5.7	15.1	11.3
4	Sample4 (5%)	5.9	7.3	6.1	6.4

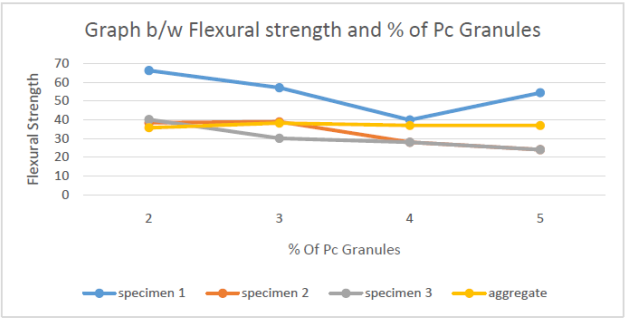

Figure- 4.3 Graph between impact strength & "percentage of pc granules"

5. CONCLUSION:

- A series of polymer composites material has been successfully developed by varying % of polycarbonate.
- Mechanical tests such as tensile, elongation, flexural and impact test were successfully carried as per the ASTM standard.
- Physical characterization such as density and particle size test were carried out successfully.
- Developed composite having 4% polycarbonate is showing good results in tensile testt.
- Developed composite having 2% filler by weight is showing good results in flexuralstrength.
- It is observed that when percentage polycarbonate increases, tensile strength of the specimen increases up to 4% and then it shows decline.

- The impact strength comes out to be maximum at 4% filler content and then it starts decreasing when the percentage of polycarbonate content increases

6. FUTURE SCOPE:

- As we all know waste management is one of the biggest challenges of the future. As population is increasing rapidly we have to be ready for an alternative resource which can fulfill the demand of people. Sugarcane trash is an agricultural waste material which can be utilized in the development of material. This will minimize the deposition of waste material which is produced by industries and help in waste management.

- Since the strength of developed composite material obtained is low, it can be increased by silage treatment of filler material or by using hybrid filler. We can add thermoplastic like poly carbonate for increasing the toughness of the material, the flexural strength increases by adding the pc and now the flexibility of the sheet has increased and it is no longer brittle and no w can bear more load.

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