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Analysis of Mechanical Properties and Behaviour of Polymer Composite Material

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Abstract
Particulate fillers are of significant hobby, not simplest from an financial point of view, but as modifiers especially the physical properties of the polymer. A incredible boost inside the polymer enterprise has been using fiber and particulate fillers as reinforcements in polymer matrix. Over the previous few many years, the substantial interest has been devoted toward rice husk stuffed polymer composites because of its many benefits. those encompass specially the stepped forward environmental performance, due to the usage of biodegradable substances and the reduction within the use of non-renewable (oil based) resources during the entire life cycle of the composite; the low price of rice husk, the lower unique weight of those fillers, in comparison to the traditional mineral-inorganic ones; the development in safety for the manufacturing employees and the unique aesthetic residences of the composites. even though there are numerous reports inside the literature which speak the mechanical conduct of timber/polymer composites, however, very restrained paintings has been accomplished on effect of rice husk fillers on mechanical conduct glass fiber-based polymer composites. towards this history, the present studies work has been undertaken, with an objective to explore the capacity usage of rice husk dirt filler as a reinforcing fabric in polymer composites and to investigate its effect at the mechanical behavior of the ensuing composites. in the end, the SEM evaluation has been made on fractured surfaces of composites after exclusive exams.

Keyword: SEM, Epoxy-Resin, Hardner, fillers, composite, polymer

Introduction

Owing to their excellent mechanical properties, composite materials have been widely used throughout the last four decades. A composite material is defined as a combination of two or more materials that results in better properties than when the individual components are used alone. As opposed to metal alloys, each material retains its separate chemical, physical and mechanical properties, etc. Composite materials are consisting of one or more discontinuous phases embedded in a continuous phase. The discontinuous phases are usually harder and stronger than the continuous phases and are called the 'reinforcements 'or 'reinforcing materials', whereas the continuous phase is termed as the ' matrix' which is more ductile and less hard. The reinforcements serve to strengthen the composites and improve the overall mechanical properties of the matrix. Properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them. The composite properties may be the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) influences the properties of the composite to a great extent. The concentration distribution and orientation of the reinforcement also affect the properties. The interface has characteristics that are not depicted by any of the component in isolation. The interface is a bounding surface or zone where a discontinuity occurs, whether physical, mechanical, chemical etc. The matrix material must "wet" the fiber. To obtain desirable properties in a composite, the applied load should be effectively transferred from the matrix to the fibers via the interface. This means that the interface must be large and exhibit strong adhesion between fibers and matrix. Failure at the interface (called deboning) may or may not be desirable.

Methodology

This chapter describes the details of processing of the composites and the experimental procedures followed for their characterization evaluation. The raw materials used in this work are

1. E-glass Fibre
2. Epoxy resin
3. Rice husk dust
4. Hardener

2.1. Specimen preparation

Cross plied E-glass fibers are reinforced in epoxy resin to put together he composite. The composite slabs are made via traditional hand-lay-up approach. Rice husk dirt (discern 2.1) is used as particulate filler in this composite due to the fact Rice husk is abundantly to be had in India. Rice husk dirt is gathered from local dealer is sieved to attain particle length in the range 300 μm. The low temperature curing epoxy resin (LY 556) and corresponding hardener (HY951) are mixed in a ratio of 10:1 by way of weight as encouraged. Epoxy LY 556 resin is chemically belonging to the 'epoxide' family and its commonplace name is Bisphenol Adiglycidyl Ether. The epoxy resin and the hardener are furnished by way of Ciba Geigy India Ltd. Composites of 3 one of a kind compositions (zero wt%, 10 wt% and 20 wt% alumina filling) are made and the fiber loading (weight fraction of glass fiber inside the composite) is stored at 50% for all of the samples. The castings are placed under load for

About 24 hours for correct curing at room temperature. The designations of these composites are given in desk

2.1. The mixture is stirred manually to disperse the fibers in the matrix. The solid of every composite is cured below a load of approximately 50 kg for 24 hours earlier than it eliminated from the mildew. Then this solid is put up cured inside the air for

every other 24 hours after casting off out of the mold. Specimens of appropriate measurement are reduce the usage of a diamond cutter for mechanical testing.

Figure 2.1: Rice husk dust

Table 2.1: Designation of Composites

C1	Epoxy (50 wt%) + Glass fiber (50 wt%) + Rice husk dust (0 wt%)
C2	Epoxy (50 wt%) + Glass fiber (50 wt%) + Rice husk dust (5 wt%)
C3	Epoxy (50 wt%) + Glass fiber (50 wt%) +Rice husk dust (10 wt%)

2.2. Mechanical trying out

After fabrication the take a look at specimens had been subjected to various mechanical assessments as per ASTM requirements. The tensile take a look at and three-point flexural exams of composites were accomplished using Instron 1195. The tensile test is typically carried out on flat specimens. A uniaxial load is applied via both the ends. The ASTM standard check approach for tensile homes of fiber resin composites has the designation D 3039-76. Micro-hardness size is accomplished the use of a Leitz micro-hardness tester. A diamond indenter, in the shape of a right pyramid with a square base and an perspective 1360 among contrary faces, is forced into the cloth beneath a load F. The diagonals X and Y of the indentation left at the floor of the cloth after elimination of the load are measured and their mathematics mean L is calculated. within the gift look at, the weight considered F = 24.54N. Low pace instrumented impact exams are executed on composite specimens. The assessments are accomplished as consistent with ASTM D256 the use of an effect tester. The charpy effect trying out machine has been used for measuring effect electricity. figure 2.2 suggests the examined specimens for tensile, flexural, impact and hardness take a look at respectively. parent 2.three shows the experimental installation and loading arrangement for the specimens for tensile and 3 factor bend test.

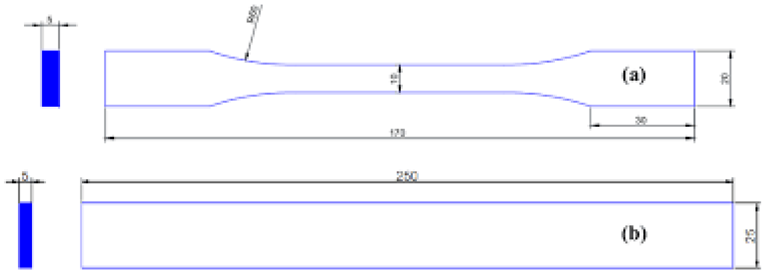


Figure 2.2: Tested Specimen

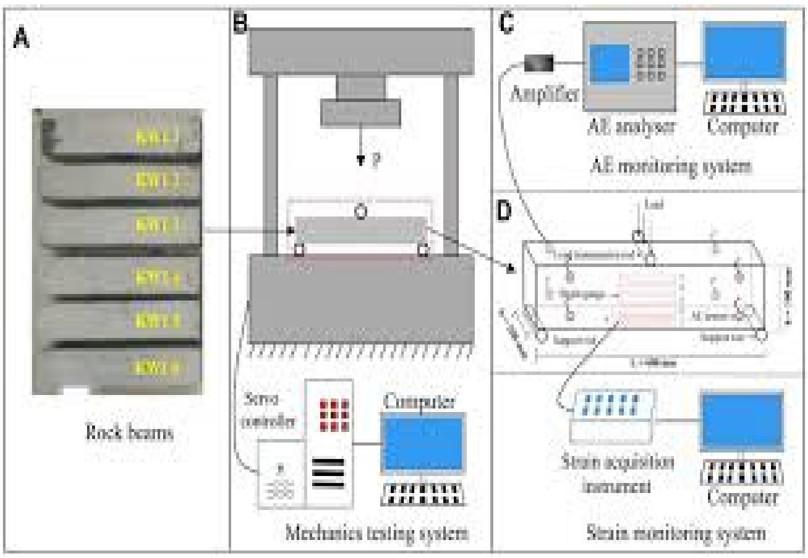


Figure 2.3: Experimental set up and loading arrangement for the specimens for tensile test and three points bend test

2.3 Scanning electron microscopy (SEM)

The scanning electron microscope (SEM) JEOL JSM-6480LV (determine 2.4) changed into used to become aware of the tensile fracture morphology of the composite samples. The surfaces of the composite specimens are examined directly via scanning electron microscope JEOL JSM-6480LV. The samples are washed, cleaned very well, air-dried and are coated with one hundred Å thick platinum in JEOL sputter ion coater and located SEM at 20 kV. similarly the composite samples are hooked up on stubs with silver paste. To beautify the conductivity of the samples, a skinny film of platinum is vacuum-evaporated onto them before the photomicrographs are taken

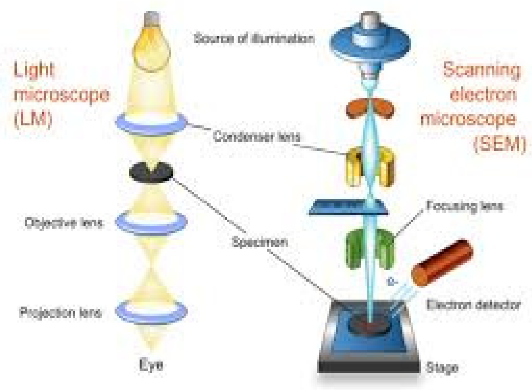


Figure 2.4: SEM Set up

2.4 statistics evaluation

The acquired records from the mechanical trying out and SEM analysis are statistically analyzed the usage of appropriate software. The outcomes are provided in the shape of tables, graphs, and micrographs, and are interpreted to draw conclusions about the mechanical conduct of the polymer-based composites with and with out wood dirt filler.

III. **Result and Discussion**

The This chapter presents the mechanical houses of the wood dirt stuffed glass fiber bolstered epoxy Composites prepared for this gift research. info of processing of those composites and the tests performed on them were described inside the previous chapter. The effects of numerous characterization checks are mentioned here. This consists of assessment of tensile electricity, flexural electricity, effect power and micro hardness has been studied and mentioned. the interpretation of the consequences and the comparison among various composite samples are also provided.

3.1 Mechanical characteristics of Composites

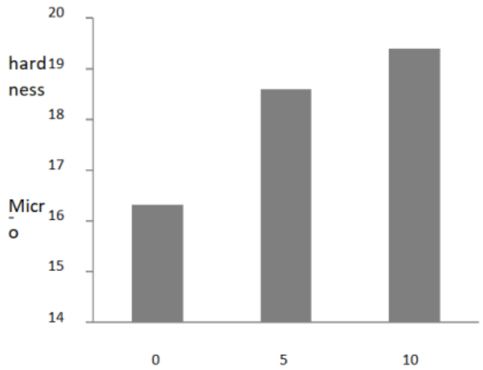
The characterization of the composites reveals that the filler content is having significant impact on the mechanical properties of composites. The mechanical properties of the composites with different filler content material under this investigation are supplied in table 3.1

Table 3.1: Mechanical properties of the composites

Composites	Hardness (Hv)	Tensile strength (MPa)	Tensile modulus (GPa)	Flexural strength (MPa)	Impact energy (KJ/m2)
C1	16.41	73.30	4.105	19.10	9.90
C2	18.72	87.56	4.150	23.90	12.57
C3	19.50	134.5	4.678	44.05	15.52

3.1.1 Effect of filler content on Micro-hardness

figure 3.1 suggests the have an effect on of filler content on micro-hardness of wood dust filled glass fiber strengthened epoxy composites. From the discern it's miles clear that filler content has huge affect over micro-hardness. With the filler content the micro-hardness cost increases and reaches most as much as 19.4Hv for filler up to20 wt%.

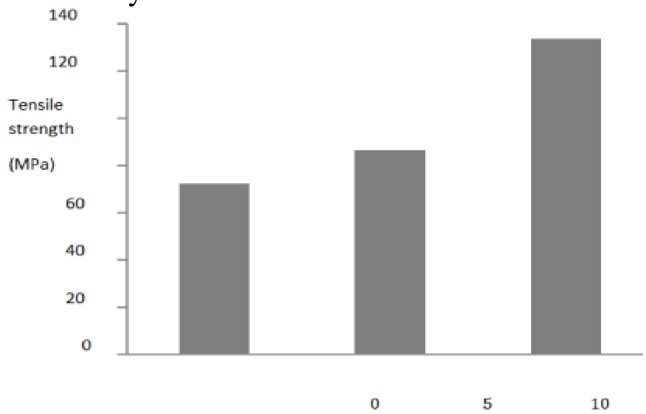


Filler content (w%)

Figure 3.1: Effect of filler content on micro-hardness of the composites

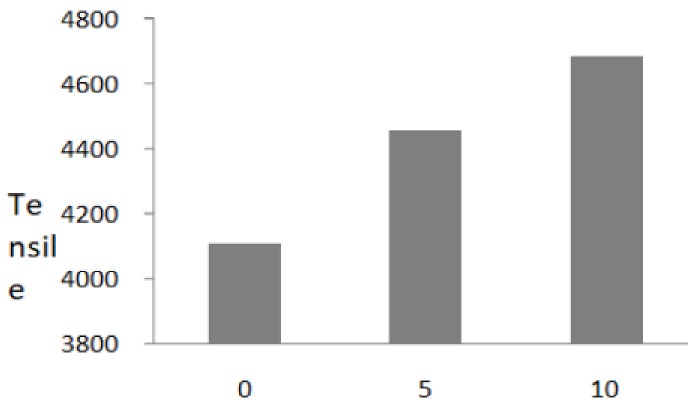
3.1.2. Impact of filler content on tensile homes

The impact of filler content material on tensile strengths and moduli are proven in Figures 3.2 and a couple of.3, respectively. It is visible that the tensile electricity of the composite will increase with increase in filler content. There may be reasons for this growth in the energy properties of these composites as compared. One opportunity is that the chemical reaction at the interface among the filler debris and the matrix may be too robust to switch the tensile. From discern three.3 it's far clean that with the growth in fiber period the tensile moduli of the Rice husk dust stuffed glass fiber bolstered epoxy composites increases considerably.



Filler content (w%)

Figure 3.2: Effect of filler content on tensile strength of composites

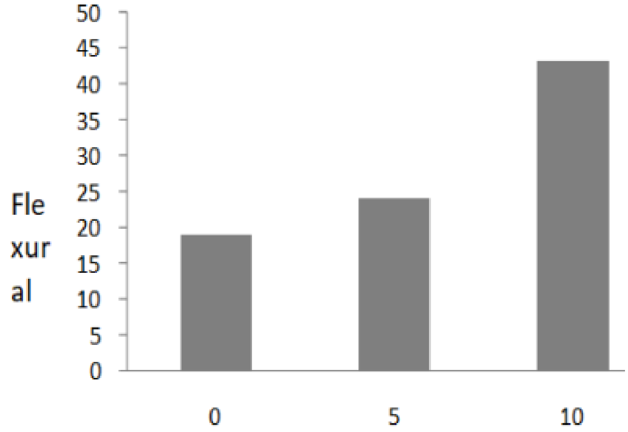


Filler content (w%)

Figure 3.3 Effect of filler content on tensile modulus of composites

3.1.3. Effect of filler content material on Flexural energy

figure 3.4 indicates the evaluation of flexural strengths of the composites acquired experimentally from the bend checks. it's far interesting to observe that flexural electricity will increase with boom in filler content material. this may be because of the good compatibility of filler and epoxy resin

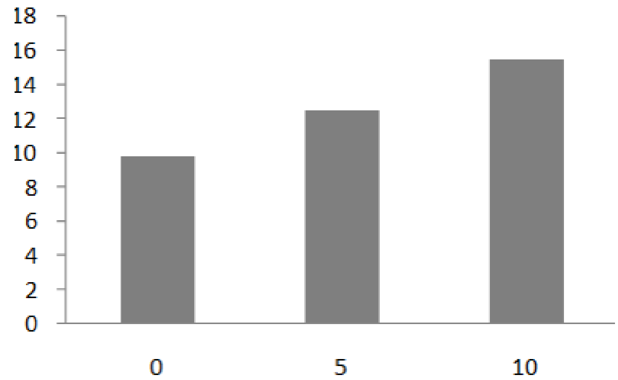


Filler content (w%)

Figure 3.4: Effect of filler content on flexural strength of composites

3.1.4 Impact of filler content material on impact power

The effect electricity values of various composites recorded throughout the effect assessments are given in table 3.1. It indicates that the resistance to effect loading of Rice husk dirt crammed glass fiber bolstered epoxy composites improves with boom in filler content as shown in parent 3.5 high stress fees or effect hundreds may be predicted in many engineering packages of composite materials. The suitability of a composite for such packages should therefore be decided not simplest via traditional design parameters, but by way of its effect or energy Soaking up properties



Filler content (w%)

Figure 3.5 Effect of filler content on impact strength of composites

3.2. Floor morphology of the composites

The fracture surfaces look at of glass fiber reinforced epoxy resin packed with Rice husk dust composites after the tensile check, flexural test and effect test has been shown in parent three.6. Figures 4.6a-b display the SEM of tensile failure surfaces of Rice husk stuffed glass-epoxy composites with 0wt% to 10wt% at an interval of 5wt%of Rice husk filler has been delivered. within the gift work with boom in Rice husk dust from unfilled to crammed composites the tensile power goes on increase. it may be seen that at 5wt% Rice husk dirt there may be very excessive

Pull- out of glass fiber at the fracture surface of the composite. The surfaces of composites show that failure befell on the timber dirt because of robust adhesion between dirt and matrix (determine 4.6a). however, the failure floor of different composites with slightly better husk dirt content material i.e 10wt%

shows better tensile electricity (discern 4.6a) and from figure four.6b the tensile fracture is much less compared with 5wt% of husk dirt composites. beneath a flexural strength loading situation, the fillers apparently aid the weight bearing capability of a composite, in preference to act as strain raiser as is the case in tensile loading. this is due to compressive stresses tends to close cracks at the higher floor of the composites and flaws which might be perpendicular to the implemented pressure, contrary to the crack beginning mechanism taking place in a tensile loading scenario [48, 49].it is well known that
bearing failure occurs inside the fabric right away adjacent to the contact place between the fastener and the laminate and is brought about mostly via compressive stresses acting at the hole floor. At better weight fractions of wooden dirt particle, the negative interface bonding or adhesion between the wooden dust and the epoxy resin matrix, or the presence of a huge agglomerate segment within the matrix may arise and cause the lower bearing strengths. The presence of agglomeration within the composites glaringly deteriorates their mechanical properties. Agglomerations may additionally effortlessly take place for smaller particles at higher filler contents due to the decreased inter particle distance.
Agglomerates are vulnerable points in the material and break fairly without problems while stress is carried out. broken agglomerate then behaves as a strong stress concentrator. but, as in keeping with literature to be had above generally inclusion of filler material within the base matrix shape vulnerable interfacial bond, however by using addition of Rice husk dirt the bonding between husk dirt and epoxy matrix indicates sturdy interfacial electricity as shown in Fig. 4.6c. On similarly addition of husk dust in the base matrix the flexural power increases further as shown in parent 4. 6d. additionally, the composite specimens with 10wt. % husk dust content have better bearing energy than that of the composite specimens with 5 wt. % husk dust particle content material and unfilled composite specimens. This might be because of the decrease void content of the composite specimens with 10wt.%husk dust particle content material. It is widely known that high void content material have terrible outcomes on the mechanical residences of composite substances Figures 4.6e and f display SEM graphs of effect fractured surfaces of Rice husk dust epoxy composites.
The impact power of composite is going on growing with the growth in timber dirt content. Also, some fiber traces are visible in case of Rice husk dust composite and greater amounts of husk dusts and epoxy matrix removed out from the composite surface. that is proof of poor interface bonding at 5wt% of husk dirt. In similarly addition of husk dust within the base matrix, there may be less said plastic deformation of the encircling matrix concerned as proven in determine 4.6f. it is well known that the interface among the polymer Matrix and the husk dust content material plays a main position in enhancing the houses of composites. In fact, when particulate Rice husk filler is dispersed into glass epoxy composites, the effect electricity, tensile electricity and flexural electricity are will increase with the increase in husk dirt content. therefore, from the above micro structural evaluation it could be concluded that Rice husk dust may be used as ability stuffed cloth in polymer composites for structural packages.

Conclusion

The present investigations of mechanical behaviour of Rice husk dust stuffed glass fiber reinforced epoxy composites results in the subsequent conclusions:

- in the present research paintings, glass fiber strengthened epoxy composites filled with husk dust filler has been a hit fabricated via simple hand lay-up method.
- it's been noticed that the mechanical houses of the composites such as micro-hardness, tensile strength, flexural power, impact power and so forth. of the composites are also significantly inspired by using the filler content material
- The morphology of fractured surfaces is examined by the use of SEM after diverse checking out. From this look at it has been concluded that the best interfacial bonding is liable for better mechanical residences.

