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Preparation and Testing Of Composites with Slag and Egg Shell Powder Filler

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ABSTRACT
Composite materials can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part.The mechanical behavior of the composite material depends upon fiber length and fiber loading and fiber orientation. In the present work, an attempt has been made to produce hybrid composite materials with egg shell power and slag in resin matrix. Epoxy is considered as matrix and slag and egg shell powder as reinforcement. The egg shell powder and slag are used in the form of particulates. Specimens were produced by keeping the egg shell powder constant and varying the slag powder. For the prepared specimens mechanical properties like tensile strength, flexural strength, and Impact strength were tested.

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I. INTRODUCTION

Particulate reinforced composites are very attractive due to the ease of manufacturing and mouldability. It has been observed that the additions of hard filler particles into polymer based composites, can optimize the developed composites in the form of higher modulus and improved strength. The accumulation of large amounts of waste in nature is a core problem from an environmental perspective. Government regulations and eco-consciousness has therefore forced the engineering sector to look for alternative methods to use these wastes. Appropriate usage of these industrial wastes as filler in composites development can enhance both the physical and mechanical properties of conventional polymer materials. Industrial waste such as red mud, blast furnace slag, fly ash, flue dust has been used as filler to reinforce polymer.

Considerable interest has been generated in the manufacture of thermoplastic composites due to their unique properties, including their good mechanical properties, their thermal stability, and a reduced product cost. Due to the combination of more than one material, the properties of composites are influenced by many factors such as filler characteristics, filler content, and interfacial adhesion. This can cause the behavior of filled polymers to be more complex than their unfilled counterpart.

II. MATERIALS AND METHODS

Egg shell means the thin, hard outer layer of an egg, especially a hen's egg. The hard exterior covering of egg is thoroughly cleaned, egg shells are made into a fine powder. Once the fine powder is obtained, it is treated with distilled water for 12–14 times and then treated with Sodium hypochloride (NaOCl).

The powdered shell is treated with NaOCl and stirred for 30 minutes with a Magnetic Separator, then three layers are formed , top two layers are decanted and the egg shell paste at the bottom is heated up to 110℃ till a constant weight of egg shell powder is obtained.

Preparation of Slag:

Slag is a broad term covering all nonmetallic co products resulting from the separation of a metal from its ore, its chemistry and morphology depends on the metal being produced and the solidification process used.

Fig.1 Powdered slag

Fig.2 Powdered egg Shell and Mold used for preparation of the composite

Preparation of Mold

A glass mold of 200 mm *200 mm* 3 mm cavities is prepared for preparing composite samples and a plane plastic sheet is used to cover the mold.

Manufacturing Processes

Hand Layup Method is used for this fabricate composites. The base plate is fixed inside the frame to fabricate the resin hardener mixture and remaining slag and eggshell powder used. The mixed resin and hardener is filled in the pattern. The prepared composite are randomly poured in the resin hardener mixture without any gap. The mixture of Eggshell, slag and resin is poured in the pattern. This process is simultaneously done till the height of 3mm.The plane plastic paper is placed on the top of the frame to distribute the load evenly on the mold. Then plastic sheet is placed on the mold again rolling is done. Then it is kept for 24 hours, after that specimen is taken off from the mold. This process is repeated for different weight by keeping the slag as constant of 5% and varying the eggshell powder of 5%, 10%, 15% , 20%,25%. Some releasing gel like wax is used for easy removal of specimen from the mold.

III. TESTING OF MECHANICAL PROPERTIES OF THE COMPOSITES

Tensile test

Fabricated composite was cut to get the desired dimension of specimen for mechanical testing. For the tensile test, the specimen size was 100x20x3 mm. Tensile strength was tested in Instron machine. The specimen with desired dimension was fixed in the grips of the Instron machine. The experimental set up for tensile test is shown below.

Flexural strength test:

Specimen dimension for flexural test was 100 × 20 mm and three point bend test method was used for finding the flexural strength using Universal Testing Machine Instron 3308.The loading arrangement for flexural strength is shown in the figure.

Impact Strength Test

Impact is a very important phenomenon in governing in the life of a structure. Impact tests are used in studying the toughness of the material. A material toughness is a factor of its ability to absorb energy during plastic deformation Brittle materials has low toughness as a result of the small amount of plastic deformation that they endure.

Specimen dimension for impact test is 60mm×15mmx3mm. Impact testing was conducted in Impact testing machine. Izod impact testing is a method of determining the impact resistance of composites. In impact test, an arm held at a specific height is released during the testing. The arm impacted on the sample and breaks the sample. Its impact energy is obtained from the energy absorbed by the composite or sample. The experimental set up for impact test is shown below.

IV. RESULTS AND DISCUSSION

Influence of slag loading on tensile strength: The tensile strength is the predominant property in processing of composite materials. Figure shows the variation of tensile strength of Slag and Egg shell powder Reinforced Epoxy composite. It is observed that the tensile strength gradually increased at 18% of slag and then decreased by Slag%. Maximum value noticed at 18% of slag, Due to random distribution of slag in matrix. Results predict that as the reinforcement wt% increases, the tensile strength of composite increases.

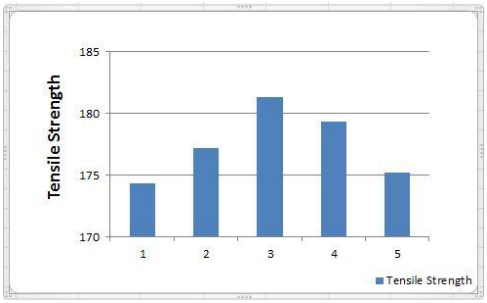

Fig.1: Influence of slag percentage on tensile strength

S.No	Egg shell (%)	Slag (%)	Tensile strength [N/mm^2]
1	6	6	174.3
2	6	12	177.2
3	6	18	181.3
4	6	24	179.3
5	6	30	175.2

It is found that when the weight of egg shell is kept constant and the slag weight composition is increased, the Tensile strength first increases and then decreases. From the graphs, it is known that the maximum tensile strength of Slag and Eggshell reinforced Epoxy composite maximum strength is found at 18% weight of slag

Influence of slag loading on flexural strength

Flexural characteristics represent the flexibility of the materials and good flexural strength indicates the materials have brittle properties and high hardness. Flexural strength behaved with a similar trend to tensile strength behavior; fiber content has the highest stress to resist deformation under flexural condition.

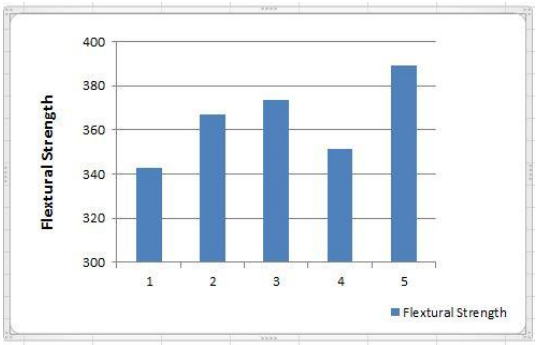

Fig.2: Influence of slag percentage on flexural strength

S.No	Eggshell (%)	Slag (%)	Flexural Strength (MPa)
1	6	6	342.8
2	6	12	367.2
3	6	18	373.4
4	6	24	351.2
5	6	30	389.21

From the experimental tests it found that as the weight of Egg shell is kept constant and the Slag composition is increased, the Flexural stress increased. From the graphs, it is known that the maximum flexural strength of Slag and Eggshell reinforced Epoxy composite maximum strength is found at 30% weight of slag.

Influence of slag loading on impact strength:

Impact characteristics represent the sudden loads on the materials and good impact strength indicates the materials have ductility properties. By the application of sudden loads on the material, it's impact strength is determined.

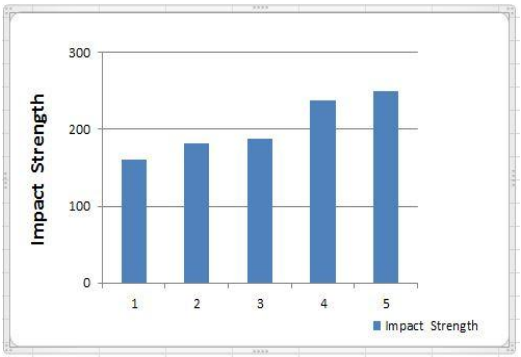

Fig.3:Influence of slag percentage on Impact strength

S.No	Eggshell (%)	Slag (%)	Impact strength (J/N)
1	6	6	160.3
2	6	12	181.21
3	6	18	187.26
4	6	24	237.65
5	6	30	249.21

Influence of slag percentage on impact strength

From the tests it is observed that as the weight of Egg shell is kept constant and the Slag composition is increased, the impact strength increased. From the graphs, it is known that the maximum impact strength of Slag and Egg shell reinforced Epoxy composite is found at 30% weight of slag.

Effect of Slag on strength of Egg shell Epoxy composite

The strength of composite mainly depends upon Slag. When the slag composition is low, the strength of the composite is also low. When the weight of slag increases more than its 18%, it leads to decrease of the tensile strength of the composite material. And in case of flexural and impact the strength increases as the weight of slag increases.

Maximum Tensile strength: 181.3 N/mm^2 at 18% of slag
Minimum Tensile strength: 174.3 N/mm^2 at 6% of slag
Maximum Flexural strength: 389.21 Mpa at 30% of slag
Minimum Flexural strength: 342.8 Mpa at 6% of slag
Maximum Impact Strength: 249.21 J/N

at 30% of slag
Minimum Impact Strength: 160.3 J/N
at 6% of slag

V. CONCLUSIONS

The following conclusions are drawn from experimental observation:

- Present study has developed Eggshell and Slag Reinforced Epoxy Composites by varying Slag weight percentages.
- Hand Layup technique has been successfully implemented to produce the Eggshell and Slag Reinforced Epoxy Composites.
- The tensile strength of the Slag and eggshell reinforced epoxy composites increases gradually up to 18% of slag in weight and then decreases.
- The strength of the Slag and Egg shell Reinforced Epoxy composites increases as in the case of flexural and impact strength as the weight of slag increases.

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