Fabrication and evaluation of Bio-composite containing coconut jute and egg shell powder

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Abstract

Chicken egg shell, an industrial bio product containing 95% calcium carbonate which is a serious waste and its decomposition is also a serious issue. In this research work, powder of chicken egg shell was used as a matrix material and 4 wt.% coconut jute fibers were used as a reinforcement. Composite were prepared by powder metallurgy processing under pressurized die compaction. Water absorption test and shore D hardness measurement confirms the sufficient bonding and suggest the utilities for various applications.

Keywords: Egg Shell, Coconut Jute, binder, shore D hardness

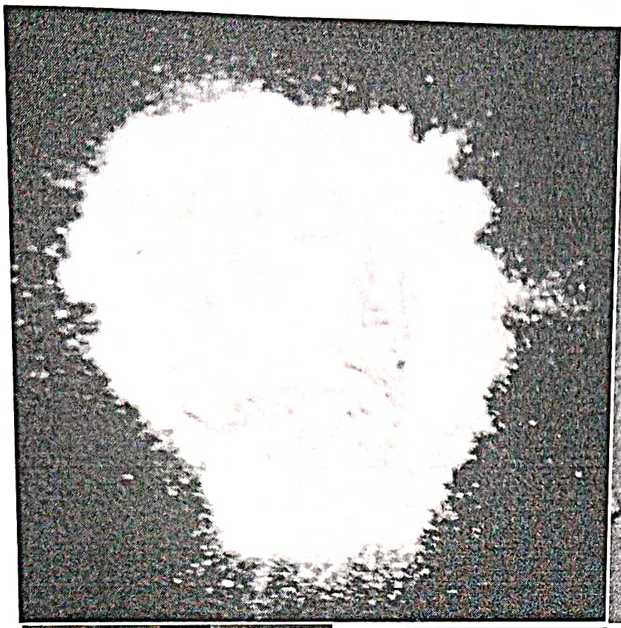
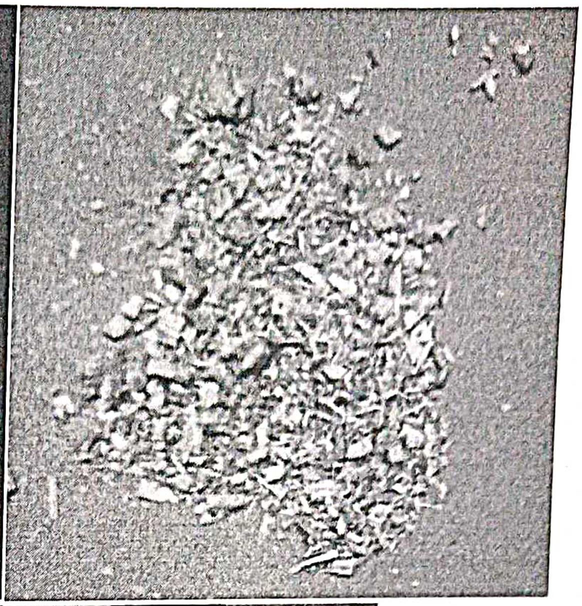
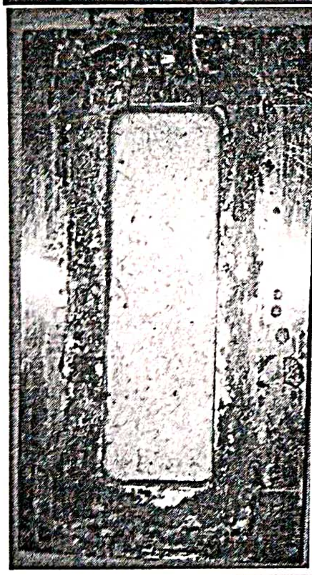
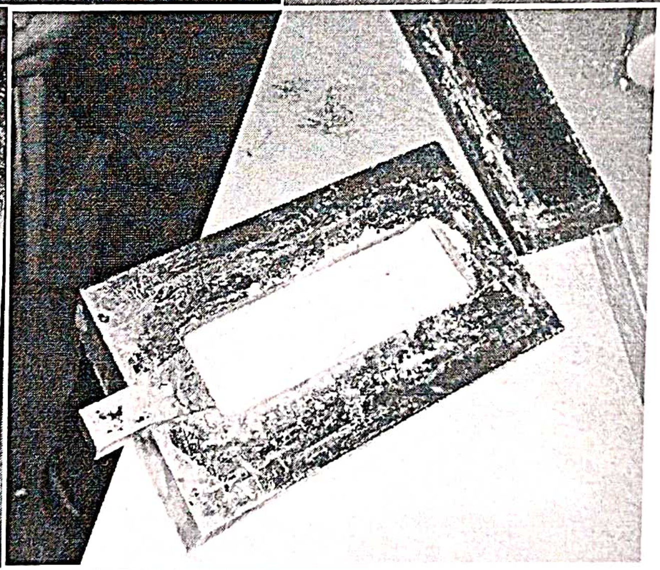
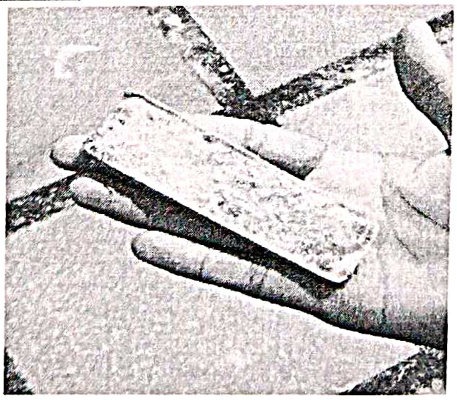
Introduction

Composites are materials consisting of two or more identifiable constituents of different natures. Special consideration has been given to those composites which consist of synthetic fibers or mineral particles with a high modulus reinforcement embedded in a comparatively lower modulus matrix, such as polypropylene. However, due to the high cost of the petroleum-derived products or to environmental hazard, a growing effort has emerged in recent years on the research, development, and application of bio-composites. A bio-composite contains at least one constituent that is derived from renewable resources, such as avian feathers or cellulose fibers from kenaf, ramie, flax, sisal, coir, rice-husk and jute [1-5].

Chicken egg shell (ES) composites can be used as inorganic matrix such as mineral calcium carbonate and talc [5–7]. Whereas, coconut jute fiber (CJ) is an aviculture byproduct that has been listed in India as one of the waste environmental problems, where the egg product industry is also well developed. In the India alone, about 150,000 tons of this material is disposed in landfills. ES contains about 95% calcium carbonate in the form of calcite and 5% organic materials such as type X collagen, sulfated polysaccharides, and other proteins [8,9]. Although there have been several attempts to use eggshell components for different applications, its chemical composition and availability makes eggshell a potential source of CJ composites [10-13]. In this report, chicken egg shell/coconut jute composite was used for an analysis to order of water absorption rate and hardness also with a suggestion for utilization of waste for various applications.

Materials and Methods

In the process, initially chicken egg shells (ES) were collected and cleaned via distilled water. After cleaning ES were dried and then using grinding process, powder of the ES were prepared. On the other hand, jute of the coconut (CJ) was boiled to remove impurities and then dried under microwave heating. Clean CJ was chopped by scissor and then again boiled to remove light low strength fibers. Chopped CJ were grind to prepare jute reinforcement. Further, Gelatin powder was mixed with semi-hot water (50°C) via continuous stirring. Gelatin powder and water was mixed under a ratio of 1: 15. Prepared thick gelatin liquid gel was used to form green composite lump in which ES powder was used 98% by weight whereas 2% CJ were mixed. 3 ml gelatin gel was used by dropper and simultaneously hand stirring was performed for the ES and CJ mixture for an hour. Mixed green composite lump was placed inside the cavity of the die and under a pressure of 37 MPa. Due to effect of pressure CJ and ES were compressed and excess gelatin gel was squeeze out. After initial compression, for proper binding between ES and CJ in green composite lump, epoxy binder was used and then lump was again pressurized above 40 MPa and 50 MPa via hydraulic compression machine. In last, composed part were left for drying and process takes near 48 hrs. Processed composite and details of the materials are shown in figure 1.

Results and Discussion

Characterization is in progress

Water absorption Test

Prepared composite were tested for water absorption rate in which several pieces of the composite were left for the water absorption and figure 2 shows the water absorption rate with respect to time. From figure 2 it is clear with successive time water absorption rate become constant. Initial 90 minutes water absorption amount is higher and then constant after 150 minutes. This confirms that composite is stable with respect to water. When, initial water absorption become stable and then this rate is near zero for stable condition.

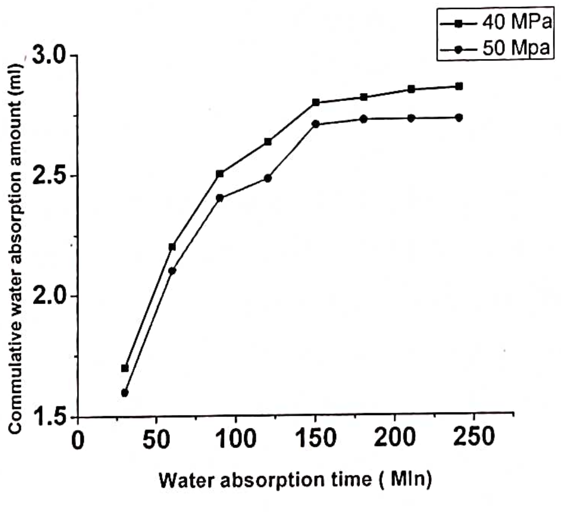


Figure 2 water absorption as a function of time

Shore D hardness measurement

Shore D hardness was measured by Shore Durometer according to ASTM D 2240 and figure 3 shows the variation for the pressurized series of the composites. At corners hardness of the composite is more due to effect of pressure and it is low at both the ends of the composite for both pressurized composites.

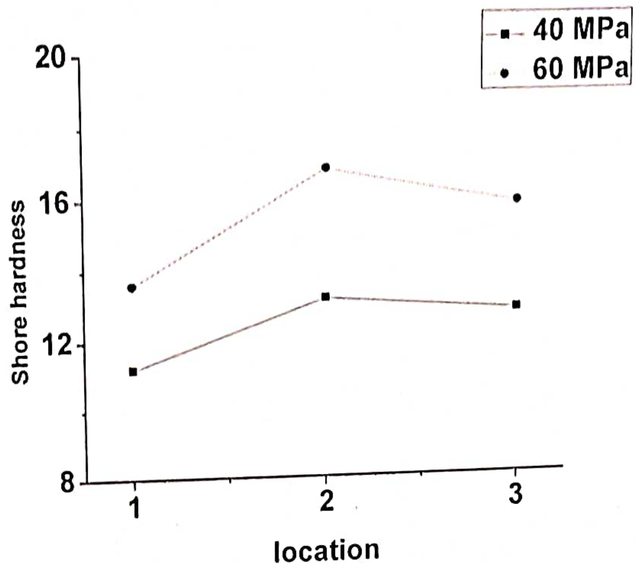


Figure 3 Shore hardness at different location

Conclusions

Egg shell waste was successfully used to fabricate composite by the coconut jute reinforcement. Lump of ES/CJ was used to form final composite under pressurized via powder metallurgy process by die. Results reveal that composites have sufficient stability against water with sufficient hardness. Process is also useful for the waste utilization and process suggest a successful alternate for the other hazards composite. These composites are bio- friendly and can be utilize for the kitchen purpose.

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