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Extended Abstract

Compatible Kenaf Composites with the Rapid Manufacturing Concept of Prefab Building Components

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Abstract

Although many scholars have developed natural fibres as reinforcements for industrial composite materials, the available information regarding these natural fibres is insufficient. For rapid manufacturing (RM) systems and products, the main materials used are thermoplastic materials, epoxy resin, acrylonitrile butadiene styrene plastic and polyester materials. Natural and biodegradable composites provide important environmental advantages to the automotive industry, and sustainability, eco-friendliness, and obtaining green chemistry materials are the main objectives for the development of industrial materials, products, and systems.

Biocomposites may be a viable substitute for glass fibre-reinforced composites in automotive by-products and partial building applications. However, to obtain stronger products, hybridisation of these so-called natural fibres with other fibres is necessary. Biocomposites employ polymers as matrices, resulting in lighter, stronger, and more cost- effective products that, at the same time, can be melted, sintered, or solidified, similar to RM systems.
The combination of Kenaf bast fibres, a type of natural fibre, with polymer matrices results in satisfactory performance that can compete with synthetic fibre composites. However, the RM process of the fibre composites requires special attention and investigation. The present study aimed to evaluate the effect of special features of RM on Kenaf/carbon hybrid composites by simulating processing steps and assessing the resulting properties. The tensile and shear strengths of the end products were of reasonable values compared with carbon or Kenaf/polymer matrices

Keywords:

Sustainable biocomposites; Hybrid composite; Polymer matrix; Kenaf bast; Carbon/Kenaf fibre reinforcement

Introduction

Various types of materials are used in the house construction industry depending on the process to be used, the specifications of instruments, or the design employed .Currently, the materials used in rapid manufacturing (RM) for considerable parts of buildings are neither biodegradable nor eco-friendly.Although the main materials in use for rapid prototyping system include thermoplastic materials, epoxy resin, acrylonitrile butadiene styrene plastic, and polyester materials,many scholars have made efforts to develop biofibres as fillers and composite reinforcements for industrial building systems. Materials currently in use in RM are limited to those that can be sintered or melted and solidified quickly .The problem with using polymeric materials lies mainly in their price and non-eco- friendliness, both of which make the system inappropriate for adoption in the construction field .Providing an eco-friendly material with cost-effective components can allow the use of such systems within the construction industry.

Compression moulding employment

The SLS of materials involves producing parts layer by layer, generating whole components, and providing heat (by laser beam) to melt the matrix to fuse particles together .These special characteristics affect the porosity and strength of the end products, which mainly focuses on the placement of powdered materials layer by layer, and the effects of the process on the mechanical properties of the resulting product.

Material preparation

Kenaf basts and carbon fibres were ground separately into short fibres using a Pulverisette from Universiti Putra Malaysia INTROP 3 (0.5 mm) and sifted through a 0.3 mm sieve. Kenaf fibres were then immersed in water and dried for 48 h at room temperature. The dried fibres were heated in an oven for 1 h at 120°C as suggested by previous scholars .Polyester powder was ground to 0.5 mm and sifted

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through a 0.3 mm sieve. The sieved polymer was dried in the oven at 120°C for 4 h and set aside. The prepared fibres and matrices were blended in the proportions of 45% Kenaf, 5% carbon, 3% polyester, 45% PP, and 2% maleic anhyride additive. The materials were blended using a Brabender blending machine run for 10 min at 170°C and 50 rpm. Afterwards, the compounds were powdered into 0.05 mm particles by cryogenic grinding. Several batches of the prepared powder mixture were set aside to produce 15 samples (15 cm x 15 cm).

Results and Discussion

The failure mode in the tensile tests occurred through fiber and matrix breakage. Fiber pull-out was also observed in the present study. When failure of the specimen occurred, the test was stopped and the related data were obtained

The specific Young's modulus and specific strength of the composites constituted the comparison criteria, while the critical factor for the composites was the tensile property. As shown in Table 2, the specific strength of the bio composite is greater than the reported strength of Kenaf/PP fiber composites obtained by previous researchers. Such an improvement is attributed to the incorporation of carbon fibers into the composite.

The figures illustrate that the composite exhibited properties in good agreement with common structural materials, such as carbon fiber-reinforced plastic, and even better than those of Kenaf/ PP composites (Figure 3A-3C). The results also show satisfactory properties compared with concrete as a general structural material. The composite can produce curvilinear forms without imposing extremely high costs. Hence, it can be claimed that the composite can be used for a wide range of structural purposes provided that the total distributed stress and strain loads do not exceed its design allowances

Conclusion

In the current study, we aimed to evaluate the mechanical properties of Kenaf/carbon/PP fiber composites fabricated from randomly scattered fibers. First, the process (heating and compressing) was performed well below 180°C to avoid fiber degradation. Control of the mounding process (time, temperature, and press) was crucial to reduce fiber damage. During determination of the processing parameters that needed to be adjusted to each thermoplastic polymer, the rheological and thermal properties of neat polymers must be considered. The second part of the study focused on the mechanical behavior of the polymeric matrix composites reinforced by the hybrid fibers. With volume fractions of 45% Kenaf and 5% carbon fibers, satisfactory performance levels were obtained for the Kenaf/carbon/PP fiber bio composites.

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