Kenaf Fiber Reinforcement and Application in Polymer Composites: A Brief Review

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Abstract:
Synthetic fiber-reinforced polymer composites play an important role in the automotive industry and give fuel-efficient cars a paradigm shift etc. But due to the non-recyclability of the synthetic fibers, it evolve the major problems related to the environment and global warming. All these concerns leads to require a sustainable material which do not have any foot prints on the environment. This critical study of polymer composites reinforced by natural fibre gives an insight on the benefits in structural applications, automobile applications and medical sector etc. Physical and mechanical properties and morphological analysis of kenaf fiber reinforced polymer composites has been discussed.

Keywords: Polymer composite, kenaf fiber, SEM

1. Introduction:
Because of its optimized properties such as high strength and less weight, more precise strength etc., natural fiber reinforced composites play an important role in advanced technology. Natural fiber composites are used in most applications, starting from household products, interior decoration, and automotive applications, as well as in medical applications, due to global environmental concerns. Lot of car companies are beginning to develop the cars’ interior products from natural fiber reinforced composites. Natural fibers are mainly classified according to their source. Figure 2.1 show the types of natural fibers.
The whole stalk and external bast fibers of Kenaf have many possible specific uses, containing as paper and composite. The use of kenaf fibers is also particularly important from the point of view of environmental approachability. A number of new uses for kenaf products are currently emerging including paper products, building materials, absorbents, bedding for feed and livestock. Kenaf is one of the major seed crops grown in temperate climates by synthetic oils. Figure 2 shows the kenaf fiber structure.

![Figure 1: Constituents of Green Composites](image1)

![Figure 2: Schematics of possible cell wall organisation](image2)

2. Kenaf Fiber

The kenaf plant has a lifecycle of 90–125 days including growth, flowering, and maturation periods. The kenaf stem has a diameter of 1–2 mm in size, with a height of about 80 cm. The fundamental fibers which are both cellulose material are the primary and secondary cell walls. Cellulose fibrils (diameter between 0.2 μm and 0.25 μm) are introduced into a compact lamella consisting of approximately 3%
pectins and 14% hemicellulose, resulting in thermal fiber and water degradation. The kenaf plant grows when the temperate climate suffices for humidity. There are two kinds of plants of kenaf seed and fiber. Kenaf is cultivated for both seeds and fibres. Fiber kenaf is designed for small, strong fiber growth. The kenaf plant is an annual plant that reaches a height of approximately 100 cm. The plants are pulled by hand or machine and all the fiber from the top to the root is intact. Figure 3 shows the kenaf plant.

![Kenaf Plant](image)

The stem part is taken for the after pulling retting operation. The fleshy portion of the stem is rotted almost for a week due to contact with water. Finally, the kenaf stem is pushed and pounded on a sharp edge, where fibers are loosened.

### 3. Kenaf Fiber Physical and Mechanical Properties

Kenaf is the best among organic cellulosic fibres. Kenaf is two to three times more wear- and abrasion-resistant than cotton fiber. It absorbs well moisture, and is a very breathable fabric. Because of the lack of elasticity of kenaf fibers, fabrics made from kenaf do not seem to lose their shape quickly. In recent years, the use of kenaf fibers in the automotive industry has increased dramatically. [2]. As regards properties, kenaf fiber has the potential to replace the synthetic fibers. Some of the investigators had researched the properties of kenaf fibers. According to Pan et al. [3] kenaf fiber reinforced with PLLA improve the mechanical properties as well as to accelerate the crystallization of PLLA. Bernard et al. [4] The effect of processing parameters on the mechanical properties of the kenaf / PP composites was investigated and it reveals that the processing parameters have a great impact on properties of the composites. Nitta et al. [5] explored the influence of alkali treatment on tensile properties of kenaf fibers and results reveals that tensile strength is greatly improved with 15 wt % NaOH for one hour as
compared to the un-treated fiber. Figure 4 shows the SEM images raw fibers and surface treated kenaf fibers.

Figure 4a SEM of (a) untreated, (b) Alkali solution, (c) Silane and (d) Alkali-Silane treated Kenaf fiber[6]

Bajpai et al. [7] developed the jute/hemp/Flax reinforced hybrid composite and investigated its mechanical properties. Mechanical characterization results reveal that the ductile properties are more in hybrid composite as compared to the jute fiber reinforced epoxy, flax fiber reinforced epoxy and hemp fiber reinforced epoxy composites. Figure 5a shows the SEM images of jute/hemp/flax reinforced epoxy composites.

Figure 5 SEM image of a) jute/hemp/flax reinforced epoxy composites b) Hemp/Flax/Epoxy Composite [7]

Interfacial bonding among the fiber and matrix shows a vital part for defining the mechanical properties of the composite material[8]. Some of the findings are tabulated in the table 1.
Table 1 shows the physical and mechanical properties of Kenaf fibers.

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Ultimate stress (MPa)</th>
<th>Density (kg/m³)</th>
<th>Young’s Modulus (GPa)</th>
<th>Water absorption (%)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.16-0.40</td>
<td>370-630</td>
<td>1510</td>
<td>13-51</td>
<td>0.85</td>
<td>[9]</td>
</tr>
<tr>
<td></td>
<td>229-970</td>
<td>1200-14500</td>
<td>15.7-57</td>
<td>13-17</td>
<td>[10]</td>
</tr>
<tr>
<td>0.13-0.29</td>
<td>950</td>
<td>1460</td>
<td>57</td>
<td>11-18</td>
<td>[11]</td>
</tr>
<tr>
<td>0.85</td>
<td>953</td>
<td>1500</td>
<td>56</td>
<td>12-18</td>
<td>[12]</td>
</tr>
<tr>
<td>-</td>
<td>800</td>
<td>1500</td>
<td>15.5-58</td>
<td>12-15</td>
<td>[13]</td>
</tr>
</tbody>
</table>

4. Kenaf F Reinforced Polymer Composites

Nowadays lot of researchers are working in the area of hybrid composites especially for the structural applications. Srinivasan et al. [14] evaluate the tensile and thermal properties of banana-kenaf/epoxy hybrid composites with the help of compression moulding machine. Mechanical properties such as tensile strength, flexural strength and impact strength have been investigated and structural morphology has been tested using SEM. Results found that the mechanical properties of glass-banana-kenaf based hybrid composites possess higher values as compared to the glass/epoxy, banana/epoxy and kenaf/epoxy composites. Ghani et al. [15] deliberate the mechanical behavior of kenaf/PLA composites and record that the 35% fiber volume fraction leads to better mechanical properties. It was also found that at less fiber volume fraction, mechanical properties gets deteriorated. Poor bonding between the matrix and reinforcement was observed at higher fiber loading. Apart from the mechanical properties of the kenaf reinforced polymer composites, researchers had also tried to study the effect of ageing on the ductile properties. In one of the study, Immersion of the composites into the water has been shown to have a degrading effect on the mechanical properties. Figure 6 shows the SEM images of fractured bio composites. Atiqah et al. [16] deliberate the impact of hygrothermal ageing on the ductile properties of kenaf/epoxy based composites. Results indicates that the mechanical properties were affected significantly due to the ageing process. Jacob et al. [17] studied the environmental influences on the fabrication of kenaf textile yarn. Reducing environmental influences associated with the production of hemp yarn should give priority to reducing energy consumption during the fiber processing and yarn production phases and reducing eutrophication during the crop production phase. Yang et al. [18] premeditated the effect of thermal treatment on kenaf fibers for the improvement of wetting and swelling properties. The thermal treatment has been shown to make fibers less hydrophilic.
Figure 6 shows the SEM images of fractured bio composites [15]

5. Conclusions

The complete study, focus on the critical review for the reinforcement of kenaf fibers in the polymer composites. Natural fibre-reinforced polymer composites have increased wide interest because of eco-friendly and sustainable content. Specific polymer composites of kenaf fiber were intentionally the possible material for substituting synthetic fibers for polymer composites. Kenaf fiber is one of the natural fiber having a more mechanical properties as compared to other fibers. The complete review also touched upon the different mechanical properties of kenaf fibers and its applications.

6. Future Work

From the various studies illustrated, cited by the various researchers on the mechanical properties of polymer composites reinforced by kenaf fiber. The outcome of these research studies leads to provide the future scopes in the following areas:

1. Most research involves the enhancement of mechanical properties with the use of fiber surface treatments.
2. The area of development in the surface finish of natural fiber-reinforced polymer composites has been less explored.

References


