Effect of Different Concentration of Sodium Hydroxide [NaOH] on Kenaf Sandwich Structures

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Abstract. Sandwich panels are structures that made of three layers, low-density core inserted in between thin skin layers. This structures allow the achievement of excellent mechanical performance with low weight, thus this characteristic fulfill requirement to be use in aircraft application. In recent time, sandwich structures have been studied due to it has multifunction properties and lightweight. The aim of this study is to fabricate a composite sandwich structures with biodegradable material for face sheet [skin] where the fibre being treat with different concentration of sodium hydroxide [NaOH] with 10 and 20 hours of soaking time. Kenaf fibre [treated] reinforced epoxy will be used as skins and Nomex honeycomb is chosen to perform as core for this sandwich composite structure. The mechanical properties that are evaluated such as flexural strength and impact energy of kenaf fibre-reinforced epoxy sandwich structures. For flexural test, the optimum flexural strength is 13.4 MPa and impact strength is 18.3 J.

1. Introduction

Composites are the most widely chosen materials because of their adaptability to different situation to combine with other materials to serve specific purposes and exhibit desirable properties. Recently, due to its’ cost-effectiveness, composites are used in processing of components for heavy transport vehicles Basic requirement of good composite materials are good reproductively and resilience handling by semi-skilled workers. Composite can be very dynamic because of its strong and stiff yet very light in weight, so that ratio of strength to weight and stiffness to weight are better than steel of aluminium [1]

Nowadays the development of using natural fibre in high performance engineering products is increasing worldwide due to renewable and environmental issues. Among many type of natural fibres, recently kenaf fibres has been extensively exploited [2]. According to [3], natural fibre in sandwich composites received a great deal in research, development and industrial sector due to high demand in many applications such as automotive, construction and aerospace industries.

Due to it has low weight and good mechanical properties and also it is inexpensive, Kenaf is one of good properties of natural fibre [4]. Kenaf is a valuable fibre plant of the Hibiscus cannabinus family cultivated mainly in India. Kenaf is an industrial crop with high potential for cultivation in a tropical climate and it is a source of raw materials for fibre-based industries. Since 2000, research has been conducted to explore its adaptability and utilization in Malaysia.

Natural fibre composites are gaining more attention due to their eco-friendliness, biodegradability and cost effectivenes [5]. However, natural-fibre reinforced composites are lacking in terms of water...
resistance properties and mechanical performance compared to the conventional glass-fibre reinforced composites [6].

For aviation industry, composite materials are important because they provide structural strength comparable to metallic alloys, but at a lighter weight. This situation will result on improving fuel efficiency and performance for an aircraft. The most common composite material is fiberglass, and consists of glass fibres reinforced resin matrix. Besides that, because of the ability of sandwich composite structure to absorb large amount of energy under impact loads that result in high structural crashworthiness make it widely used in aerospace industry.

2. Experimental procedures
This chemical treatment of kenaf fibre with sodium hydroxide [NaOH] result in increasing hydrogen bonding between the fibres and also remove impurities that can make the kenaf fibres behavior more efficient. Kenaf fibres are cut into pieces to make it easy for fabricating process. Then the kenaf was rinsed with distilled water to remove dirt. Then kenaf was dried in oven for 2 hours before immersed in sodium hydroxide for 2 hours to make the solution totally absorb into the fibres. After two hours, wash and rinsed again with distilled water then manually press and dry in room temperature for 2 days.

After treatment of kenaf done, kenaf fibres are ready to fabricate as the skin layer of sandwich structure. Mixture of epoxy and hardener is prepared. This ratio of this mixture is [2:1], epoxy is 100ml and hardener is 55ml. The mixtures were applied on the kenaf fibre using hand lay-up method to fabricate the skin layer. After applying all the mixture, roller should be applied on the top surface to avoid formation of air bubble trapped inside the skin layer. Then the skin layer is left for 24 hour to make sure the epoxy and hardener mixture is dried.

3. Results and Discussion
SEM result shows that microstructure of kenaf fibre for the treated kenaf is less impurities to be compare to untreated kenaf. The lignin and hemicelluloses of the fibre peel off during the treatment of kenaf fibre with alkaline solution. Figure 1 shows SEM result of treated kenaf.

![Figure 1. Microstructure of treated kenaf under SEM](image)

To determine flexural strength of sandwich panels, flexural test were conducted. Through the maximum stress of the load, the flexural strength can be obtained. The experimental result of flexural test of each specimen between ranges 9.2 Mpa to 13.4 Mpa. The experimental data is as shown in figure 2.
Figure 2. Flexural strength of different alkalized treatment kenaf fibre composite

Treatment of 6% NaOH for 10 hours soaking time sandwich structure displayed the highest flexural strength [13.4 Mpa], while the lowest alkalinization treatment of 9% NaOH with 10 hours soaking time. The decrease of flexural strength when the concentration of NaOH was increased up to 9% might be because the high concentration of NaOH could be damage the fibres. From the data, the result of alkalinization treatment for 6 % NaOH with soaking time of 10 and 20 hours both gives a good result of flexural strength. This shows that 6% of NaOH gives the best result for flexural properties. In term of soaking time, it also gives effect to the flexural strength. There was displayed that flexural strength increased with increased in concentration of NaOH but slightly decreased in flexural strength when soaking time increased. However, the flexural strength of 9% NaOH is slightly different. Flexural strength increased after soaking time increased from 10 hours to 20 hours.

Charpy Impact Test. can obtain the energy absorption capability of every different alkalinization treatment of kenaf composite structure. This test is conducted to obtained impact energy, which is required to fracture a part subjected to shock loading. The result of energy absorption capability of different alkalinization treatment is shown in figure 3.

Figure 3. Impact strength of different alkalized treatment kenaf fibres reinforced epoxy sandwich structures

The sandwich structures tested displayed low strength for 3% of NaOH alkalinization treatment for both 10 hours and 20 hours soaking time, which are the average of 13.7 for both treatments. The highest result were shows in the alkalinization treatment of 6 % NaOH with 20 hours soaking time and 9% NaOH with 10 hours of soaking time which gives impact strength of average 18.3 J. Impact energy tested result showed the soaking time does not really gives effect. Regardless of 10 or 20 hours soaking time applied in the alkalinization treatment, the result of impact energy does not give big
changes. According to Edeerozey A M et al., [7] the impact energy was dissipated by debonding, fibre fracture and fibre pull out. Fibre fracture dissipates less energy than fibre pull out.

Scanning electron microscopy provides an excellent technique for examination of surface morphology and fracture surface of composite. The morphology changes that occur in every alkalization treatment for failure fracture of impact test were examined.

![Image](image.png)

**Figure 4. SEM micrograph for impact fracture of [a] 3% 10 hours alkalization treatment and [b] 3% 20 hours of alkalization treatment**

Figure 4 shows the microstructure of SEM for impact fracture of alkalization treatment 3% NaOH with 10 and 20 hours soaking time. The microstructure for both treatments shows that natural compound such as hemicellulose, wax and lignin, which are still present on the fibre surface after treatment of 3 % solution of NaOH. The microstructure of fibre surface is clean after treated but the deposits contribute to poor matrix interfacial bonding by decreasing the interfacial area of contact between matrix and fibre and the failure is cause by fibre break-age might be because of improper layup technique [8].

4. **Conclusion**

The objective of this study to investigate the properties of treated kenaf with different concentration of sodium hydroxide [NaOH] and different soaking time by characterization using SEM is successfully achieved. Besides that, the fabrication of sandwich structure using the different treatment of kenaf also successfully achieved. The mechanical properties of different alkalization treatment of sandwich structure were analyzed using three different mechanical testing which are Flexural tests, Impact test, and indentation test. The overall result of mechanical testing shows the higher concentration of NaOH used, the better result of mechanical properties, but 9 % of NaOH sometimes shows slightly decreased of mechanical properties perhaps because of the higher concentration might burned the fibre. In term of soaking time, some mechanical properties shows effect of soaking time such as indentation test. 20 hours of soaking time gives higher result of indentation load of each alkalization treatment. However, since testing is on sandwich structure, the result might be influence by the core also.

The production of this sandwich structure by using treated kenaf reinforced epoxy may support the commercialization of using natural fibres widely in the industry, thus this will improve the production of biodegradable materials that is environmental friendly. The result obtained from this study perhaps will help other researcher in the same field and will contribute to find information about fabrication and mechanical properties of treated kenaf in sandwich structure.

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