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Flexural Strength Enhancement in Sugarcane Bagasse-Polypropylene Biocomposite through Maleic Anhydride Grafted Polypropylene (MAPP) Addition

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Abstract. *Sugarcane bagasse has been investigated as reinforcement fiber for polypropylene matrix. Based on previous research, there should be advanced research to produce composite with mechanical characteristic (flexural strength) based on industrial needs. In this research, MAPP is in varied amounts, i.e. 0,5%, 1%, and 1,5%. Then, MAPP addition to composite is evaluated by measuring the flexural strength based on ASTM D790-12. These results were compared to the current products from the automotive industry which are made from black woodboard and brown woodboard.*
The result of flexural strength testing of sugarcane bagasse composite without MAPP addition has average 15,31 MPa. MAPP addition increases the flexural strength up to 17,74 MPa at 0,5% MAPP concentration. An addition of MAPP more than 0,5% percent the flexural strength strength decreases. The flexural strength obtained is 50,1%-56,9% and 52,8%-59,9% lower than black woodboard and brown woodboard respectively.

Keywords : *composite; sugarcane bagasse; polypropylene; MAPP; flexural strength*

1 Introduction

Since 1955 material that is stronger and lighter than ferrous called composite has been made by humans. Industry uses synthetic fiber prior to the research about nature fiber because synthetic fiber can be produced fit with the demand. According Geyer, Jambeck, dan Law (2017) since 1950 plastics production in the world is up to 8,1 billion ton and around 79% plastics ends in garbage dumb. So the purpose of composite manufacture is to decrease the use of plastic.

Sugarcane bagasse fiber is one of the most nature fiber in Indonesia. At 2015, sugracane production in Indonesia up to 2.623.931 ton and at 2016, the production up to 2.715.883 ton[7]. In the future, sugarcane production will be increasing parallel with the people demands. Sugarcane bagasse is currently used for animal feed, fertilizer, and boiler's fuel even though sugarcane bagasse has low heat value around 2200 kcal/kg. Sugarcane bagasse have 46,4 % cellulose, 23,9% hemicellulose, and 23,6% lignin[4]. Therefore, sugarcane bagasse have added value if it is used as biocomposite.

According the previous research, sugarcane bagasse had been used as composite fiber and combined with polypropylene (PP) as matrix. The bagasse was given alkali solution, i.e. NaOH solution and $Ca(OH)_2$ solution for 4 hours[1]. This research used bagasse in different length of 30mm, 50mm, and some were kept as their original length. The tensile strength with NaOH solution was 24,92 MPa and $Ca(OH)_2$ solution was 11,30 MPa. From this research, NaOH solution can give better tensile strength compare $Ca(OH)_2$ solution.

Danyadi mixed the woodflour with polypropylene and added maleic anhydride grafted polypropylene (MAPP) to increase the tensile strength of biocomposite[2]. This research uses 0%-80% volume fraction of woodflour and two types of MAPP, i.e. Licomont AR 504 and Orevac CA 100. Biocomposite which had 50% volume fraction of woodflour and Orevac CA 100 obtains tensile strength up to 40 MPa.

To increase the flexural strength of biocomposite sugarcane bagasse-polypropylene then, in this research, MAPP is added to biocomposite and studied the effect of MAPP addition for biocomposite's flexural strength.

2 Experimental

Sugarcane bagasse used in this research was obtained from a sugar mill. They were neutralized by soaking in 70% ethanol with a volume ratio of ethanol (litre) to the weight of fibers (g) 1:250. The purpose of neutralization was to prevent bagasse from fermentation. Neutralized bagasse was then dried in an open air for three days. MAPP percentage adde is varied from 0,5%, 1%, 1,5%, and without MAPP.

PP as the matrix was available in the form of long fibers. They were supplied by PT. Classic Prima Carpet Industries. To ease the mixing and in order to achieve homogeneous mixture between bagasse and PP, the PP fibers were cut into 1 cm length.

The next step, 25 g of bagasse and 75 g of PP were mixed manually. After the bagasse and PP have been mixed homogeneously, MAPP was added to the mixture. The mixture was then placed in hotpress machine to shape a preform. The preform was made using hotpress which was set at heating temperature of 150°C and pressure 5MPa with a duration of 1,5 minutes each surface. Then, the preform was further pressed at temperature 200 °C and pressure 5MPa for 1,5 minutes each surface. Curing was performed at room temperature. A 22x27 cm^2 hotpressed composite was produced and then flexural test sampels were prepared according to ASTM 790-12. Flexural test was performed using Shimadzu AGS-50kN Xplus.

a)  b) 

Figure 1 a)Sugarcane bagasse as-received, b)sugarcane bagasse has been sieved

3 Result and Discussion

3.1 Areal Density of Composite.

Areal density measurement was done to all flexural test sampels with dimesion of 110x15 mm or each has an area of 1650 mm^2. Fig.1 shows the areal density of all samples produced together with the areal density values of PP and woodboard sampels. Lightweight materials as indicated by areal density measurement are required by the automotive industry to achieve fuel efficiency.
From Figure 1 sugarcane bagasse composite had 26,9%-33,0% lower areal density compared to brown woodboard and 35,3%-40,7% lower than black woodboard.

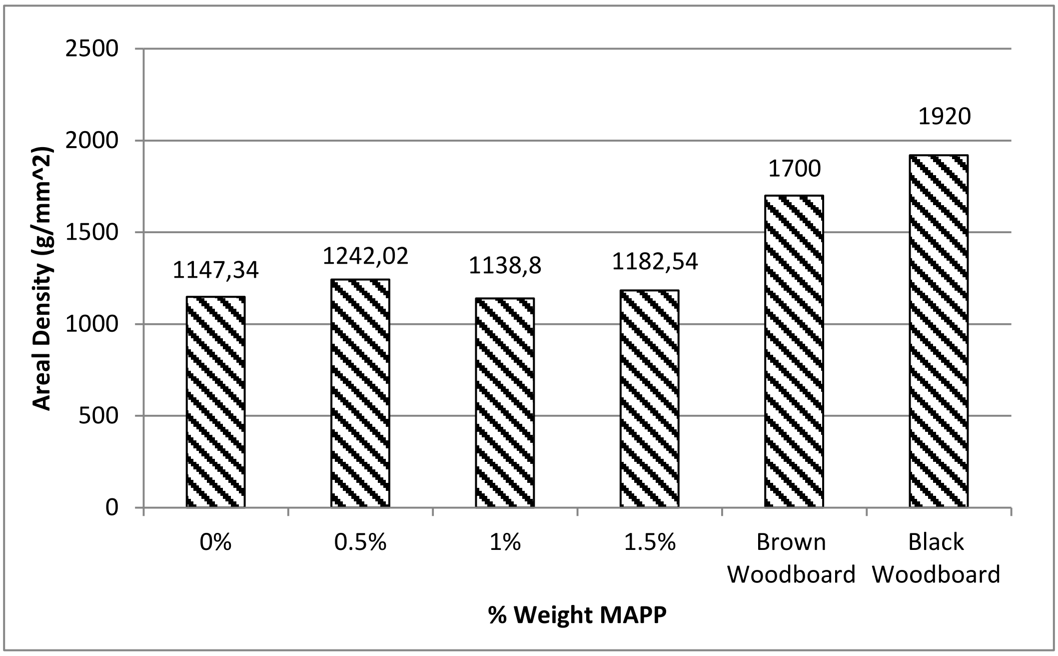

Figure 2 Areal density of composite sampels in comparison with the same density of PP and wooboard from the indsutry

3.2 Flexural Properties.

Composite using untreated fibers and MAPP added were made to study their flexural properties and compared with woodboard samples from indsutry so that the effect of MAPP can be evaluated. Figure 2 shows the flexural strength of the composites with different percentage of MAPP compared woodboard sample from industry.

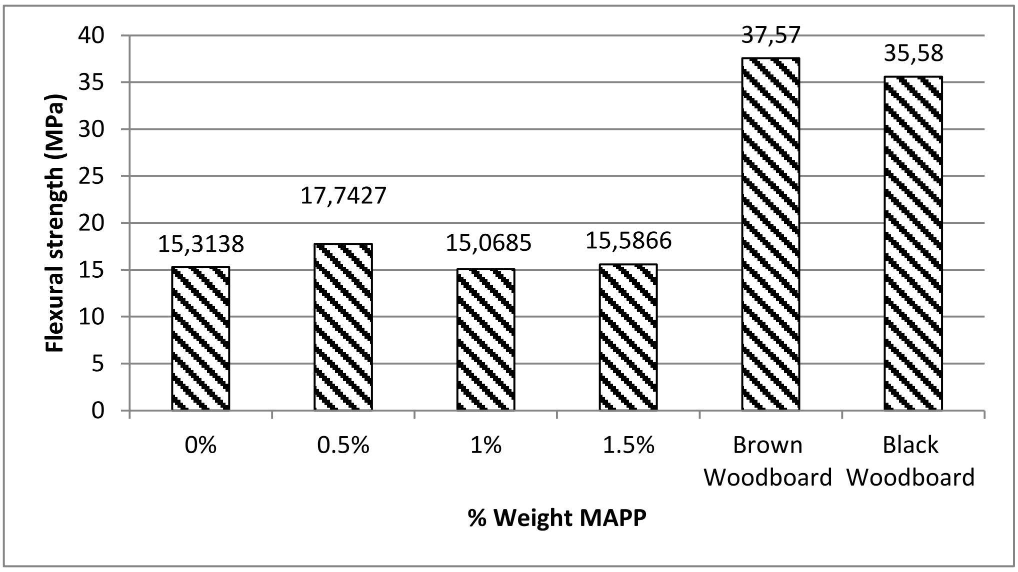

Figure 3 Flexural strength of the composites with different percentage of MAPP compared woodboard sampels from industry.

Figure 2 shows that composite with MAPP 0,5% addition had the highest flexural strength up to 17,74 MPa compared composite with MAPP 1% (15,07 MPa), 1,5% (15,59 MPa), and without MAPP (15,31 MPa). The decreasing of flexural strength at MAPP 1% and MAPP 1,5% addition because MAPP has a lower molecular weight compared PP which seems responsible for plastizicing effect [5][6].

The flexural strength of the composite 52,7%-59.8% lower compared to brown woodboard and 50,1%-57,6% lower compared to black woodboard.

4 Conclusion

MAPP addition in sugarcane bagasse-polypropylene composite can increase the flexural of the composite. Composite with MAPP 0,5% addition has the highest flexural strength (17,74 MPa). Percentage MAPP addition at 1% and 1,5% can decerease the flexural strength of the composite. Composite sugarcane bagasse-polypropylene is lighter compared woodboard samples.

5 References

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