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PREPARATION AND CHARACTERIZATION OF COMPOSITE PARTICLE BOARD FROM COCONUT SHELL POWDER WITH BINDER HDPE RECYCLING WITH MECHANICAL TESTING ABSTRACT

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Abstract

This research aimed to improving the quality of materials in order to produce composite board which had the standard score based on Indonesian National Standard (SNI). The focus of this research was the using of coconut shell powder as a filler material (filler), mixed with High Density Polyethlene (HDPE) recycling as a binder (matrix). On testing of the mechanical character obtained the varied nature i.e. for elastic strength was better on composition of the 60 : 40, elastic modulus was better on composition of the 50 : 50, internal adhesive strength was better on composition 30 : 70, impact strength was better on composition 70 : 30. In general, for the incorporation of the value of the mechanical composition of 50:50 indicated the dominant values to fulfill the Indonesian National Standard (SNI) 03-2105 - 2006. This research conducted a few tests which include mechanical testing on the samples that have been made. Mechanical tests including: Modulus of Rupture Test (MOR), Modulus of Elasticity (MOE), internal adhesion strength test and impact strength test.

Keywords : Composite board, coconut shell powder, HDPE, mechanical testing, physical testing

A. INTRODUCTION

Technology of material recently is progressing significantly, both in metal and non-metal materials. One type of non-metal materials are widely studied by people is a composite material. The development of composite materials with natural fibers can be used as a board table, chairs, windows, doors, ceiling and other household items. According to Irfandi, 2013 that the output of the composite material can be used more widely is used by car manufacturers as a reinforcement panel of the car, the rear seats, the dashboard, and also in the manufacturing industry. Composite is a combination of two or more materials are held together by a matrix. Composites can be grouped based on density, usability, and also the manufacturing process. Composite material is a combination of two or more organic or inorganic components.

Composites are generally composed of a binder material (matrix) and a reinforcing material which is also called filler material (filler). Basically, the composite material is a combination of two or more different materials into a microscopic form, which is made from various combinations of characteristics or a combination of fiber and matrix.

According to Zainal Mahmud and Julius Ferry 2005 that the production of Indonesian coconut have average of 15.5 billion grains / year, equivalent to 3.02 million tons of copra, 3.75 million tons of water, 0.75 million tons of charcoal, 1, 8 million tons of coir fiber, and 3.3 million tons of coir dust (Allorerung and Lay, 1998; Anonymous, 2000; Nur et al., 2003; APCC, 2003). Basically, oil processing industry are still focused on the processing of fruit pulp as the primary outcome, while the industrial which is processing another product beside the fruit pulp (by-product) such as: water, coir and coconut shell is still traditional and have a small scale whereas the potential availability of raw materials for building the processing industry is still very large.

On the other hand, most of Indonesia territory is an earthquake-prone. The frequency of earthquakes in Indonesia is very large, the number of damaged buildings with the highest degree of damage to the building is on the wall of the building. With the real conditions, it will be a national problem of how to provide homes with affordable prices and friendly eco-friendly for Indonesian society.. So that, to help solving those problems it is needed an alternative material technologies to provide the building walls are more economical and cheaper. One alternative is to create a composite material as thin and strong interior walls that can replace the use of interior walls of concrete (cement-brick) because it is too thick and in-efficiency space (Irfandi, 2011). This study aimed to conduct a study on how to produce composite board in accordance with the benchmark set by SNI so that it can be used in general. The use of coconut shell powder as a filler material (filler), with High Density Polyethylene (HDPE) recycling, which has a higher crystallinity characteristics and more rigid so as to produce a composite board materials suitable with Indonesian National Standard (SNI).

B. RESEARCH METODOLOGY

This research used coconut shell powder with a size of 80 mesh as a raw material. In manufacture of composite boards was used an adhesive high density polyethylene (HDPE) recycling of used oil bottles. With different levels of scale comparisons between materials and adhesives HDPE recycling percentage of 70%: 30%, 60%: 40%, 50%: 50%, 40%: 60%, 30%: 70%. Some of the tools which was used in the manufacturing process of composite board was hot and cold press. The manufacturing process was HDPE bottles of used oil was cleaned, after it was dry then cut to the size of ± 0.5 cm x 0.5 cm. Coconut shell powder which has been filtered with a sieve of 80 mess dried with a blower 50 ^{0}C oven until completely dry. Then the solvent was evaporated in the oven. Furthermore, the tool was extruded in an extruder at a temperature of 170 ^{0}C to form polyblend and then coupling agent was ready to use.

Furthermore, for the manufacturing composite board samples was made with compression heat (hot press) at 170 ^{0}C with a pressure of 40 bar for 15 minutes, with 2 repetitions with a composite board based on SNI 03-2105-2006 tested for particle board. To determine the mechanical charactersitics, the composite particle board was conducted several tests as follows:

a. Modulus of Rupture (MOR) Testing
Modulus of rupture testing was conducted with Universal Testing Machine (UTM) by using the width of the buffer rod (distance prop) 15 times of the thick of the sample, but not less than 15 cm. MoR values was calculated with the formula:

$$\text{MoR} = \frac{3PL}{2bd^2} \quad \text{..... (1)}$$

where :

MOR : *Modulus of Rupture* (kgf/cm^2) b : the width of sample (cm)
P : maximum weight (kgf) d : the thick of sample (cm)
L : distance prop (cm)

b. Modulus of Elasticity (MoE) Testing
Modulus of elasticity testing was conducted jointly with firmness or bending strength testing using the same sample. The amount of deflection that occurred during the test was recorded at every interval of specified load, the value of MoE was calculated with the formula :

$$MOE = \frac{\Delta PL^3}{4\,\Delta Y\, b\, d^3} \quad \text{..... (2)}$$

where :

MOE : *Modulus of Elasticity* (kgf/cm^2)
ΔP : weight load before limit proprtion (kgf)
L : distance prop (cm)
b : the width of sample (cm)
d : the thick of sample (cm)
Δ Y : deflection of load (cm)

c. Strong Impact Testing

For impact strength testing, samples with the measure of 5 cm x 10 cm x 1 cm. Impact testing could be done by using a Wolpert Type : CPSA Cap : 4 Joule model of Charpy. The difference between Charpy and Izod was the placement of the specimen. Charpy testing by using more accurate meanwhile on Izod testing the specimen holders also absorb energy, so that the measured energy was not the energy that was able to absorb the material completely. The impact test was intended to test the resistance of decorative fiber board against impact due to dropping of ballast vertically to the surface.

d. The Constancy of Internal Bond (IB)

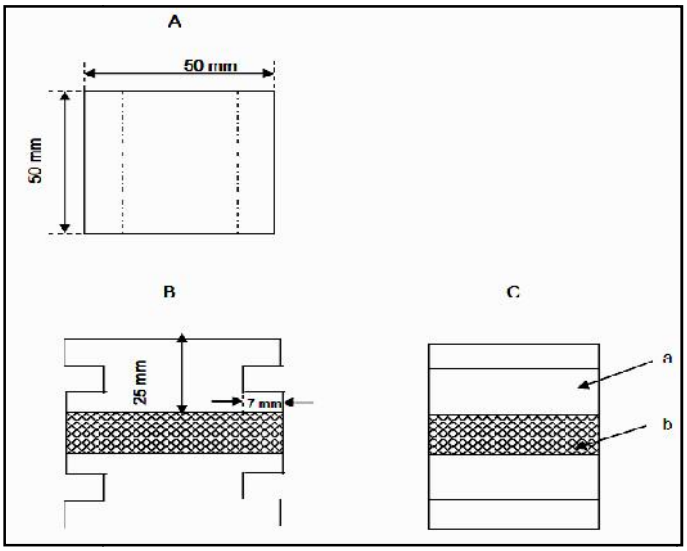
The sample size of 5 cm x 5 cm x 0.50 cm was measured with a micrometer. The test sample was bonded on two blocks of iron using iron-adhesive glue and allowed to dry for approximately 24 hours. After drying up, both of iron blocks was pulled perpendicular to the sample surface until the maximum load. Internal bonding strength value was calculated using the formula:

$$IB = \frac{B}{P \times L} \quad \text{.....(3)}$$

where :

IB = *Internal Bond* (Kgf/cm^2)
B = Maxium Load (Kgf)
P = Length (cm)
L = Width (cm)

Below was the illustration the concept of internal bonding strength test with a picture as follows:



Picture 1. Sketch of Internal Bond Testing

Description :
A : Sample test viewd from above
B : Sample test viewd from front side
C : Sample test viewd from the side
a : Iron block
b : Test sample

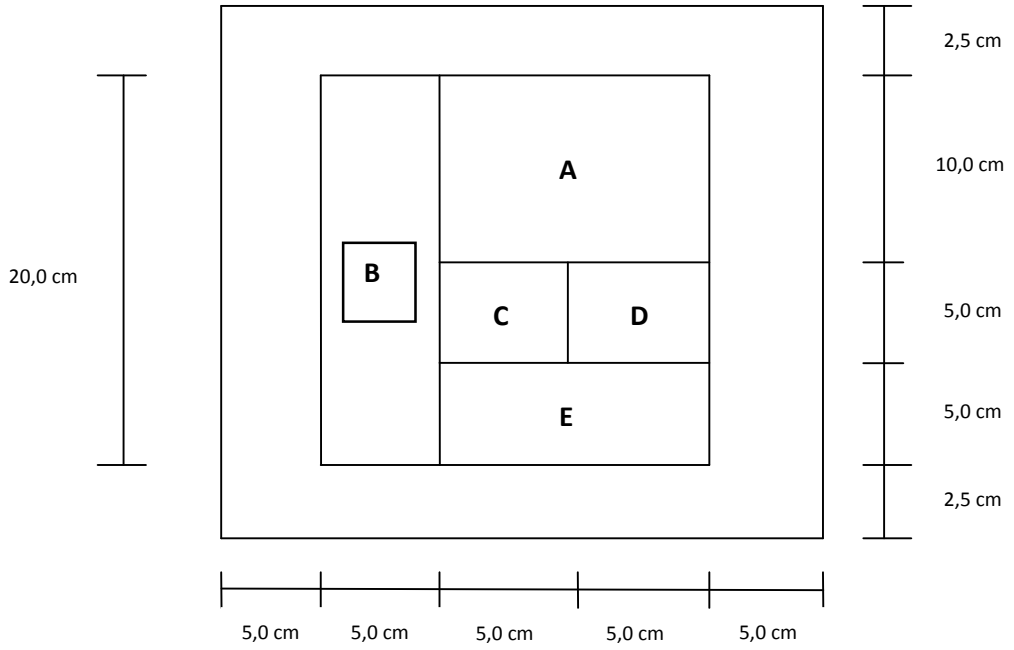
At the time sheets forming composition of coconut shell powder and plastic is made with 5 comparison with the following specifications:

Table 1. The Comparation of Matrix Material Composition

SHEETS	COMPOSITION	
	PLASTIC HDPE	COCONUT SHELL POWDER
I	30%	70%
II	40%	60%
III	50%	50%
IV	60%	40%
V	70%	30%

C. Sample Manufacturing

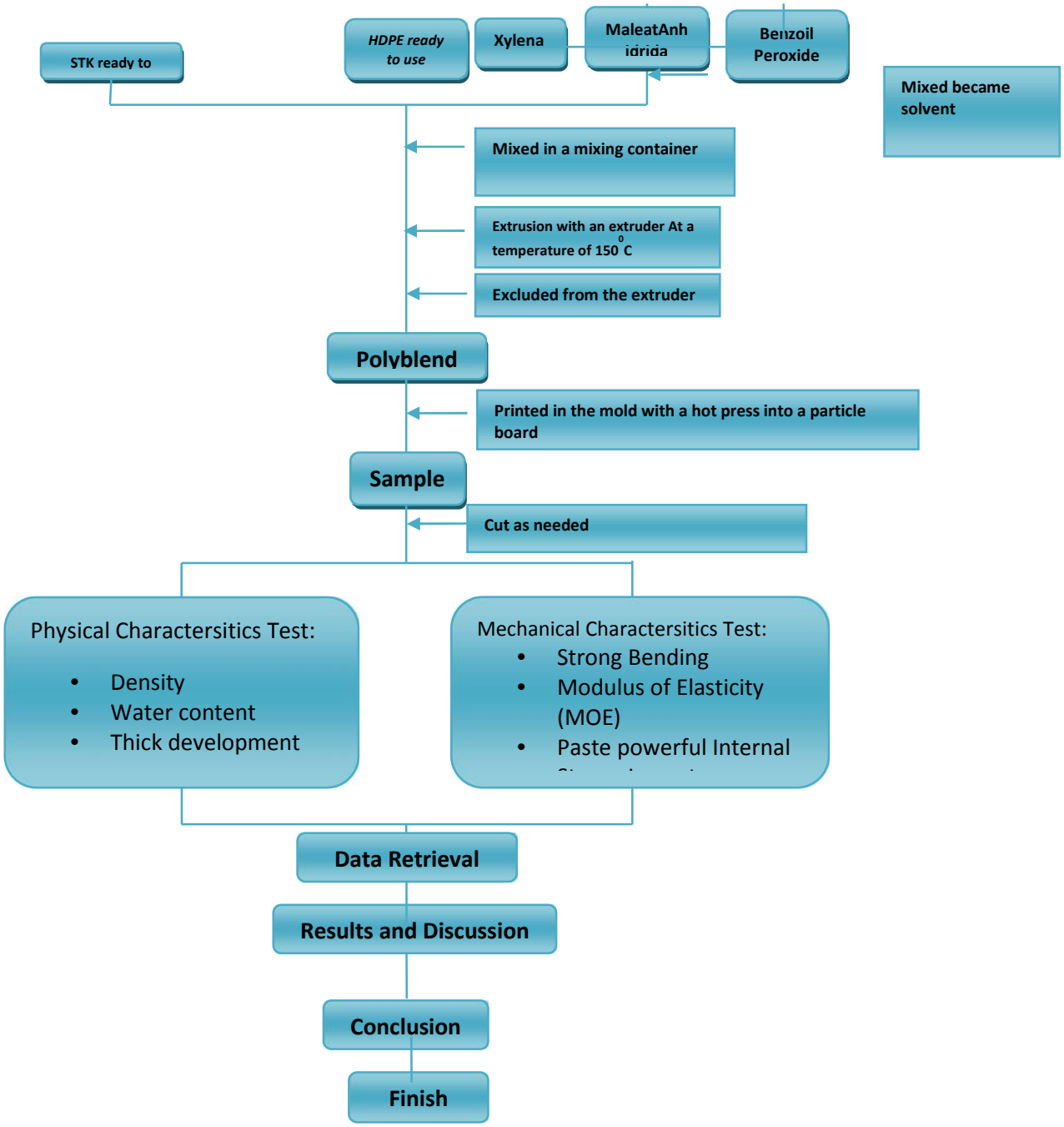
Samples that have been printed in the form of plates and cut pieces according to the test sample. The forms of the test sample was made according to the standard and each test sample was different. Making the samples by cutting material that was made refered to the standard SNI 03-2105-2006 as shown in the following figure:



Picture 2. The Size of Test sample Based on SNI 03-2105-2006

Description:
A: Samples for testing density and moisture content
B: Samples for testing MOR and MOE
C: Samples for testing thickness swelling
D: Sample for testing internal adhesive strength
E: Samples for testing impact strength

Diagram of manufacture of particle board



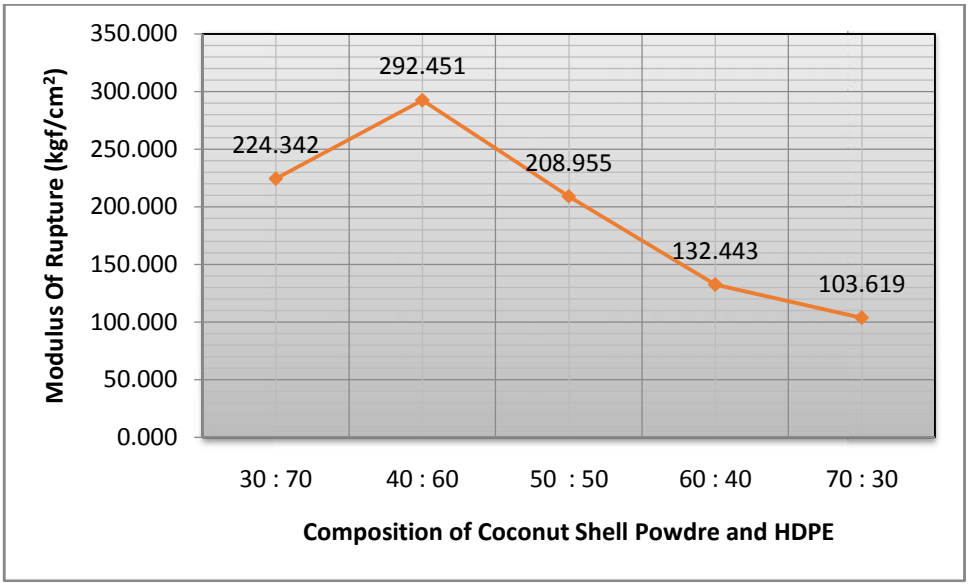
Picture 3. Diagram of Manufacture of Particle Board

D. RESULT AND DISCUSSION

MECHANICAL CHARACTERSITICS OF PARTICLE BOARD

The Results of Modulus Of Rupture (MOR) Test

Modulus of Repture was quantities in the technical field which indicated the maximum load that could be retained by the material (in this case was a composite board) per unit area until the material was broken. From these results modulus of repture (MOR) obtained quite high. The lowest value at 70:30 composition of 112.17 kgf /cm^2 while the highest at 60:40 of 103.261 kgf /cm^2.



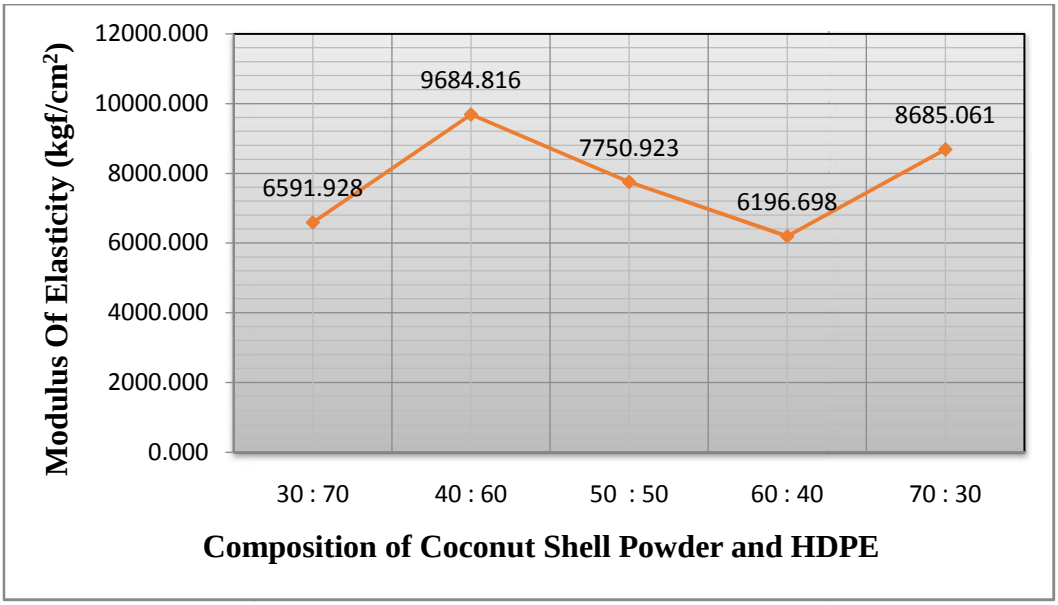
Picture 4. Graph of Values Modulus of Repture

The results showed that the more levels of HDPE plastic the more elasticity become. Otherwise, the more level pf coconut shell powder (STK) the less flexibility become. Coconut shell powder at a ratio (STK) and HDPE 30:70 decreased on 224.342 kgf /cm^2. It was suspected because of coconut shell powder and recycled HDPE plastic was mixed manually, it made the mixing of particle board unevenly.

Indonesian National Standard (SNI) 03-2105 - 2006 particle board, requires the value of flexural strength (MOR) of at least 80 kgf / cm2. Then, the result of composite board met with the standard. Thus, the result of composite board was very good based on its MOR.

The Results Modulus of Elasticity Test

Modulus of Elastic (MoE) is the quantity in the technical field that indicates the size of the resistance of the material (in this case the particle board) hold the load in proportion limit (before the break).



Picture 5. Graph of Values Modulus of Elasticity

The test results showed the value of the lowest MOE on the composition of the 60:40 of 6196.698 Kgf/cm^2 while the highest at 40:60 compositions of 9684.816 Kgf/cm^2. This was allegedly because of mixing coconut shell powder (STK) and polypropylene with the same amount so that produced highest MOE.

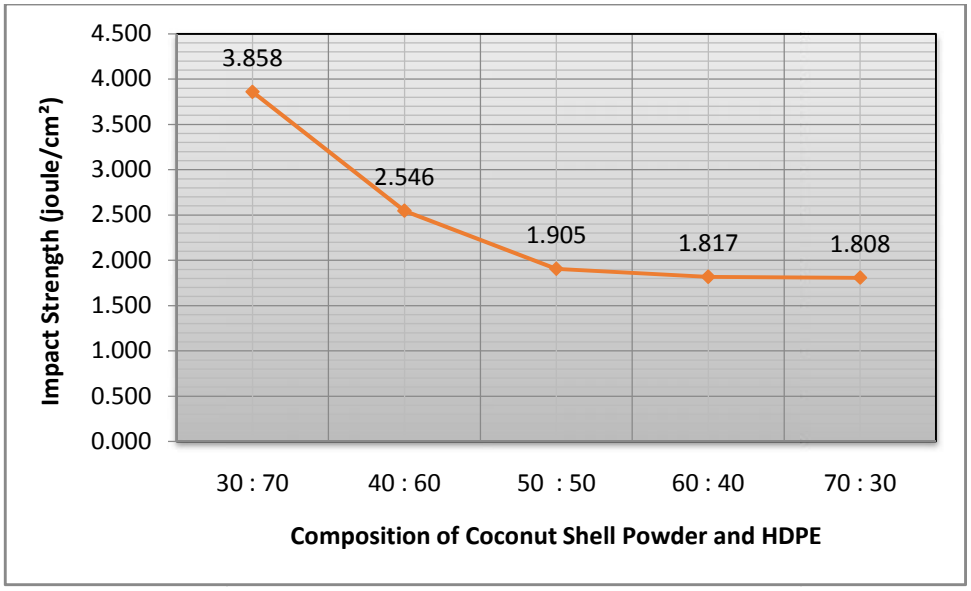
The MOE value of particle board result was still far below the standard. Indonesia National Standard (SNI) 03-2105-2006, particle board, which requires the value of at least 20000 MOE Kgf/cm^2. This was allegedly because of the characteristics of HDPE which has value 1,10 x 10^4 – 1,36 x 10^4 Kgf/cm^2 was far below the standard of the SNI.

This was also due to the weak interaction between the plastic and the particles, the weak adhesion, particle uneven deployment, transfer between a low phase causes the cohesiveness limited. MOE values were supposedly too low because the effect offelt temperature and time were low. According Kusnadi (2003), the temperature of felts used in the manufacture of particle board with plastic adhesive HDPE) is 180^{0}C with a time of 30 minutes felts. Meanwhile, the research Setyawati (2003), the temperature of felts used were 170^{0}C with a composite board with a compatibilizer between 2.5 - 3 minutes and for composite boards without compatibilizer was 100 seconds. While in this study used felts temperature was 170^{0}C with a felt time was 20 minutes, but it also when we looked at the density of their physical characteristics, the particle density of the board was high and medium density thus implicated in its modulus of elasticity.

Therefore, the value of MOE obtained did not meet with the standards of the SNI 03-2105-2006.

The Result of Impact Strength Test

This testing used Wolpert Tool Type: CPSA Com. No. 8803104/0000 with a given treatment of sample materials were placed between the bat, the bat (sledgehammer) of 4 Joules. Wolperts Tool Type: CPSA Com. No. 8803104/0000 used energy blank (empty) of 0.2 Joule obtained from zero correction tool used to perform impact testing so that accuracy values were more accurate.



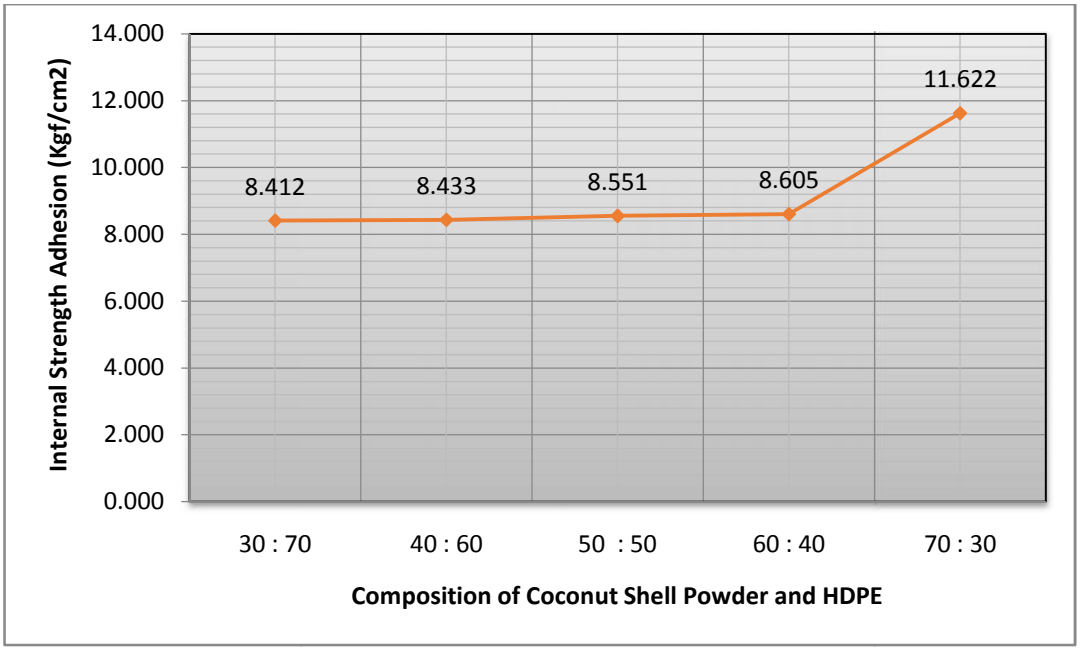
Picture 6. Graph of Value Strong Impact

Impact strength was a criterion to determine the brittleness of materials. The test results showed that there were significant differences in the composition of the treatment ranged between (1.81 to 3.86) Joules / cm^2. On the composition of 70:30 until 50:50 there were no significant changes, on the composition of the above 50:50 there are a change brittleness very striking force to the impact strength 3.86 joule/cm^2

From the graph of the strength of the impact on the treatment of 30:70 composition of 3.86 Joules/cm^2 and the force of the impact the composition of 70:30 smaller i.e. of 1.81 Joules/cm^2. This was allegedly because the bonds between the molecules in the moment in a plastic Binder HDPE plastic adhesive strength then the binds of the particles of the powder coconut Shell getting stronger so that the strength of the impact getting bigger. Whereas, in the composition of the 70:30 coconut shell powder and HDPE, the particles between the powder did not tied strong because dominant coconut shell powder.

The Results of Internal Strength Adhesion Test

This test used a Universal Testing Macihne Type SC - 2DE MFG. No. 6079 Capasita 2000 kgf. Strong internal adhesion was one of quantity technical to test the adhesive strength of the particle board. In this study, the glue that used to placard between the particle board was Dexton iron glue.



Picture 7. Graph of Internal Strengh Adhesion

The test results showed the value of strong internal adhesion at 70:30 bigger composition of 11.622 kgf/cm^2 and the smallest at 30:70 composition of 8.41 kgf /cm^2.

Indonesian National Standard (SNI) 03-2105 - 2006 Particle Board, required a minimum value of Internal Strength Adhesion 1.5 kgf/cm^2. Therefore, the result of composite board met the standards because it can reach thr minimum score. Thus, the quality of particle board produced based on internal strength adhesion was excellent.

E. CONCLUSIONS

1. In general from the result, the score of physical and mechanical charactersitics of composite board was quite good and fulfilled the standard from SNI 03 – 2105 – 2006 except the score of modulus elasticity was far below standard.
2. For the mechanical testing obtained, SNI 03 - 2105-2006 requires that at least 80 kgf/cm2 for the bending strength, while the result obtained 103.619 kgf/cm^2 - 292.451 kgf/cm^2, for a score of modulus of elasticity did not meet with the standard ISO 03 - 2105-2006, because the interval of elasticity modulus from the result obtained at intervals 6196.698 kgf/cm^2 - 9684.816 kgf/cm^2, while the required score for internal strength adhesion SNI 03-2105 - 2006 was at least 1.5 kgf/cm^2 on the research showed 8.412 kgf/cm^2 - 11.622 kgf/cm^2 and the impact test obtained the highest score 3.858 joules /cm^2 and the lowest score was 1.808 joules/cm^2.
3. The results of ranking the quality of a better particle board was treated at 50: 50

F. REFERENCES

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