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PROSIDING
The 5th University Research Colloquium

Yogyakarta, 18 Februari 2017

"CINTA NEGERIKU"

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Prosiding The 5th University Research Colloquium

Cinta Negeriku
Yogyakarta, 18 Februari 2017

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KATA PENGANTAR

BISSMILLAAHIRRAHMANIRRAHIM

ASSALAMU'ALAIKUM WR.WB.

Puji syukur kami panjatkan kehadirat Ilahi Robbi, karena hanya dengan taufiq-Nya, kami dapat menyelesaikan penyusunan prossiding makalah-makalah yang disampaikan pada Seminar **University Research Colloqium (URECOL) ke-5** "Cinta Negeriku". Kami menyadari bahwa penerbitan prossiding ini sangat dinantikan oleh para pemakalah yang sangat bergairah dalam mengikuti kegiatan Seminar **University Research Colloqium (URECOL) ke-5** pada tanggal 18 Februari 2017 di Kampus 1 Universitas Ahmad Dahlan Yogyakarta.

Kami juga bersyukur bahwa kegiatan seminar ini mendapat dukungan sepenuhnya dari Universitas, para narasumber utama dan seluruh pemakalah, serta peserta kegiatan ini. Prosiding ini memuat 307 makalah penelitian dan pengabdian dalam bidang MIPA, kesehatan, pendidikan, humaniora, agama, sosial ekonomi, psikologi, teknik dan rekayasa.

Akhirnya kami menyampaikan terima kasih kepada semua pihak yang telah berjasa pada kegiatan seminar dan penyusunan prossiding. Demikian, semoga dengan sampainya prossiding ini ditangan para pemakalah dan pembaca pada umumnya selesai pula tanggung jawab kami dalam menyelenggarakan Seminar **University Research Colloqium (URECOL) ke-5** dengan segala keterbatasannya. Akhirnya hanya kepada Allah SWT kita memohon pertolongan.

WABILLAHITT TAUFIQ WAL HIDAYAH

WASSALAMU'ALAIKUM WR.WB.

Yogyakarta, 18 Februari 2017
Ketua Pelaksana

Dr. Surahma Asti Mulasari, S.Si., M.Kes.

DAFTAR ISI

DAFTAR MAKALAH

EFECT OF FILLER SIZE AND CONTENT ON THE IZOD IMPACT TOUGHNESS OF PEANUT SHELL/EPOXY COMPOSITES

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Abstract

Timber demand for crafts, furnitures and structures has been increased while the supply from natural and industrial forrest is getting more and more limited, thus, alternative materials may be needed for timber substitution. Peanut (Arachis Hypogea) shell as waste of agricultural product can be used as filler for polymer-based composite, but it has not extensively been studied. The objective of this work is to determine the effcet of the size and content of peanut shell particles on the Izod impact toughness of peanut shell/epoxy composite system. Fiber content of 0, 10, 20 and 40 vol%, as well as mess size between 11 and 16, and passing through mess 16 were used. The particel boards were produced using press-mould technique, while specimen preparation and testing were carried out according to the ASTM D5941 standard. Failure modes were evaluated by close observation on the photo macrographs of the samples. It was revealed that the smaller the particle size the higher the absorbing energy capacity (E_a) and impact toughness (I_{It}) of the samples. To the contrary, both E_a and I_{It} were found to increase with the increase of fiber content. For particel size of between mess 11 and 16 at 40 vol% fiber content, the E_a and I_{It} were found being 2.3 J and 0.043 J/mm^2, respectively. For the same fiber content at particle size of passing through mess 16, those were found being 2,8 J and 0,050 J/mm^2, respoectively. Most of the samples were exhibited single plane fractures.

Keywords: *epoxy, filler content, impact toughness, absorbing energy capacity, peanut shell particle.*

1. INTRODUCTION

During the last a couple of decades, the materials for handycraft and furniture have been shifted from timber to particle boards, and the are generally produced in knocked-down system in order to ease of packaging and trasportation. Even some parts of structures, such as doors, windows and panels have also been produced from particle boards. Particle boards are commonly produced using wood particles as by-product of sawing mills, but due to the increase of environmental awareness, the amount of timber being produced is getting fewer and fewer[1] leading to more limited amount of wood particle as by-product of sawing mills. Thus, alternative materials for wood particle substitution should be invented in order to save the existing rain forest and further save the environment.

Different natural fiber and filler materials have been studied for being utilized for composite materials. Purba[2] investigated the phisical and mechanical properties of randomly oriented empty oil palm fruit bunch fiber/recycled polypropylene, and reported that optimum impact strength was found being 3.85 kgf/cm^2 (~0.3777 MPa) at 30 wt% fiber content, and flexural strength of 135.78 kgf/cm^2 (~13.320 MPa) at 50 wt% fiber content. Firdaus[3] investigated the impact properties of low (5 – 10 vol%) filler content of peanut shell wishker-reinforced unsaturated polyester composite, and found out that impact toughness increases with the increase of filler content. The impact toughness was reported being 0.033 J/mm^2 at V_f = 10%, and 0.023 J/mm^2 at V_f = 3%. Most of the specimens were underwent brittle fracture where the cract propogates in the direction perpendicular to the direction of tensile stress. Khailani[4] reported that impact toughness of peanut shell wishker/epoxy composite decreases with the increase of filler content from 20 vol% to 40 vol%. The impact toughness was reported being 0,018 J/mm^2 at V_f = 20%, 0,016 J/mm^2 at V_f = 30%, and 0,010 J/mm^2 at V_f = 40%. Other natural fillers that have been investigated are bamboo fibers[5,6], coir fibers[7], hemp, jute, and sisal[6].

Peanut can well be grown at an altitude of less than 500 mater above the sea level, at temperature of 28°C – 32 °C, with humadity of 65%-75%, and annual average rain fall of 800 mm – 1300 mm (Rukmana, 1993). Thus, Indonesian farm land are generally suitable for growing peanut, where the product can reach up to 3 tons/hectare of peanut kernel, and according to the National Bureau of Statistics total national product of 657.590 tons of peanut kernel in 2015 (Nuryati et al., 2015)[8]. Average quality of unshelled peanut contains 30-32 wt% of shell[9]. According to Davis et al (2016), high quality unshelled peanut contains 21-29 wt% of shell[10]. Considering the density of the shell is smaller than that of the kernel, shell volume content is higher than shell weight content.

In this research, peanut shell was considered for being substitute.

2. RESEARCH METHOD

Peanut shell was obtained from local source. After being dried, the shell was ground and sifted. First, the ground shell was sifted using a 16-mesh sieve. Particles that did not pass throuh this sieve were reground, and those that pass the sieve were then sifted using an 11-mesh sieve. Those that pass through this second sifting were used as fine particles while those that did not were used as the coarse particles (Fig. 1). Given the geometry of the mould, and peanut shell density of 0.228 gram per cubic centimeter[4], the mass of the filler can be calculated according to Eq. (1).

$$m_\mathrm{f} = V_\mathrm{f}\ v_\mathrm{c}\ \rho_\mathrm{f}\ \mathrm{(g)} \qquad (1)$$

where V_f, v_c (cm^3) and ρ_f (g/cm^3) are the volume fraction of the filler, volume of the mould and density of the filler, respectively.

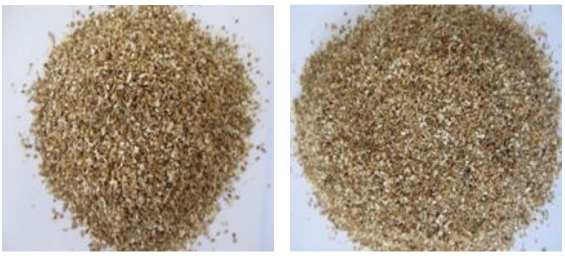


Fig.1. Peanut shell filler: (a) coarse particles, (b) fine particles

The matrix being used is epoxy that consists of general purpose bisphenol A-epichlorohydrin resin combined with general purpose polyaminonamide hardener supplied by the P.T. Justus Kimia raya. The mixing ratio of 1:1 as recommended by the supplyer. Specimens were prepared in accordance with the ASTM D5941[11] standard. The specimens (Fig. 2c) were were cut from 200 mm x 250 mm particulate composite boards using circular saw rotating at 6000 rpm. The boards were produced by means of mold-press technique as presented in Fig. 2a. The resulted compsoite particle boards have been presented in Fig 2(b).

Impact test were carried out using a Controlab impact tester. The amount of energy being absorbed and impact toughness were calculated using Eqs. (2) and (3), respectively. Fracture modes were determined by close observation of the photo macrographs of

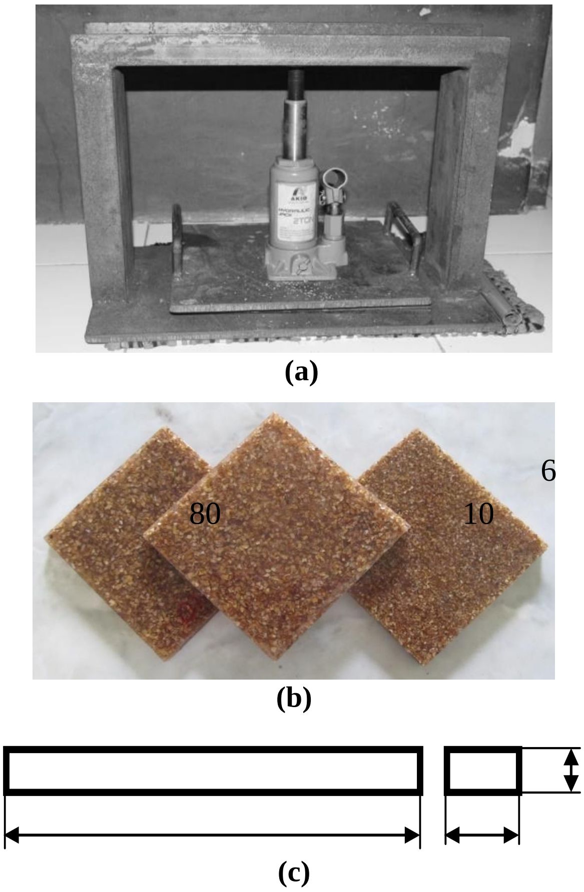


Fig.2. (a) Specimen geometry, (b) press-mould, (c) comnposite particle boards

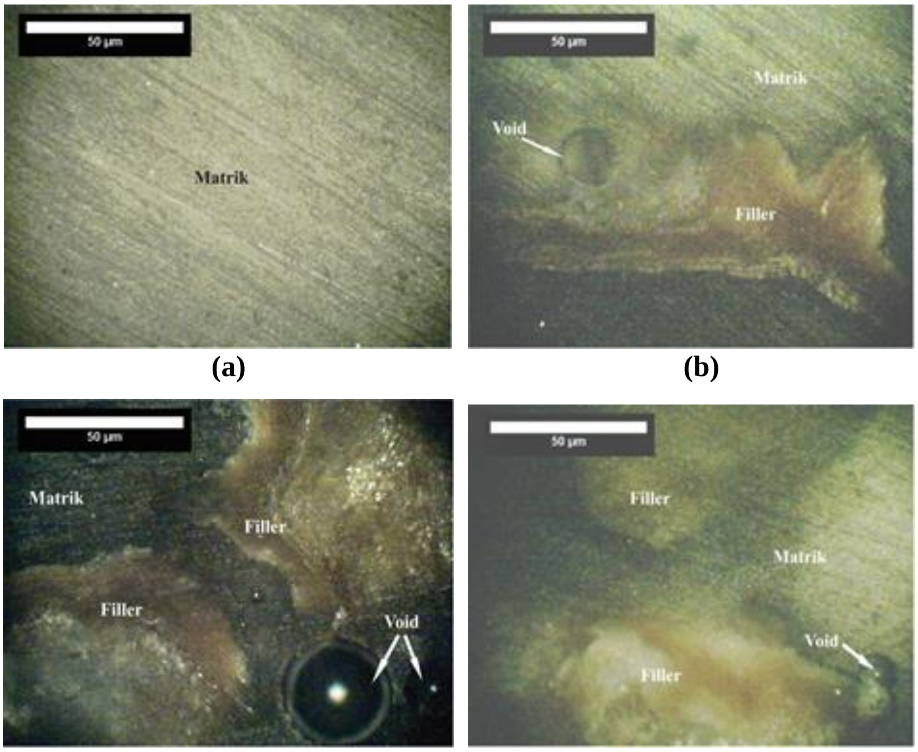
representative fractured specimens. The photos were capture using a Zeiss microscope equipped with an Axiolab digital camera possessing maximum resolution of 5 MPx, and connected with a computer for image variable adjustment.

$$E_{\mathrm{a}} = m\,g\,R\left(\cos\beta - \cos\,\alpha\right) \ \ (\mathrm{J}) \qquad (2)$$

$$I_{\mathrm{t}} = \frac{E_{\mathrm{a}}}{A} \ \ (\mathrm{J/mm^2}) \qquad (3)$$

where

E_a = the amount of energy being absorbed (J)
m = the mass of the pendulum (kg)
g = gravitational acceleration (m/s^2)
β = final angle of pendulum arm (°)
α = initial angle of pendulum arm (°)
I_t = impact toughnes (J/mm^2)
A = cross sectional area of specimen (mm^2).



(a) (b)

(c) (d)

Fig. 3. Microstructure of fine (mesh 16) particle-filled composite boards: (a) pure matrix, (b) V_f = 0.2, (c) V_f = 0.3, (d) V_f = 0.4

Photo micrographs of representative samples were closely evaluated in order to determine the composite microstructure and failure mode of the specimens. Prior to being cuptured under a microscope, the representative fractured specimens were cut and mirror polished.

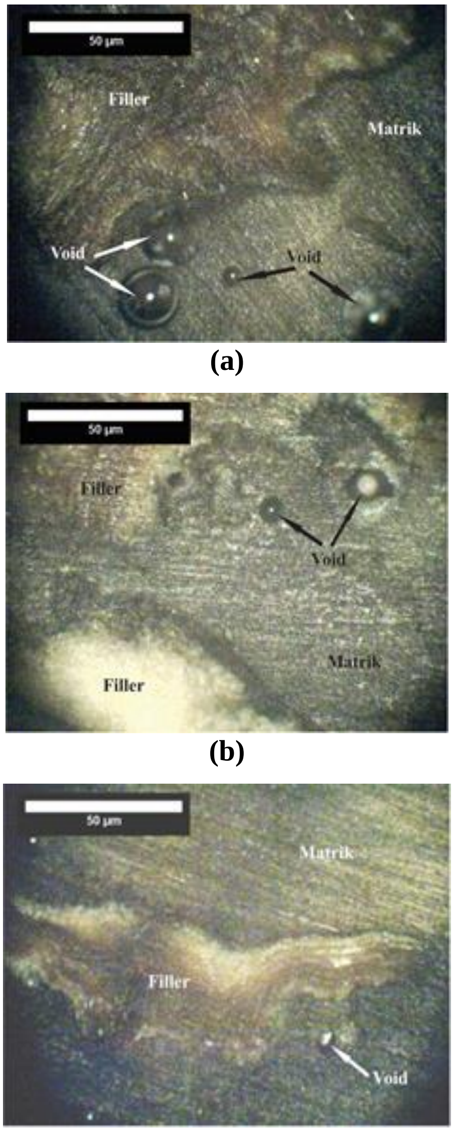
3. RESULT AND DISCUSSION

3.1. Composite Board Microstructure

Composite microstructure exhibits tiny and fine voids, in which void content of coarse particle-filled composite board was found being higher than that of fine particle-filled composite board as presented in Figs. 3 and 4.

It can be seen in Fig. 3(a) that pure matrix is considerably void free, while maximum void content was found at V_f = 0.3 (Fig. 3(c)). Theoretically, void content tends to increase with the increase of filler content. There is no trend being found on the relationship between filler content and void content, as can be observed in Figs. 3(b), 3(c) and 3(d). Fully manual fabrication process may be responsible for such phenomenon.

Unlike fine particle-filled composite, coarse particle-filled composites demonstrate that the amount of void decreases with the increase of filler content, which is to the contrary with the theory. The same reason as that for fine particle-filled composites may also be applied to these coarse particle-filled composites, where it is very difficult to precisely control any fabrication variables in fully manual fabrication process.



(a)

(b)

(c)

Fig. 4. Microstructure of coarse (mesh 16 to 11) particle-filled composite boards: (a) $V_f = 0.2$, (b) $V_f = 0.3$, (c) $V_f = 0.4$

3.2. Energy Absorbing Capacity

The effect of filler content on the absorbing energy capacity of the particulte composite boards has been presented in Fig. 5.

The figure shows that the amount of energy being observed increases with the increase of filler content. In addition, fine particle-filled compiste boards absorp more energy in comparison with coarse particle-filled composite boards.

3.3. Impact Toughness

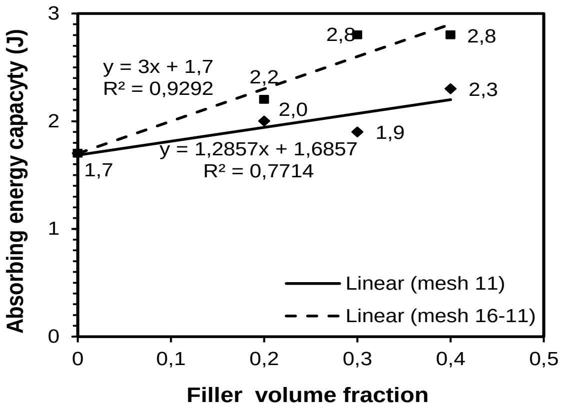


Fig.5. The effect of filler content on the absorbing energy capacity

Fig. 6 shows the effect of filler content on the impact toughness of particulate composite boards.

Very much similar with Fig. 5, it can also be seen in Fig. 6 that impact toughness increases with the increase of filler content, as well as fine particle-filled composite boards exhibites higher impact toughness in comparison with coarse particle-filled composite boards. This result is significantly higher than that previously reported[4], where the impact toughness of peanut shell/epoxy composite system being 0.018, 0.016 and 0.010 J/mm2 for filler volume fraction of 0.2, 0.3 and 0.4, respectively. It should also be noted that in the current research the impact toughness increases with the increase of filler content which is in the opposite way of the previously being reported. Although these values are comparatively high, these are significantly lower than those of coir fiber/epoxy composite system[12].

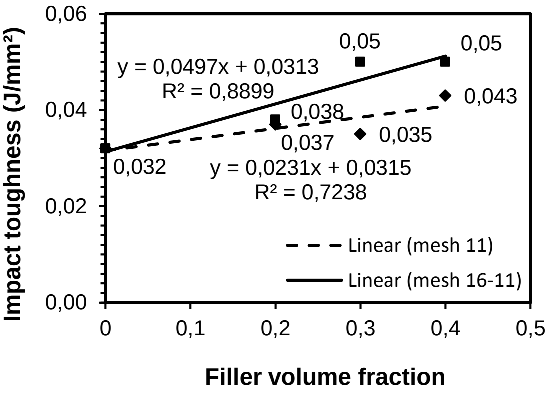


Fig.6. The effect of filler content on the impact toughness

3.4. Failure Modes

It can be seen in Fig. 7, that pure epoxy and mesh-16 particle filled composite boards demonstrated single-plane failure under impact loading. It may be caused by suddent load being applied such that the specimen under loading did not have enoug time to transfer the load from the matrix into the fillers and firther redistribute to its surrounding. In addition, filler distribution is considerably even as can be observed in Figs. 7(a), (b) and (c).

Fig. 8 confirms that there is no significant effect of particle size on the failure mode of the particulate peanut shell/epoxy composite system.

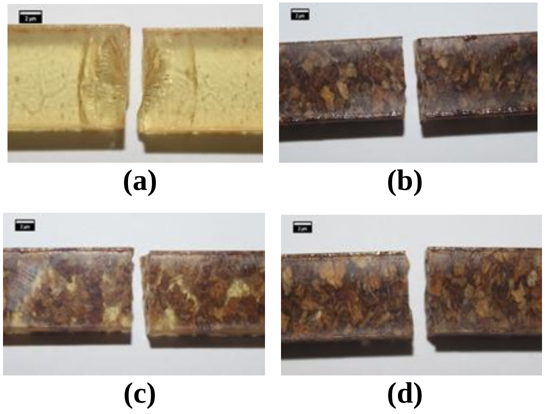

(a) **(b)**
(c) **(d)**

Fig.7. Failure mode of coarse particle-filled composite boards: (a) pure matrix, (b) V_f = 0.2, (c) V_f = 0.3, (d) V_f = 0.4

4. CONCLUSION

Peanut shell particle-reinforced epoxy composite boards have fabricated and tested. It can be cpncluded that:

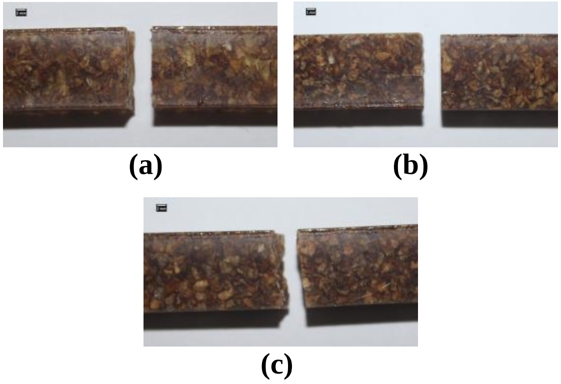

(a) **(b)**
(c)

Fig.8. Failure mode of fine particle-filled composite boards: (a) V_f = 0.2, (b) V_f = 0.3, (c) V_f = 0.4

1. Due to the difficulty in controlling fabricaton parameters, the relationship between filler content and void content could not determined.
2. Both absorbing energy capacity and impact toughness increases with the increase of filler content, in which the finer the filler size the higher both the absorbing energy capacity and impact toughness.
3. The effect of filler size on the failure modes was not observed. All af the specimens experienced single-plane failure.

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