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Study of Crack Connections in Materials Composite Based on Polymer

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Abstract. The main problem in composite materials based on polymer arises when receiving dynamic loads resulting in initial cracks that continue to propagate. When crack on the metal, it can be connected by welding. Also, when a crack on concrete can be reconnected by grouting. While when crack in composite materials based on polymer, there is no special way to deal with cracks so far. The purpose of this research is to reconnect the composite material based on polymer which has cracked and do the impact test (ASTM D6110-04 standard) is carried out to determine the impact strength and the amount of energy to break, tensile strength test, and observe the structure using Scanning Electron Microscopy (SEM). The highest of impact strength and the amount of energy to break, and tensile strength in sample A is 50% resin + 1% catalyst + 19% calcium carbonate + 25% fine fiber + 5% roving fiber, with an impact strength value of 23.89 Joules / mm² and a large amount of energy to break 130.67 Joules, and value of tensile strength is 7.22 kgf/mm². While observed microstructure by using SEM shows the crack that happened is brittle.

1. Introduction

Composite materials are everywhere in our daily lives. Many products on the market contain composite materials or structures, such as plywood, golf clubs, canoes, and coated knives. Although the term composite is very broad and refers to the combination of two or more materials at the macroscopic level, this article refers to a composite as a fiber-reinforced plastic (FRP) or polymer matrix composite (PMC). Reinforcement typically is fibers and the matrix is a thermoset resin. Polymer matrix is most commonly referred to as resin. In about 90 percent of these composites fiberglass is used for reinforcement, and either polyester or vinyl ester is used as a matrix. The open molding technique is used for 65 percent of the composites manufactured, whereas the remaining 35 percent of the composites are manufactured through closed molding [1].

The use of natural fibres (e.g., straw, flax, hemp, banana and jute) as material reinforcement was investigated with considerable interest in last decades [2-5]. The most common concerns about the use of these fibres regard their coupling with a polymeric matrix, which needs to be compatible with the cellulose contained in the fibres [6]. A number of thermoplastic and thermoset matrices were used with this aim [7-8]. However, the best results were obtained so far with polyester and some phenolic resins [9-11]. Another issue widely investigated is the weathering behaviour of natural fibre reinforced composites, including the study of the influence of water sorption on the mechanical properties of the laminate [12]. Top of Form Nowadays a lot of material that the object of research is some kind of plastic such as polyethylene, polypropylene, LDPE, PVC and others. With manipulate the properties of the base material is capable of making such materials into raw materials that are superior to each of



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the constituent elements. With advances in the field of composites, it opens opportunities to open new materials, the survey includes a large volume commodity plastic, cheap plastic and plastic for engineering as well as modern plastics. Thermoplastic that dominate the market (for example: PE, PVC, and PP) plastic type of development entirely new very expensive.

The results of research by [13] Bismarck A., et al, 2002 and Jamasri [14] (2005-2006) have used kenaf fiber and palm fiber waste as an amplifier for executive train (K1) and economy train (K3) panel at PT INKA Madiun, Santoso et al [15] (2006) also concluded that the optimization of increased bending and shear strength can be done by providing variations in the addition of random kenaf fibers. Based on the description of the results of research and application of the composite green panel that has been observed by the author, it shows that the prospect of utilizing kenaf natural fibers in the future will be certainly very likely to be used as the main structural panel, both those suffering from dynamic or static loads. The majority of panel plate failures that suffer from dynamic loads are initial cracks that continue to propagate. Therefore, testing and analysis of crack propagation on a green composite panel plate is important to investigate. The purpose of this research is make to joint when composite materials base on polymer if there is a crack/broken.

2. Experimental Studies

2.1 Materials Research

Materials that use are: resin (epoxy), catalyst, potassium carbonate/ CaCO_3 powder, met/mes (soft fiber) and roving (hard fiber), and composition of each ingredient are made listed in **Table 1**.

Table 1. Composition of samples

Materials	Composition (%)			Note (unit)
Resin (Epoxy)	50	50	50	5000 ml
Catalyst	1	1	1	0.5 ml
CaCO_3 powder	19	19	19	150 gram
Met/mes (soft fiber)	25	20	15	(30 x 30) cm
Roving (hard fiber)	5	10	15	
Code	A	B	C	
Code D is origin				

2.2 Tensile Test

Preparation of test substance adjusted to the standard ASTM D 638 type IV (Standard Test Method for Tensile Properties of Plastics) with test conditions as follows:

- Temperature test chamber = 23°C
- Humidity test room = 50% relative for more than 40 hours.
- Speed drag = 10 mm / min

The size of the test materials shown in **Table 2** and shapes of test materials such as **Figure 1**. Machine examiners use TM 113 Universal 30 KN

2.3 Impact Test

The making of impact test specimens refers to the ASTM D6110-4 standard (**Figure 2**) with the specimens to be tested in the form of rods with a cross section of a square given a notch V by means of the machining process on the side.

Table 2. The size of the test material

Notation	Size (mm)	Tolerance
T = thick test materials	3	-
W = width at the narrow part	6	$\pm 0,5$
L = length at the narrow part	33	$\pm 0,5$
Wo = width of test materials	19	± 6
Lo = length of test materials	115	-
G = length limit of measurement for the	25	$\pm 0,13$

Notation	Size (mm)	Tolerance
test materials		
R = inner radius	14	± 1
Ro = outer radius	25	± 1
D = the distance between the clamp	64	± 5

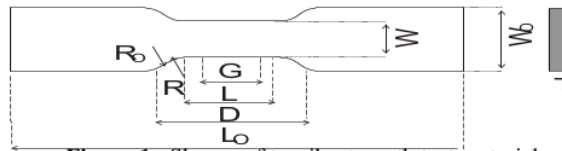


Figure 1. Shapes of tensile strength test materials

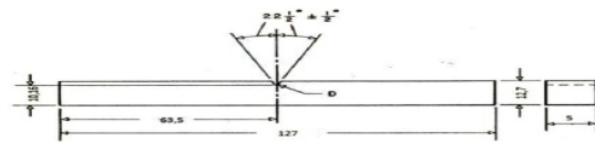


Figure 2. Sample of impact test (ASTM D6110-4 standard)

3. Result and Discussion

3.1 Result of Tensile Test

Figure 3a and 3b shows the composite material that has been made for tensile testing, and the sample of material has been broken during tensile testing (Figure 3c). Result of tensile strength found in the Table 3.

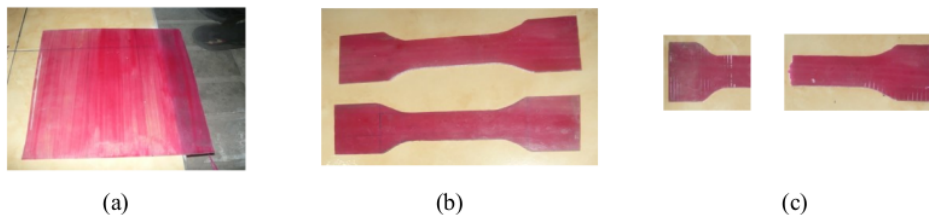


Figure 3. Composite material for tensile test

- (a) Composite material that has been made
- (b) Samples for tensile strength test
- (c) Material has been broken during tensile testing

Table 3. Value of tensile strength

No.	Samples	Tensile Strength (kgf/mm ²)	Strain/Elongation
1.	A	7,22	0.92
2.	B	6,35	0.67
3.	C	5,67	0.46
4.	D (origin)	7.06	0.99

From table 3 shows that a tensile test sample code A that is sample A is 50% resin + 1% catalyst + 19% calcium carbonate + 25% fine fiber + 5% roving fiber, showed the highest tensile strength (7.22 kgf/mm²) and strain/elongation value is 0.92. While sample D (origin) have value of tensile strength and strain not much different value (difference 2.22% for tensile strength and 7.07% for elongation).

Comparison between tensile strength and elongation before fracture in tensile testing of materials PE50 with PE50 after patched, show prices are not much different value (difference 16% for tensile strength and 7% for strain/elongation)..

3.2 Result of Impact Test

The highest of impact strength and the amount of energy to break in sample A is (50% resin + 1% catalyst + 19% calcium carbonate + 25% fine fiber + 5% roving fiber) is 23.89 Joules/mm², and 130.67 Joules. **Figure 4a** shows the composite material that has been made for impact testing, and the sample of material has been broken during impact testing (**Figure 4b**).



Figure 4. Composite material for impact test

- (a) Samples for impact test
- (b) Material has been broken during impact testing

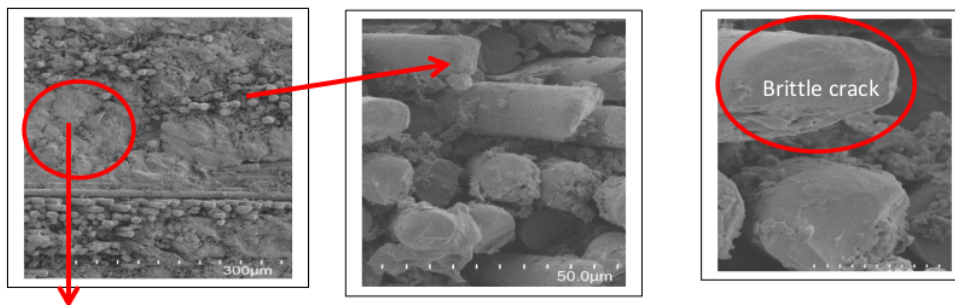
The results of the impact test data (impact strength and amount of energy to break), are complete in Table 4.

Tabel 4. Value of impact data

Samples	Amount of energy to break (Joule)	Impact strength (J/mm ²)
A	130.67	23.89
B	120.54	20.54
C	118.97	15.33
D (origin)	129.34	23.31

3.3 Result Image of Scanning Electron Microscopy (SEM)

The microstructure of composite material sample A (50% resin + 1% catalyst + 19% calcium carbonate + 25% fine fiber + 5% roving fiber) was observed using Scanning Electron Microscope (SEM) each is displayed in **Figure 5a**, **5b**, and **5c**. Showed from figures that resin and fiber not united properly (fiber does not support matrix) and this material is brittle. Next research to try joining/connecting crack connections in materials composite based on polymer with ‘plastic welding’



Resin and fiber not united properly (fiber does not support matrix)

4. Conclusion

Composite material based on polymer has been successfully obtained from 50% resin + 1% catalyst + 19% calcium carbonate + 25% fine fiber + 5% roving fiber but joining/connecting with this method in this research has not produced optimum results, because between matrix and reinforcement it is not connected properly.

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