Study On Mechanical Properties of Composite Geomaterial Powder Waste Tiles and Glass Fiber

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Abstract. The roof tile bags of dust consequent from the waste of roof tile manufacturing have not been utilized in the technical field. The Kendal roof tile bags of dust are prospective as geomaterial composite material for they have a high strength, high hardness, and a high-temperature resistance. To create strong and fire-resistance composites, polyester resin, and glass fiber are required. The Kendal root oven at the temperature of 100 °C for an hour, and molded with hand lay-up the technique with the matrix of polyester resin + glass fibers. The variations employed were fiber orientation differences of 0/90° and 45/45° with the variables of volume fraction (Kendal roof tile bags of dust + glass fibers = 40%) and with the fixed polyester resin volume fraction (60%). The result of the research shows that the fiber orientation composition of 0/90° and a variation of 1% clay 39% fiber gelass variation has the tensile stress of 225.21 MPa and the elasticity modulus of 3.56 GPa. The geopolymer composites are very useful to be used as industrial components particularly for the automotive industry as they have an excellent tensile strength.

1. Introduction

The development of composites technology very rapidly with increasing industry needs to material with characteristics commensurate with metal. The advantages of using composites that are corrosion and resistant, the ratio between the forces and its density are high enough (light), cheap and easy manufacturing process. Composites have been widely applied in various fields of industry, automotive, and military (defense and armaments). Composite robust and its density little of which is a composite fiberglass-UPRS BQTN. Fiberglass is one of many composite materials used in the application of composite technology. Glass fibers have mechanical properties well, its small density gives gains on the application. Conducted research on geopolymer glass fiber reinforced matrix composite to than short type (crude fiber geopolymer composites) with different volume fraction, the microstructure of the composite studies and correlated with the fiber content [5] . The results showed that the short glass fiber great strengthening and toughening effect on the volume percentage Low fiber (3-5% by volume). Increasing the percentage of fiber that makes the effect strengthening and toughness of the composite, the better. This is due to the increase in shear stress occurs between fiber and matrix at high pressure. Improved properties are mainly based on short glass fiber network.
structure and the strengthening of the dominant and toughness mechanism produces a strong composite. Examined the effect of adding clay to the tensile strength, modulus of elasticity, impact force and fracture toughness of the composite unsaturated polyester and fiberglass [3]. The results show that the tensile strength and high modulus of elasticity of unsaturated polyester hybrid composite, 12.83% increase in tensile strength and modulus of elasticity of 11.15%. The addition of clay above 2% would result in exactly the opposite (downhill). Impact strength and fracture toughness maximum occur on the addition of clay by 4%. Impact strength will be increased by 26.19% and fracture toughness rose 14.43%, but the addition of clay above 4% will apply instead. Nanocomposites formed by polymers and inorganic particles generally exhibit individual particles that can be of unequal sizes (polydisperse) or agglomerated in clusters. Mechanical properties of materials are the relationship between the response or material deformation working load. Mechanical properties about strength, hardness, ductility, and stiffness. Materials can be loaded in three ways: with tensile testing, pressure testing, and shear testing [7]. The tensile test is one of the stress-strain mechanical tests that aims to identify the tensile strength of the material, where the test material will be pulled off. The tensile test is done to look for stress and strain (stress-strain test). From the tensile test can be known some mechanical properties of materials needed in engineering design. The result of this test is a graph load with extension/elongation [7].

2. Methodology/Experimental

Implementation of research conducted at the Laboratory of Material University Merdeka Madiun, while the application of composites in tensile testing Laboratory Sanata Dharma University in Yogyakarta and Training Center Surakarta.

2.1. Material

Hand Lay-Up process used in this process because the fabrication process is very easy and can be done on a small scale/simple. At first, clay was heated to 80 °C for 1 hour in the oven is done to reduce the water content in the clay.

The materials used in this study are: (a) Powder Clay from Kendal, Wonogiri sifted passes 200 mesh, (b) glass fiber diameter ± 12 m, (c) Polyester Resin BQTN, Promoter and catalyst Mako: methyl ethyl ketone peroxide compounds. In the first stage the material used is clay powder and polyester resin. Clay composition of a variation of 1%, 2%, 3%, 4% and 5%. Then from the stretcher captured the best for glass fibers coupled with the variation directions are 0-90 and 45-45.

2.2. Tool

Some of the equipment used in this study as follows: (a) Digital scales, the brand Vibra, a maximum range of 50 kg, the accuracy of 0.001 grams, (b) Oven temperature is low, the brand Modena, 0-250 °C, accuracy 1 °C, (c) Thermocouple, brand Fluke 51 II, the maximum temperature of 600 °C, an accuracy of 0.1 °C. (d) Measuring cups, Tristar brand maximal volume of 500 ml and 5 ml accuracy. (e) Stopwatch, brand QQ span of 60 minutes, 0.01 seconds accuracy. (f) Plastic glass container and stirrer (g) Universal testing machine (UTM), the brand Geotech GT 7010 A2, maximum load of 10.000 N with a precision of 1 Newton.
2.3. Moulds specimens.
Molds specimens made of glass as the base and forming formed cavity such that the specimen mold meets the standard ASTM D638 (test method for tensile properties of plastics).

2.4. Specimen Testing
Tensile test using ASTM standard D638 type 1 Universal Testing Machine in temperature room with a speed of 50 mm/min.

![Diagram of tensile test specimens](image)

**Figure 1.** The size of the tensile test specimens static composite rod polymer, according to the standard.

| Symbol | Description                  | Value |
|--------|------------------------------|-------|
| W      | Width Of Narrow section      | 13 mm |
| L      | Length Of Narrow section     | 57 mm |
| Wo     | Width overall                | 19 mm |
| Lo     | Length Overall               | 165 mm|
| G      | Distance between grips       | 115 mm|
| R      | Radius of fillet             | 76 mm |
| T      | Thickness                    | 3 mm  |

3. Results And Discussion
From the results of the test of showing the influence of clay content on the tensile strength of the hybrid composite polyester resin and clay. From Figure 3 it can be seen that the addition of clay to 4% by weight fraction, addition of 1% by weight fraction of clay on polyester matrix seen an increase in tensile strength, although only small, visible also for the addition of clay more than 1% by weight is precisely the opposite effect: lower tensile strength.
The percentage increase in tensile strength at the content of 0% to 1% by weight of clay is an increase in tensile strength of 50.86 MPa highest. On the content of 1% to 2% by weight fraction of clay, the strength decreases. At 0% strength 48.56 MPa, 49.65 MPa strength of 2%, 3% strength 47.98 MPa, and 4% strength 45.76 MPa.

After the first stage, which is to get the best results from a composite with the addition of 0-4% powder in the composition. The proficiency level of the results showed that the best results on the composition of 1% volume fraction of clay powder. Furthermore, for the second process is the variation homoeosis glass fibers and clay with a variation of 60% polyester and 40% powdered clay (the clay powder also of 0, 1, 2, 3, 4%) and glass fiber (variation 45/45, 0/90º). The results of this process can be seen in the table below. The modified clay showed a positive result, whereas its structure remained intact through the adsorption and reduction of silver ions. However, the Ag-MMT org. nanocomposite showed greater antimicrobial activity against E. coli than Ag.-MMT purif. because the material contained more silver nanoparticles in its structure. Our results demonstrated that the combination of Ag-MMT organo-clay nanocomposite with various types of material is relevant and advantageous for potential industrial applications by [8].

Table 1. Results of testing the tensile strength variation 0/90 and 45/45

| No | Variable remain Polyester | Comparison of Clay and Glass Fiber | Tensile Strength (Mpa) |
|----|--------------------------|-----------------------------------|------------------------|
|    |                          |                                   | 45.45º | 0.90º |
| 1  | 60%                      | 0% Clay : 40% Glass Fiber         | 97.88  | 225.21|
| 2  | 60%                      | 1% Clay : 39% Glass Fiber         | 93.56  | 220.67|
| 3  | 60%                      | 2% Clay : 38% Glass Fiber         | 81.71  | 189.54|
| 4  | 60%                      | 3% Clay : 37% Glass Fiber         | 76.47  | 148.64|
| 5  | 60%                      | 4% Clay : 36% Glass Fiber         | 72.87  | 142.76|
From these data, we can explain that the influence of clay seen in the variation of 0% to 1%, the graph shows that the effect of clay is good enough to increase the tensile strength. On the percentage of 0% to 1%, a decrease in tensile strength is not very significant when compared to the variation of 1% to 3%.

At 0-1% variation of its power down, this is due to the glass fiber content also dropped. Clay here has a pretty good role as a substitute for glass fiber though it can not equal it, most do not already have a good contribution as a factor of the amplifier. It has also been investigated on the influence of clay by [1] as a reinforcement for Composite clay.

The results of this study meerkat by [2] which says fracture surface of the fiber that has a surface flatter, pull out the shorter, the matrix can be attached to the fiber, and the shape of fracture surface of composite is also more even show the bond between matrix and reinforcement better.

Load received an overall composite will be retained by the amplifier / reinforcement (in this case the glass fiber), while the model serves as a binder or maintain a position amplifier to remain in place.

The cross-section glass fiber experiencing tensile loading is shown in figure 4.2. Tensile stress in the glass fiber with a 0-90° angular orientation of 1 = x applies unidirectional / horizontal to
the cross-section of the glass fiber. The tensile stress of $2 = x \cos 45^\circ = \frac{1}{2} x$ occur in the fiber with 45-45° angular orientation of the cross-section of the glass fiber [4]. Tensile testing results show that in addition to the glass fiber is still no binding resin that also acts an amplifier and withstands tensile force is received, so the magnitude of the composite tensile test results is greater.

The tensile strength of the composite geomaterial is also influenced by the number of percentage of reinforcing fibers and bonding between the matrix and the reinforcing [2]. The bond between the matrix and the amplifier can be proved whether there is a matrix that is still attached to the fiber after the pull-out, fiber pull-out experience shorter or longer and fracture surface shape more flat [10]. Composites with 45-45° fiber orientation at the time burdened tensile strength fiber position as pushed out/sideways damage the fibers with resin bonding. This resulted in the glass fiber and resin same can not withstand tensile force is received.

The test results are consistent with research [6] which examines the influence of fiber orientation that affects the mechanical properties of natural fiber reinforced composite (nfrc). The result is written that the tensile strength of the fiber hemp and bamboo fibers with an epoxy resin matrix with orientation variations 0-90° stronger than the orientation angle of 45-45°. Composites with 0-90° fiber orientation that is parallel to the direction the fiber direction so that the tensile force tensile strength largely retained by the glass fiber/amplifier, while the matrix serves to bind the fibers to remain in place and transfer the forces evenly to the other amplifier. It is believed to be dependent on the toughness of fiber during a pull-out.

The modulus of elasticity is defined as the ratio between the voltage with the strain in a particular material for a style that works do not exceed the limits of elasticity of the material. Figure 4 shows the magnitude of the modulus of elasticity of composite versus the amount of glass fiber laminate used. The test results from phenolic composites, fiber glass, and tile clay shows that the elastic modulus of the composite increased in proportion to the growing number of laminated glass fibers for fiber orientation 0-90°.

![Figure 5. The relationship between the percentage of clay, fiber glass and modulus of elasticity](image-url)
Examined the effect of fiber orientation on the power pliable composite glass fiber reinforced epoxy [9]. Specimen made with the method of hand lay-up techniques vacuum chamber. The test results stated that the glass fiber orientation plays an important role in determining the flexural strength and load bearing resistance. Laminate with fiber orientation 45-45° shows flexural strength greater than 0 - orientation 90° to the fiber and the amount of the same laminate. Composites with fiber orientation 0- 90° capable of holding more than 45-45° fiber orientation.

4. Conclusions
The conclusion from the analysis of tensile testing of composite powder clay, polyester and glass fiber: The content of clay (clay) on the composite proved capable of raising the value of tensile strength and can reduce the use of glass fibers as the main amplifier. Nevertheless, clay can not fully be used as the main amplifier, but it can improve the mechanical strength of the composite material. Judging from the results on the maximum percentage of clay content of 1%.

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