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Composite Materials Characteristic Analysis of Marble Waste and Resin with Bending Test

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ABSTRACT

Marble is a natural rock product that is widely used in daily life. There is a lot of marble powder as a by-product during the production process. This powder can be converted into valuable items. To transform this by-product to be economically valuable items, there is a way to propagate composite products from marble powder and resin. There are four composite mixing ratios carried out in this research, namely 50/50%, 40/60%, 30/70%, and 20/80%. The mixing composites test shows bending strength and elasticity of the composite material.

I. Introduction

A. Background

Aceh Province is one of the vast marble suppliers, especially in the South Aceh District (Tapaktuan). Marble, in this area, is generally utilized as the foundation stone, floor raw materials, and household products and so on. Besides, marble waste can be transformed into valuable items.

Marble waste can be used as aggregate and composite. The developed alternative materials from marble waste and silica powder for solid and perforated concrete bricks that meet the standards SNI 03-0349-1989 [1]. Marble waste can be used as filler in concrete, adding marble waste to concrete can increase compressive strength to 10-20%, porosity and density of concrete with marble waste experiencing a significant increase [2].

Marble waste that passes the standard 200 mesh Tyler sieve, then mixed with a composition of 55% marble powder, 45% silica, and 8% water can be utilized to produce exposed bricks based on the synthetic woolen body. These results can be developed for pedestrian or garden roads, brick walls or insulating bricks [3]. Marble waste is used as an alternative substitute for cement in normal concrete mixes. It partly alters cement but can increase the strength of concrete by using 5% marble waste from the weight of cement [4].

II. Literature Review

A. Basic Concept

Marble is the result of metamorphosis of rough crystal stones derived from limestone or dolomite. Changes in temperature and pressure produced by endogenous forces cause recrystallization of these rocks, forming various foliations or non-foliations. Generally white marble and composed of mineral calcite.

Marble stone is commonly utilized as flooring, home foundations and other household products. Besides the main products of marble, there are by-products such as small stone fragments (gravel) and marble powder. These by-products can be reused [5].

Marble stone waste is a by-product produced during the processing of marble stones. An effort is needed to use marble stone waste to become something more useful and economically

valuable. One example of the use of marble waste as the aggregate material in concrete mixtures to increase compressive strength [6].

Resins or matrices are generally materials that have the ability to withstand heat made from polymer or plastic. Resin functions to protect and bind fibers to work well in composite matrices.

The bending test is a simple stem test with two-point holders and loading in the middle of the test bar (Three-Point Bending). It can be mathematically written as follows:

$$\sigma_b = \frac{3PL}{2bd^2}$$

information:

σ_b= Bending Strength (MPa)
P = Load (N)
L = Span Length (mm)
b = Test Rod Width (mm)
d = Test Rod Thickness (mm).

III. Research Methods

A. Tools and Material

The tools and materials used are:

a) Stirring container
b) Measuring cup
c) Brush
d) Sandpaper
e) Storage container
f) Marble powder
g) Resin
h) Catalyst
i) Alcohol 96%.

The composite used consists of:

a) Polyester resin
b) Marble powder with sieves used is 100 mesh in size.

Both of these components were mixed according to the composition as shown in Table 1 below:

Table 1. Composite Percentage

No	Ratio		
	Marble Powder (%)	Resin (%)	Identification
1	50	50	50-50
2	40	60	60-40
3	30	70	70-30
4	20	80	80-20

Steps of the composite manufacturing process:

a) Put the seared marble powder into the container.
b) Pour resin into a container containing marble powder and stir it slowly until evenly mixed, the ratio of marble powder and resin according to the composition specified in table 1.
c) After the composite is evenly mixed, then the catalyst is poured into the mixture, stirred again until evenly distributed and poured into the specimen mold.
d) The composite mixture is then dried for 1-3 days at room temperature.
e) The dried composite is removed from the mold and sanded so that the surface of the specimen is flat according to the desired shape.

Composites with compositions in table 1 were tested. Each composite ratio will be tested 5 times.

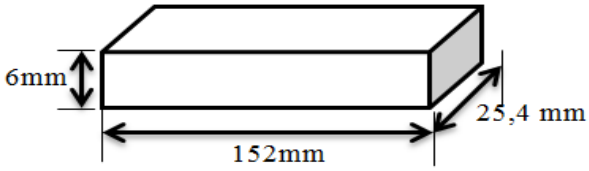

Figure 1. Bending-test Mold

IV. Results and Discussion

Each composite ratio is subjected to bending testing. The specimens used were 3 pieces each ratio. This bending test produces ultimate tensile strength and yield stress. Each composition has the maximum tensile stress and yield stress that can be seen in the figure 2 – 5.

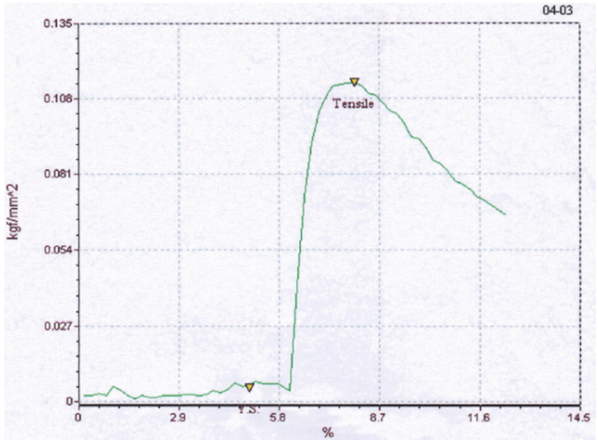

Figure 2. Bending-test Result on composite with 50 - 50 ratio

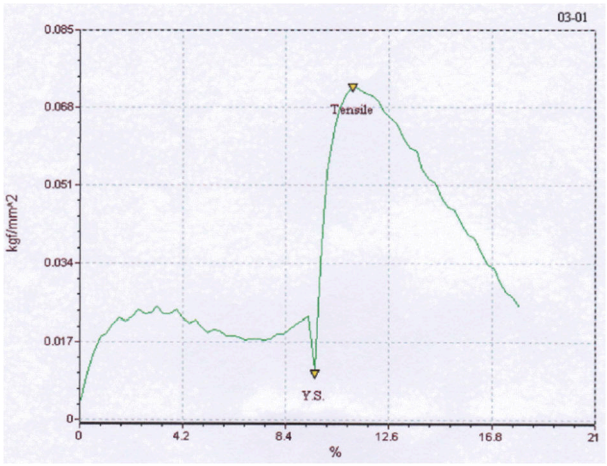

Figure 3. Bending-test Result on composite with 60 - 40 ratio

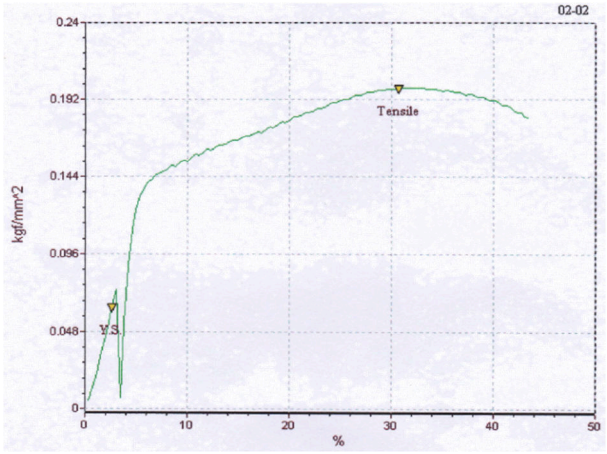

Figure 4. Bending-test Result on composite with 70 - 30 ratio

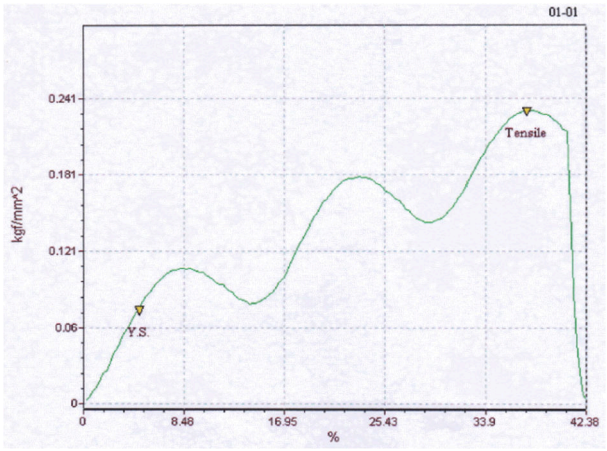

Figure 5. Bending-test Result on composite with 80 - 20 ratio

The tension that occurs in each composition, can be seen in table 2.

Table 2. The average stress/ tension of the bending test results for each Composite composition

No	Ratio	Yield Stress (kgf/mm2)	Maximum Tensile Stress (kgf/mm2)
1	50-50	0.03	0.09
2	60-40	0.05	0.09
3	70-30	0.08	0.16
4	80-20	0.07	0.17

V. Conclusion

The bending test results show that the composition of 80 - 20 has a maximum stress better than other compositions. This proves the lower the composition of the marble powder, the higher the yield strength and strength.

Ackonwledgement

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