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Research Paper

The Effect of Water Absorption on Environmentally Friendly Concrete made of Green Shell Skin Waste

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ABSTRACT: *Some construction technology research continues to be developed to produce appropriate construction technology. One of them is by utilizing shell waste produced by 89 green mussel processing units in Campurejo Village, Gresik. From 1 green mussel processing unit, it can harvest ± 100 kg per week. These activities can produce solid waste in the form of shells which is quite high. To reduce the environmental and health impacts caused by this waste, green mussel shells are used as a substitute for fine aggregate in concrete mixtures. The use of homogeneous shell powder will make the concrete mixture more reactive. Green scallop shell powder contains pozzolanic chemical compounds, which contain lime, alumina, and silica chemical compounds so that it has the potential to be used as an alternative concrete raw material.*

This research was conducted to determine the water absorption capacity of concrete in the use of waste from green mussel shells as a substitute for fine aggregate passing through sieves No. 8 and No. 16. Water absorption is one of the benchmarks that can be used as a guideline on whether the concrete will be reliable in terms of durability or not. With a large absorption capacity in concrete, the concrete tends to be less durable, compared to those with a small absorption capacity. According to SNI S-36-1990-03, the maximum absorption value in concrete is 2.5% oven-dry weight for 10 ± 5 minutes soaking, and 6.5% oven-dry weight for 24 hours soaking.

The number of test objects used in this study was 84 pieces with a size of 7.5x15 cm with each variation in the percentage of green mussel shell waste of 0%, 5%, 10%, 15%, 20%, 25%, and 30% of the weight. sand. This test was carried out when the concrete was 28 days old by immersing the container unit sample for 24 hours, then drying it with a dry cloth and drying it in an oven for 4 hours at a temperature of 100°C. The test object is weighed to determine the water absorption rate.

From the results of this study, it was found that green mussel shell waste could meet the requirements as a substitute for sand in a concrete mixture and be able to contribute as a partial substitute for aggregate in a concrete mixture.

KEYWORDS: *Concrete, Green shell waste, absorb water*

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I. INTRODUCTION

At present the development of technology in various fields has developed rapidly. Not only in the field of science and information, the construction sector has also developed rapidly. A number of construction technology research continues to be developed with the aim of producing appropriate construction technology. Research on alternative materials is something that is often used as an object of research, because by finding the right alternative materials, it will be able to have an effect on reducing the amount of raw materials we usually use.

Residents in Campurejo Village, Panceng District, Gresik Regency, mostly have a livelihood as fishermen and also as shellfish farmers. Although the main livelihood of the community is as a fisherman, but with the natural environment where many green mussels are found, the community also uses the green mussels as one of the livelihoods in order to increase their income. In Campurejo Village, there are 89 units of green mussel processing, from every 1 unit of green mussels they are able to harvest 100 kg per week (Badrus, 2015). We can see from the activities of the processing unit that it can produce high levels of solid waste in the form of shells. The waste generated from the shellfish processing unit becomes an environmental and health problem for the surrounding community. This condition motivates the community to manage waste so that it does not become polluted.

Based on this, to reduce the environmental and health impacts caused by shellfish waste, various studies have been carried out and continue to be developed. As has been done by Sahari and Mijan (2011), in their research using shells in the form of chips and powder which shows that the shell particles used in the concrete mixture have increased mechanical strength. The fine shell particles contribute more to the density, strength, mass and water absorption compared to the shells in the form of pieces and pieces.

According to Wen-Ten Kuo, et al (2013) in their research evaluating the practical application of waste oyster shells (Waste Oyster Shells / WOS) as Controlled Low- Strength Materials (CLSM), using a mixed variation of 5%, 10%, 15% , and 20% WOS as a substitute for fine aggregate. The experimental results show that there is no significant reduction in the compressive strength of up to 20% of the WOS sand substance as a substitute for fine aggregate. However, in its use, seashells as fine aggregate can fill the pores of the material which can reduce the absorption rate. Shellfish as a substitute for fine aggregate are suitable for the manufacture of building materials.

According to Arbi (2015), in his research he used shell waste as fine aggregate with various percentages to the weight of fine aggregate (sand) namely 0%, 5%, 10%, and 15%. From the test results, the increase in compressive strength occurred in a mixture of 5% and 10% of shell waste. From this it can be seen that using shells has a positive impact on the compressive strength of concrete.

According to Hidayat (2015) in this research, starting from planning a concrete mix with a quality of 22.5 MPa. Samples of shells mixed with various percentages of fine aggregate (sand) were made, namely 0%, 10%, 25%, 35%, and 50%. From the test results, the maximum increase in compressive strength occurs in a mixture of 35%. From this it can be seen that the ratio of the average compressive strength of mixed concrete at the age of 28 days increases from the average compressive strength of concrete without shells.

The results of several previous studies indicate that shells as a substitute for fine aggregate are able to produce density, compressive strength and absorption that exceed normal concrete. Seeing this, the right breakthrough steps were taken, in order to minimize the green shells waste that was dumped into the environment. One of these breakthrough steps is to utilize green mussel shell waste as a substitute for fine aggregate.

Green clam shells are the exoskeleton of clams. Green scallop shell is formed by shell cells (mantle epithelium) that secrete. The shells here are made into powder. Green conch shell powder is a powder produced from mashed shells. This powder can be used as a mixture or additive in the manufacture of concrete. Shellfish powder contains chemicals as will be presented in table 1 as follows:

Tabel 1. Green Shell Chemical Compound

Compound	Rate (%)
$CaCO_3$	77.5
SiO_2	0,60
Fe_2O_3	0.,14
MgO	0.56
Al_2O_3	0.71

Source : Surabaya Industrial Standardization and Research Institute

Green scallop shell powder contains pozzolanic chemical compounds, which contain lime, alumina and silica chemical compounds so that it has the potential to be used as an alternative concrete raw material which is expected to reduce negative impacts on human health and the environment and be able to contribute to the world of construction.

II. RESEARCH METHODS

The implementation of the research which includes inspection and testing of materials, manufacture of test objects, treatment and testing of concrete is carried out at the Concrete Technology Laboratory, Faculty of Engineering, Civil Engineering Department, University of Muhammadiyah Malang. Jln. Raya Tlogomas Malang.

Research design

This research was conducted in three stages. The first stage is the preparation stage, starting with the procurement of cement, sand, water and green shells waste. Then proceed with material inspection including cement, sand, gravel and green shells waste. Shell shell waste is used as fine aggregate, so for inspection of the material it is treated the same as inspection of fine aggregate material including: Examination of the gradation arrangement, examination of specific gravity and examination of absorption (absorption). The second stage is

the implementation stage of the research by compiling a mix design, casting and making concrete cylinder specimens. The number of test objects used in this study were 84 pieces with a size of 7.5x15 cm with each variation in the percentage of green mussel shell waste of 0%, 5%, 10%, 15%, 20%, 25% and 30% of the weight. the sand passed sieve no 8 and passed sieve no 16. This test was carried out when the concrete was 28 days old by soaking the sample unit container for 24 hours then drying with a dry cloth and drying in an oven for 4 hours at 100°C. The test object is weighed to determine the water absorption rate.

The properties of the test object are listed in the table. 2 and the mixed design are listed in table 3 as follows:

Table 2. Test Object Design

Percentage of Green Shells Waste	Test Object	Number of Test Items	
		compressive strength	Absorption
0%	Cilinder 7,5 x 15 cm	3	3
5%		3	3
10%		3	3
15%		3	3
20%		3	3
25%		3	3
30%		3	3
Number of Test Items		21	21
Total		42	

Table 3. Mixed Design

Substitute Variation	Mixed Composition				
	Cement (kg)	Sand (kg)	Green Sea shell Waste (kg)	Broken Stone (kg)	Water (l)
0%	1,72	3.92	0	4,25	1,03
5%	1,72	3.724	0.196	4,25	1,03
10%	1,72	3.528	0.392	4,25	1,03
15%	1,72	3.332	0.588	4,25	1,03
20%	1,72	3.136	0.784	4,25	1,03
25%	1,72	2.94	0.98	4,25	1,03
30%	1,72	2.744	1.176	4,25	1,03

Source: Calculation Results

Research Flowchart

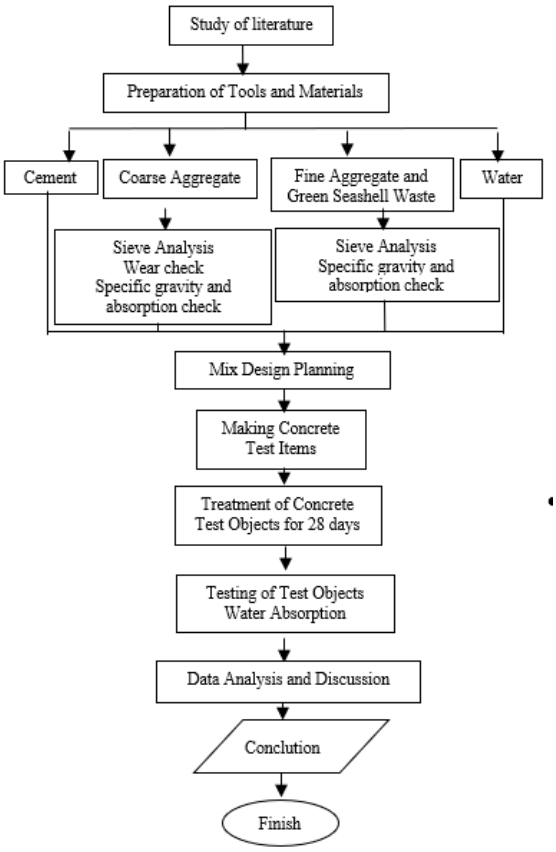


Diagram 1. Research Flowchart

III. RESULTS AND DISCUSSION

Analysis of Concrete Composing Materials

- **Portland Cement**
  In the test of cement carried out in the study only specific gravity. The cement used in this concrete mixture is type 1 cement which has a specific gravity of 3.17 gr/cm3. The specific gravity of portland cement according to the required ASTM C-188-144 is around 3.15 – 3.17, so this cement meets the requirements for use in concrete-making mixtures.
- **Fine Aggregate**
  The results of the examination of fine aggregate in the form of sand and green mussel shell waste can be seen in table 4 as follows:

Table 4. Fine Aggregate Inspection Results

Checking type	Standard	Specification	Test result
Sand Filter Analysis	ASTM C-136-46	Fm = 2 -3.5	Fm = 3.1
Seashell Waste Sieve Analysis			Fm = 2.8
Density of sand	ASTM C-128-68	2.5 – 2.7 gr/cm^3	2.7 gr/cm^3
Density of shell waste			2.51 gr/cm^3
Sand absorption	ASTM C-128-68	< 3%	1.42%
Absorption of shell waste			1.83%

Source: Calculation Results

- **Coarse Aggregate**
  The results of the examination of coarse aggregate can be seen in table 5 as follows:

Table 5. Coarse Aggregate Inspection Results

Checking type	Standard	Specification	Test result
Filter analysis	ASTM C-136-46	5-7	Max granule size 20 mm, FM= 5.04
Density	ASTM C-128-68	2.5 – 2.7 gr/cm^3	2.64 gr/cm^3
Absorbtion	ASTM C-128-68	<3%	1.46%
Wear	ASTM C-131	< 40%	13,72%

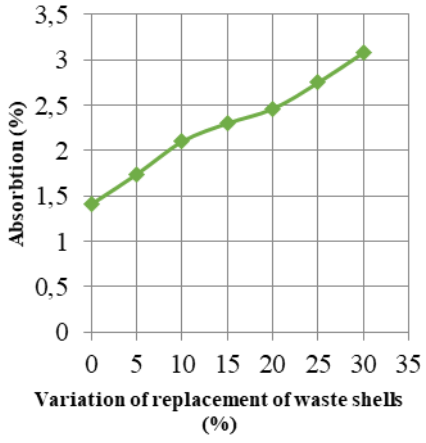
Source: Calculation Results

Test Results Test Items
Water Absorption
The results of testing the water absorption capacity of concrete can be seen in table 8 below:

Table 8. Concrete Absorption Value

No	Mixed Variations	Absorption Value
1	0%	1.41
2	5%	1.74
3	10%	2.1
4	15%	2.3
5	20%	2.46
6	25%	2.75
7	30%	3.08

Source: Calculation Results



From the results of the absorption of concrete made from green shells that has been carried out, it can fulfill the requirements as a substitute for sand in the concrete mixture and be able to contribute as a partial substitute for aggregate in the concrete mixture. the more the mixture of green mussel shell waste is added, the more the absorption value increases. Normal concrete or with 0% replacement of green mussel shell waste has the smallest absorption value, namely: 1.41% for the variation size that passes the No. sieve. 8 and 1.80% for variations that pass the No.16 sieve. However, with the addition of the variance presentation, there is an

optimum achievement of water content absorption at a percentage of 25% for sieves that pass No.08 and 20% for sieves that pass No.16 which have water absorption values of 2.76% and 2.84%, respectively. However, at the percentage of mixed variation of 28.5%, the water absorption value for both has the same value, which is 2.7%. This condition is caused by a poor binding process so that air cavities are formed which are easily penetrated by water. In addition, the absorption that occurs in the replacement of green mussel shell waste as fine aggregate is quite large. However, based on SNI S-36-1990-03 the maximum absorption value in concrete is 2.5% oven dry weight for 10 ± 5 minutes soaking, and 6.5% oven dry weight for 24 hours soaking. Based on the limitations mentioned above, the replacement of green mussel shell waste as fine aggregate by 5% to 30% in this study is still classified as water-resistant concrete.

IV. CONCLUSIONS AND SUGGESTIONS

Conclution

Based on the results of research and testing of water absorption in concrete carried out on green mussel shell waste as a substitute for fine aggregate and normal concrete, the following conclusions jcan be drawn:

• The use of green mussel shells as a partial substitute for fine aggregate in concrete has an optimum absorption capacity on a sieve that passes No.08 of 2.76% at a percentage of 25% mixture variation and on a sieve that passes No.16 of 2.84% at a percentage of 20% mixture variation.

• There is a similarity in the value of water absorption in concrete using aggregates that pass No. 08 and No. 16 sieves at a percentage variation of 28.5% which has a water absorption value of 2.7%.

Suggestions

Some suggestions that can be proposed in this research include:

• It is necessary to treat/improve chemical green shells waste material first. Thus, the compounds contained in the waste are not dominated by CaCO3 (lime) compounds.

• It is necessary to do grinding (griding) on green mussel shell waste so that its role as fine aggregate is more optimal.

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