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The Effect Of Bagasse Ash Addition In The Eco-Cement Of Egg Shell And Simping Shell To Mechanical Properties

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Abstract:*Construction of concrete has increased every year causing cement demand to increase. Based on data from the Ministry of Industry of the Republic of Indonesia in 2017 predicted that domestic cement demand will increase to 102 million tons. To meet the needs of the cement, Indonesian people use portlandcement. But the basic ingredients in the manufacture of portland cement is limestone, are non-renewable natural resources and diminishing supply. So another innovation is needed to make cement based on environmentally friendly and renewable natural resources. One of them is by utilizing the bagasse ash which is generated from the production of sugar factories, eggshells are usually discarded by the people of Indonesia after eating eggs and simping shells disposable after eating clam meat. Though simping shell and egg shell contains a lot of CaO compounds which are the basic ingredients in the manufacture of cement and ash of bagasse that contains a lot of* SiO_2 *compounds that can be used as a glue in the manufacture of cement. So this research is done by making the samples of shell-based eco-cementsimping shells, egg shells and bagasse ash using clay. From the test of compressive strength, it was found that the optimum value at the addition of 0.75 bagasse ash of 4.08 kgf / cm*^{2} *with density of 949.6 kg/ m*^{3} *and LOI of 20.8%. But this composite strength is still low compared to portland cement due to the low content of* Fe_2O_3 *and* Al_2O_3 *in the raw materials used. The superiority of the resulting eco-cement has the potential to be made as a lightweight brick because of the low density produced and without the combustion process (calcination) of raw materials. So further research is needed on the use of raw materials containing many of these compounds to strengthen the compressive strength.*

Keyword:*Bagasse Ash, Eco-cement, Egg Shells, Simping Shells*

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I. Introduction

Increasing the construction of concrete causes the need for cement also to increase. Based on data from the Ministry of Industry of the Republic of Indonesia in 2017 estimates the total national cement capacity will reach 102 million tons from the total requirement of 70 million tons per year. In addition to the ever increasing development, the industry has also increased. Example is sugar mills in Indonesia, based on data from Indonesian Sugar Plantation Research Center (P3GI) in 2008 that produced 32% of sugar cane waste from milled sugar cane and bagasse ash which is approximately 30% from bagasse weight. Bagasse ash containing SiO_2 of 55% which serves to bind the material[4]. In the coastal areas of Gresik City found many simping of shells, but the utilization of only the meat and shell parts are usually discarded or used as decoration. Though the shellfish contains CaO calcium compounds of 66.7%[6]. In addition, the amount of household waste such as eggshells. According to data Pinsar Petelur Nasional in 2016, the value of egg production amounted to 3,556,560 tons per year. Indonesian people generally only consume eggs and remove the eggshell. Though eggshell contains compound $CaCO_3$ equal to 94%. Eco-cement research previously conducted by Ariesta in 2013 eco-cement based organic waste and shells with a compressive strength produced of 7.2 kgf/cm^2[1]. So in this study used egg shells and simping shells that often contain a lot of compound $CaCO_3$ as a substitute for limestone and using ash residue of burning waste in Pabrik Gula Kremboong which contains lots of SiO_2 compounds in addition to adhesive eco-cement.

II. Theory

2.1. Eco-cement

Eco-cement is an environmentally friendly cement made of organic material (renewable natural resources) or in other words can replace or reduce the use of limestone. Eco-cement is formed from two words "ecology" and "cement" so it is concluded that Eco-cement is a type of cement developed to balance the existing ecology. Research on eco-cement began in 1992 where several Japanese scientists conducted research funded by the Japanese government and assisted by three private cement companies[3]. Research on the majority of eco-cement still use limestone as the basic material (reduce the use of limestone).

2.2 **Bagasse Ash**

Bagasse ash from the combustion of bagasse which has a very high silica (SiO_2) content to bind the material. Bagasse ash are the result of chemical changes of combustion of bagasse, comprising inorganic salts. At the time the bagasse is burned in the boiler, the change becomes charcoal (clinker) with the color change into a bright purplish color[2].

III. Methods

3.1. Raw Material for Making Eco-cement

The material used in this research is the bagasse ash from Kremboong Sugar Factory, Sidoarjo, Indonesia, the egg shellsand simping shells. All ingredients are cleaned and grinding using a blender. Then performed sieving using a mesh with mesh size of 150 microns.

3.2. X-Ray Fluorosence (XRF)

XRF testing to determine the composition (element content and compounds) contained in each ingredients that will be used as eco-cement of egg shells, simping shells, bagasse ash, clay, and sand. The XRF test was conducted at the LPPM Energy Laboratory of ITS.

3.2. X-Ray Diffraction Test (XRD)

XRD testing is used for material characterization process, compound in material and phase composition (crystalline or amorphous phase). This test was conducted at the Material Characterization Laboratory of the Department of Materials Engineering and Metallurgy FTI ITS.

3.3. Process of Making Eco-cement Samples

The eco-cement sample is made by mixing ingredients such as bagasse ash, simping shells and egg shells with clay and sand. The sample of the cube-shaped eco-cement is 5x5x5 cm in size. The sample was then dried for 7 days.

3.4. Eco-cement Testing

1. Compressive Strength Test

Compressive strength test is performed to determine the physical characteristics and the properties of eco-cement. In this research, the compressive strength test is done by following SNI 15-2049-2004 standard for portlandcement[5].

2. Density and LOI (Loss in Ignition) Test

This test aims to determine the density contained in the eco-cement that has been made. The density and LOI testing conducted is guided by SNI 15-2049-2004 standard for portlandcement[5]. The sample density test is done by calculating sample mass and sample volume. This is done to determine whether sample density is in accordance with existing cement standards.

IV. Discussion

4.1. Making of Raw Materials Powder

(a) (b) (c)

Figure 4.1 (a) Bagasse Ash Powder (b) Egg Shells Powder (c) SimpingShellsPowder

Raw materials such as egg shells, simping shells, ash bagasse are smoothed using a blender and sieved using a mesh sieve of 150 microns. The result of raw material refinement process can be seen Figure 4.1.

4.2. XRD Analysis of Bagasse Ash, Egg of Shell and Simping of Shell

At this stage XRD analysis of bagasse ash, egg shells and simpingshells have been made. Obtained XRD graphic results as shown.

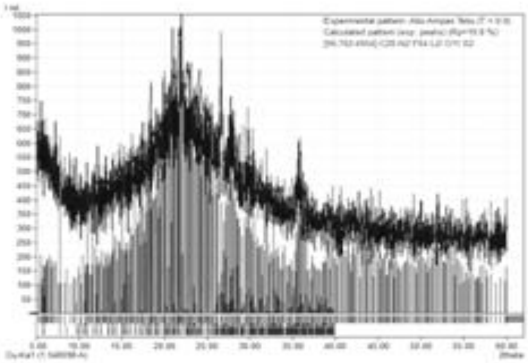

Figure 4.2. Bagasse Ash Ash XRD Graphic

From the XRD graph of the bagasse ash it can be seen that the main composition SiO_2(silica) with peak angle 19,8^{o}.Other compounds contained in bagasse ash are shown in Table 4.1.

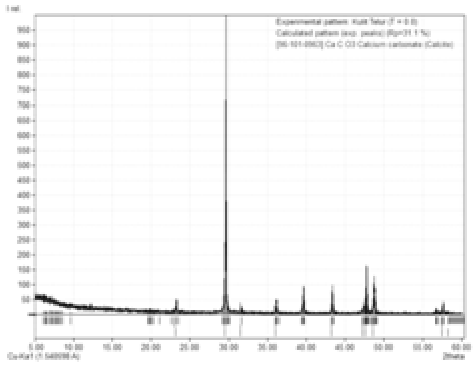

Figure 4. 3. Egg ofShell Ash XRD Graphic

From the XRD graph of the egg shells it can be seen that the main composition CaO with peak angle 31,1^{o}. Other compounds contained in egg shells are shown in Table 4.2.

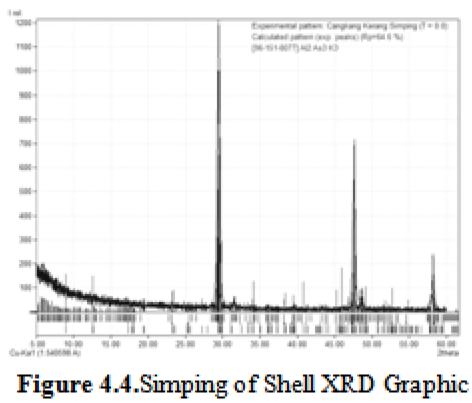

Figure 4.4. Simping of Shell XRD Graphic

From the XRD graph of the simping shells it can be seen that the main composition CaOwith peak angle 64,6^{o}. Other compounds contained in simping shells are shown in Table 4.3.

Table 4.1. Bagasse Ash Composition

Compound	SiO_2	CaO	MgO	Fe_2O_3
Composition	70,6%	6%	0,1%	8,9%

Table 4.2. Eggshell Composition

Compound	CaO	Fe_2O_3
Composition	94,4%	0,12%

Table 4.3 Simping of Shell Composition

Compound	CaO	Fe_2O_3
Composition	93,88%	0,16%

4.3. The Results of Compressive Strength Test

At this stage, concrete compressive strength test is done with the composition of the eco-cement. The results obtained from the compressive strength test can be seen in Table 4.4.

Table 4.4. The Results of Compressive Strength, Density, and LOI of Eco-Cement

	Compressive Strength (kg/cm^2)	Density (kg/m^3)	LOI (%)
Bagasse Ash 0,25	3,06	986,6	17,8%
Bagasse Ash 0,5	3,63	982,4	18,1%
Bagasse Ash 0,75	4,08	949,6	20,8%

The composition of bagasse ash 0,75 shows the best compressive strength. The density of the eco-cement decreases with the increase in the composition of bagasse ash, the weight loss (LOI) increases with the increase in bagasse ash composition

V. Conclusion

Addition of bagasse ash in the eggshells and the simping shells causes increased compressive strength. The optimum compressive strength produced is 4.03 kgf/cm^2 with addition of 0.75 bagasse ash. But it decreases the density value and increases the LOI value. But the compressive strength of the resulting eco-cement is lower than eco-cement from the shelland waste organic.

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