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The Effect of Gondorukem Addition to Increase Mechanical Properties of Eco-Cement Made From Shell and Organic Waste

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Abstract: *One of the raw materials for making cement is limestone which is a non-renewable natural resource. If limestone is taken continuously then its availability will decrease significantly. Sea shells are one of the marine products in Surabaya. The utilization of sea shells is generally limited to be consumed, while the shell tends to be seldom exploited. The Shells are usually only used as a result of crafts even though shells itself contain compound CaO about 66.7%. This compound is one of the raw materials of cement manufacture which is generally obtained from limestone. In addition to $CaCo_3$ compounds, the basic ingredients of cement manufacture are SiO_2. This compound is also present in organic waste by 46% So far, organic waste processing in Indonesia is only limited to use as compose or just burnt. Research on Eco-cement has been done by Ariesta et al using the ashes of waste and shells. The best composition was 49,1% of garbage and 49,1% shell with compressive strength 3 days (7,2 kg / cm2). Eco-cement's adhesiveness in the research that has been done is still lacking resulting in a lack of compressive strength value from the Eco-cement. Eco-cement's adhesiveness in the research that has been done is still poor, resulting in a lack of compressive strength value from the Eco-cement. The lack of Eco-cement's adhesive power in previous research is the background of this research.In this study we use adhesive substances derived from pine resin residue or gondorukem. It is known that gondorukem also functions as an adhesive and increases stiffness. Gondorukem for adhesive substance of eco-cement result in better compressive strength than using clay as adhesive substance. Compressive strength for this eco-cement can reach 21.8 kgf/cm^2 while eco-cement with clay 7.2 kgf/cm^2. The density of the ecosement decreases with the increase in the composition of gondorukem, the weight loss (LOI) increases with the increase in gondorukem composition. Thus, better compressive strength can be obtained with the increase in the composition of gondorukem but LOI will increase.*

Keywords: *Eco-cement, compressive strength, shel, waste.*

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I. Introduction

The rapid development in Indonesia resulted in increasing cement consumption. Asosiasi Semen Indonesia (ASI) recorded from the needs of about 60 million tons of cement by 2016, the fulfillment of local production reached 58 million tons. Imports about two million tons or 3% equivalent of the need. The Ministry of Industry of the Republic of Indonesia also predicts that domestic cement demand will increase to 85 million tons. The increasing demand for cement has resulted in the continuous collection of raw materials. One of the raw materials for making cement is limestone which is a non-renewable natural resource. If limestone is taken continuously then its availability will decrease significantly. Sea shells are one of the marine products in Surabaya. The utilization of sea shells is generally limited to be consumed, while the shell tends to be seldom exploited. The Shells are usually only used as a result of crafts eventhough shells itself contain compound CaO about 66.7% [1]. This compound is one of the raw materials of cement manufacture which is generally obtained from limestone [2]. In addition to $CaCo_3$ compounds, the basic ingredients of cement manufacture are SiO_2. This compound is also present in organic waste by 46% So far, organic waste processing in Indonesia is only limited to use as compose or just burnt [3]. Research on Eco-cement has been done by Syafpoetri et al. In this research, limestone and shell used as raw material [4]. Research without using limestone as raw material has been done by Ariesta et al using the ashes of waste and shells [5]. The best composition was 49,1% of garbage and 49,1% shell with compressive strength 3 days (7,2 kg / cm2). Eco-cement's adhesiveness in the research that has been done is still lacking resulting in a lack of compressive strength value from the Eco-cement. Eco-cement's adhesiveness in the research that has been done is still poor, resulting in a lack of compressive strength value from the Eco-cement. The lack of Eco-cement's adhesive power in previous research is the background of this research.In this study we use adhesive substances derived from pine resin residue or gondorukem. It is

known that gondorukem also functions as an adhesive and increases stiffness [6]. This research is expected to obtain Eco-cement with the composition and characteristics in accordance with the cement in general. By using Eco-cement it can reduce the use of non-renewable natural resources such as limestone and can also reduce waste sea shells. This supports one of the Millennium Development Goals (MDGS) global policy 7 points on environmental sustainability.

II. Theory

2.1. Eco-cement

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. According to T. Shimoda [7], there are two types of Eco-cement that can be made i.e. portland cement type and quick hardening type. Portland cement type has a chemical content similar to that of conventional Portland cement. However, there is a difference in the content of C3A compounds where the Eco-cement content is higher than that of ordinary Portland cement. This is because the content of Al2O3 on ash waste is quite high ie 10% -20%. Quick hardening type eco-cement is made by using Cl elements are mostly contained in waste ash. CaCl2 compounds will be formed to make this Eco-cement has fast hardening

III. Method

3. 1. Addition of Alarm and Trip Signal to HMI ALSPA

Materials used include waste ash, sea shells ash, gondorukem and a little iron sand mixture. The waste ash is obtained from organic waste in the form of leaves, twigs, and stems burned in the furnace The seashells ash derived from sea shells that have been mashed and heated in a furnace at a temperature of 700^0C. This shell is then mashed with mortar and sieving process. Gondorukem in the form of chunks are dried and then crushed using alu iron and then destroyed with a dry mill blender with medium speed. The Gondorukem serves as an adhesive agent in eco-cement

3.2. X-Ray Diffraction Test (XRD)

Preliminary tests were performed using XRD on garbage dust and shell dust to know their chemical composition before entering the mixing phase. They are the main materials in the eco-cement production

3.3. Mixing Material

The aim of mixing all of the raw materials for making the eco-cement is to make the material mixed evenly. Variations of ingredients of eco-cement raw materials are composed to determine the effect of these raw materials on the nature and characteristics of eco-cement. Mixing was done using medium speed dry ball mill (56 rpm) for 4 hours.

3.4. Eco-cement Testing

1. Compressive Strength Test

A 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 Portland cement.

2. Density and LOI 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 Portland cement

IV. Discussion

4.1. Making of Garbage and Shell Dust

The preparation of garbage dust in this research was done using furnace at 700^0C with 3 hours time. In this process we get gray garbage dust. The garbage dust in this study are used as a provider of CaO as the main ingredient in the manufacture of cement and other additives such as SiO2.

a b

Figure 4. 1. Organic Waste Ash (a) and Shell Ash (b)

In the process of making the shells dust , we use furnace with temperatures of 900^0C with a time of 6 hours. This heating aims to change the compound CaCO3 in the shells into CaO compounds. The results obtained white ash shells. The shell ash is used as a base material in the manufacture of cement because there are many CaO compounds.

4.2. XRD Analysis of Waste Ash and Shell Ash

At this stage XRD analysis of ash waste and shell ash shells have been made. Obtained XRD graphic results as shown.

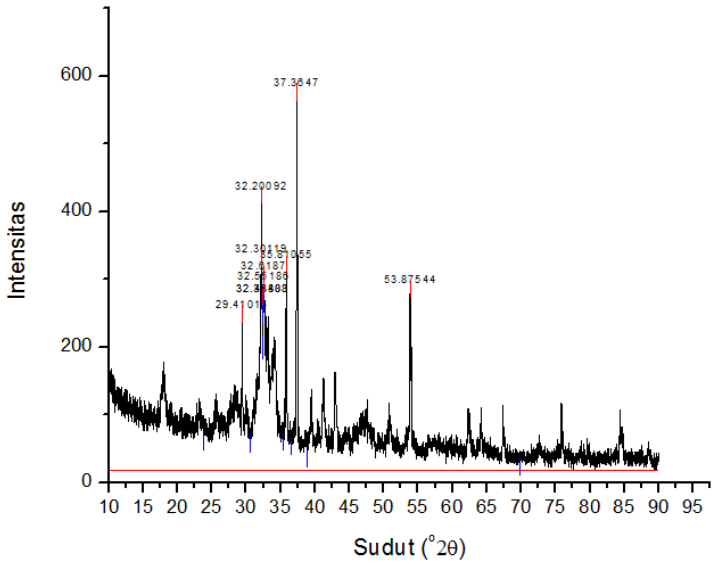

Figure 4. 2. Organic Waste Ash XRD Graphic

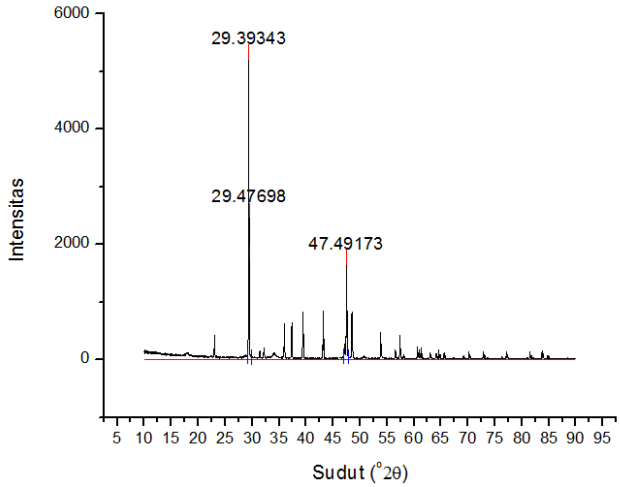

Figure 4. 3. Shell Ash XRD Graphic

From the XRD graph of the waste ash it can be seen that the main composition of the ash of waste ash is CaO with peak angle 32.2^o, 37.4^o, and 53.9^o While from the XRD of shell ash it can be found that the main composition of the constituent shell ash is $CaCO_3$ which is marked by the peak at 29.4^o, and 47.5^o. Other compounds contained in waste ash and in shell ash are shown in Table 4.1 and 4.2.

Table 4.1. Waste Ash Composition

	SiO_2	CaO	Al_2O_3	Fe_3O_4	Cl
Composition	46.6%	27.6%	12.2%	8.2%	5.5%

Table 4. 2. Compositon of Shell Ash with heating temperature of 800^oC

	$CaCO_3$	CaO
Composition	89.8%	10.2%

4.3. The Making of Cement Concrete for Strength Test

At this stage a compressive strength test sample of cement and quartz sand is to be used as a comparator in an eco-cement compressive strength test. Comparison of composite material composition of concrete in accordance with standard test of portland cement strength. Comparison of these materials include 500 gran cements, 1350 grams of quartz sand, and 242 ml of distilled water.

4.4. The Results of Compressive Strength Test

At this stage, concrete compressive strength test is done with the composition of the eco-cement according to table 3.1. The results obtained from the compressive strength test can be seen in Table 4.3.

Table 4. 3. The Results of Compressive Strength, Density, and LOI of Eco-Cement

	Compressive Strength (kg/cm^2)	Density (kg/m^3)	LOI
Gondorukem 0.75	3.05	2080	5.6%
Gondorukem 1	12.02	2018	11.2%
Gondorukem 1.25	21.8	1970	13.47%

From the table 3.1. The composition of gondorukem 0.2 shows the best compressive strength. The density of the ecosement decreases with the increase in the composition of gondorukem, the weight loss (LOI) increases with the increase in gondorukem composition

V. Conclusion

Gondorukem for adhesive substance of eco-cement result in better compressive strength than using clay as adhesive substance. Compressive strength for this eco-cement can reach 21.8 kgf/cm^2 while eco-cement with clay 7.2 kgf/cm^2. The density of the ecosement decreases with the increase in the composition of gondorukem, the weight loss (LOI) increases with the increase in gondorukem composition. Thus, better compressive strength can be obtained with the increase in the composition of gondorukem but LOI will increase.

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