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# THE EFFECT OF ADDITIVE WITH FOAM AGENT AND COCONUT SHELL ON LIGHTWEIGHT CONCRETE

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## ABSTRACT

Concrete houses have a higher social and economic status. This study provides another consideration for the selection of building materials (Wonorahardjo, 2008). There are several ways that can be used to make concrete lighter, including using lightweight aggregates, substituting coarse aggregates with foam agents, adding coconut shells and additives where coconut shell waste has not been used optimally. In this research, a lightweight concrete mixture made from additives 5M additive, foam agent and coconut shell using 3 kg cement composition. While the 5M additives variation of 3%, 5%, 10%, 15% of cement, 15 milliliters of foam agent and coconut shell of 1%, with consideration of the specimens for 28 days not soaked non-curing. The test specimen is made with a size of 15x30 cm. This study is to determine the weight, compressive strength of the lightweight concrete produced. The results of research on the use of additional 5M additives, foam agents and coconut shells cause concrete to be lighter and compressive strength decreases. The weight of light concrete at 28 days not soaked is 775 kg / cm3, while the quality of concrete is 22 kg / cm2.

**Keywords** Lightweight concrete*, mix design,* compressive strength*, additive, foam agent,* coconut shell

## INTRODUCTION

asically, concrete has a property of weak to tensile, strong to compressive and has a composition of cement, sand, aggregate, and water (Asroni, 2010). Indonesia is a country with 3,585,599 ha of coconut plantations in 2015 (2015) with a production value of 2,920,665 tons. In the industrial sector, coconuts are processed only in the coconut flesh and part of it is waste. One of the coconut wastes is coconut shell which has soft, light, absorbs water, wood texture, coconut shell has chemical components such as cellulose, lignin, pentosan, extractive solvent, uronic anhydrite, ash, nitrogen and water, then coconut shell has quality as an aggregate.

Lightweight concrete is a mixture of cement, water, aggregate with certain added ingredients (admixture), namely by making gas or air bubbles in a mortar that causes many air pores in the concrete (Husin and Setiaji, 2008). One additive chemical product for research using additive 5iton additive products produced by PT. Additon Karya Sembada.

**Raw material**

1. Cement

cement is an ingredient that acts as an aggregate binder, if mixed with portland cement it is made through several steps, so it is very smooth and has both adhesive and cohesive properties. Cement is obtained by burning carbonate or limestone and argillaceous (containing aluminia) with a certain ratio. The material is mixed and burned at a temperature of 1400º C-1500º C and becomes clinker. After that it is cooled and mashed until it is like powder. Then casts or calcium sulfate (CaSO4) are added approximately 2-4% percent as a binding time control material. Other added ingredients are sometimes also added to form special cement such as calcium chloride to make the cement harden quickly. Cement is usually packed in 40 kg / 50 kg bags (Sutikno, 2003: Menurut SII 0031-81 semen portland dibagi menjadi five types, as follows:

Type I: Cement for general use, does not require special requirements.
Type II: Cement for sulfate-resistant concrete and has a moderate hydration heat. Type III: Cement for concrete with high initial strength (fast hardening).
Type IV: Cement for concrete that requires low hydration heat.
Type V: Cement for concrete which is very resistant to sulfate.

2. Aggregate

Is a mineral grain that is the result of natural disintegration of rocks or also the result of a stone-breaking machine by breaking down natural stones. Aggregate is a filler in concrete, however the role of aggregate in concrete is very important. According to SK-SNI-T-15-1990-03 the roughness of sand is divided into four groups according to its gradation, namely fine sand, rather fine, somewhat coarse and coarse. Generally sand has fine modulus of grains between 1,5 to 3,8.

The sand used in the concrete mix must meet the following requirements:
Fine sand consists of sharp and hard grains. This is because with the sharp form of sand, the link between the aggregates will be better, while the hard nature to produce hard concrete as well.

1. The grains must be eternal. This eternal nature means that the sand is not easily destroyed by the influence of the weather, so the resulting concrete is also resistant to weather influences.
2. Sand should not contain mud more than 5% of its dry weight, because the existing mud will block the bond between the sand and cement paste, if the concentration of mud is high, the resulting concrete will be of low quality.
3. Sand must not contain too much organic matter.

**Table 1** Fine Aggregate Gradation

| Sieve Hole (mm) | Percentage of Granular Material The Sifters | | | |
|---|---|---|---|---|
| | Daerah I | Daerah II | Daerah III | Daerah IV |
| 10 | 100 | 100 | 100 | 100 |
| 4,8 | 90-100 | 90-100 | 90-100 | 95-100 |
| 2,4 | 60-95 | 75-100 | 85-100 | 95-100 |
| 1,2 | 30-70 | 55-90 | 75-100 | 90-100 |
| 0,6 | 15-34 | 35-59 | 60-79 | 80-100 |
| 0,3 | 5-20 | 8-30 | 12-40 | 15-50 |
| 0,15 | 0-10 | 0-10 | 0-10 | 0-15 |

*Source* : Tjokrodimuljo, (1996)

Information :

Area I: Coarse sand
Area II: Sand is rather rough
Area III: Sand is rather fine
Region IV: Fine Sand

The coarse aggregate that can be used must meet the requirements (Tjokrodimulyo with cement water into a paste. With the process of time and heat, the chemical reaction due to a mixture of water and cement produces the cement pavement properties. The discoverer of cement (Portland Cement) was Joseph Aspdin in 1824, a English masons, called Portland cement, because initially the cement produced had the same color as the natural clay on Portland Island

3. Additive Admixture

Admixture is an additional material for mixing concrete that is processed before or during the mixing process, the admixture function is to modify concrete characteristics with the aim of improving concrete workability, regulating cement water factor in fresh concrete, reducing the use of cement, preventing segregation and bleeding, regulating the binding time of stirring concrete, increase the strength of hard concrete, improve the waterproof properties of hard concrete and improve the durable properties of hard concrete including resistance to chemicals, resistance to friction and others.

4. Coconut Shell

Coconut shell; Coconut shell is waste (residual processing) from households or industries that use coconut as the main ingredient. Its presence is widely found around us, and its use is mostly limited to firewood. According to (Soroushian and Bayasi, 1987) and according to (Tjokrodimuljo, 1990).

5. Water for

making concrete must meet the minimum requirements as drinking water that is fresh, odorless, and does not contain ingredients that can damage concrete, such as oil, acids, alkali, salt or other organic materials which can damage concrete or reinforcement (SNI 03-2847-2002, Procedures for Calculating Concrete Structures for Buildings). In addition to the binding reaction, it can also be used for maintenance after the concrete has been poured. Curing water must have a higher requirement than water for making concrete. The acidity must not be pH> 6, nor should it contain too little lime. The use of water for concrete should meet the following water requirements, (Kardiyono Tjokrodimulyo, 1992): 1. Does not contain mud or other floating objects more than 2 gr / liter. 2. Does not contain salts which can damage concrete (acids, organic substances) more than 15 gr / liter. 3. Does not contain Chloride (Cl) more than 0.5 gr / liter. 4. Does not contain sulfate compounds more than 1 gram / liter.

## RESEARCH METHODOLOGY

Processing coconut shell as an aggregate, first cut coconut shell with size <10 cm. The materials used include, among others, coconut shells that have been processed, Foam Agent and Additive Additon 5M that is used is the "Additon" brand. Planning the proportion of concrete mix material using a mixture selection plan based on SNI 7656: 2012 with the results as a reference for normal concrete that is developed into innovation concrete

**Table 2** Test Object Formula

| Test Objects | Cement | Sand | Gravel | Additon 5M | Foam Agent | Coconut shell | w/c Ratio |
|---|---|---|---|---|---|---|---|
| | (kg) | (kg) | (kg) | (milliliter) | (*l*) | (kg) | (*l*) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Concrete K.300** | 4,13 kg | 6,81 kg | 10,21 kg | - | - | - | 0,52 |
| **ADBK 1** | 3 kg | 3,25 kg | 0% | 5% from cement | 15 mililiter | 1% from sand | 0,3 |
| **ADBK 2** | 3 kg | 3,25 kg | 0% | 10% from cement | 15 mililiter | 1% from sand | 0,3 |
| **ADBK 3** | 3 kg | 3,25 kg | 0% | 15% from cement | 15 mililiter | 1% from sand | 0,3 |
| **ADBK 4** | 3 kg | 3,25 kg | 0% | 3% from cement | 15 mililiter | 1% from sand | 0,3 |

***Source:*** Narotama University laboratory test results.

The making of test specimens is made of 30 pieces in cylindrical shape, each made with two variations of the test specimen. Test specimens in cylindrical shape which has a side of 15 x 30 cm. At the mixing stage, Motar mixed with 5M addition is stirred until it is homogeneous, then makes up the Foam Agent that has been mixed with water until it becomes foam, when making foam must be considered the level of viscosity of the foam, after the foam becomes the next step mixing the foam agent with the mohtar. finally with coconut shells and stirring until concrete is mixed. After fresh concrete reaches homogeneous. At the treatment stage the test specimens were carried out by the non-curing method. Compressive strength testing is performed on specimens aged 7, 14 and 28 days. Compressive strength testing is carried out at the Mechanical and Concrete Laboratory of Civil Engineering, Narotama University, Surabaya. The relationship between quality and weight is the equation of compressive strength (fc') divided by specific gravity (kg/cm$^3$).

## RESULTS AND DISCUSSION

In compressive strength testing, the compressive strength results are obtained as follows;

**Table 3**. Results of Compressive Strength and Specific Gravity Tests

| No. | Concrete type | | Weight Average | | | Compressive Strength Average (kg/cm2) | | | Ratio Fc'/Weight 28 Days |
|---|---|---|---|---|---|---|---|---|---|
| | | | 7 Hari | 14 Hari | 28 Hari | 7 Hari | 14 Hari | 28 Hari | |
| 1. | CONCRETE NORMAL | CR | 12.311 | 12.111 | 12.021 | 203 | 275 | 313 | 7,2 |
| | | CR | 12.421 | 12.127 | 12.053 | 205 | 278 | 316 | 7,1 |
| 2. | ADBK 1 | NC | 4.287 | 4.141 | 4.112 | 7 | 10 | 11 | 70,54 |
| | | NC | 4.377 | 4.156 | 4.119 | 8 | 11 | 12 | 64,75 |
| 3. | ADBK 2 | NC | 4.182 | 4.102 | 4.041 | 11 | 15 | 16 | 47,62 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | NC | 3.992 | 3.891 | .3.819 | 11 | 15 | 16 | 45,06 |
| **4.** | **ADBK 3** | NC | 4.331 | 4.143 | 4.103 | 11 | 15 | 16 | 48,37 |
| | | NC | 4.426 | 4.215 | 4.101 | 11 | 15 | 16 | 48,37 |
| **5.** | **ADBK 4** | NC | 4.394 | 4.161 | 4.105 | 14 | 20 | 22 | 35,22 |
| | | NC | 4.419 | 4.221 | 4.098 | 14 | 20 | 22 | 35,13 |

*Source:* Narotama University laboratory test results.

Seen from the summary table of the results of the density of normal concrete and lightweight concrete with cylindrical test specimens at the age of 28 days, and the results of compressive strength of norm concrete and lightweight concrete with mix design using cement, sand, 5M addition , foam agent, coconut shell with lightweight concrete not soaked (non-curing) maintenance. In normal concrete at 28 days the average density is 2274 kg/cm$^3$, and the normal concrete compressive strength at 28 days is 316 kg/cm$^2$, for the ratio fc '/ weight at 28 days at 7.2.

In lightweight concrete (ADBK 1), the treatment is not soaked (non-curing) specific gravity of 777 kg/cm$^3$, has a 65.88% decrease compared to normal concrete and with a compressive strength of 12 kg/cm$^2$, has decreased 89.79% of the compressive strength of concrete normal, whereas the ratio fc'/weight is lightweight concrete (ADBK 2) not soaked (non-curing) 70.54.

In lightweight concrete (ADBK 2) the treatment is not soaked (non-curing) concrete density 762 kg/cm$^3$, decreased 68.31% from normal concrete and with a compressive strength of 16 kg/cm$^2$, decreased 94.94% of the compressive strength of concrete normal, whereas the ratio fc'/weight is lightweight concrete (ADBK 2) not soaked (non-curing) 47.62.

In lightweight concrete (ADBK 3) the treatment is not soaked (non-curing) concrete density of 774 kg/cm3, decreased 65.95% of normal concrete and with compressive strength 16 kg/cm$^2$, decreased 94.94% of concrete compressive strength normal, whereas the ratio fc'/weight is lightweight concrete (ADBK 3) not soaked (non-curing) 48.37.

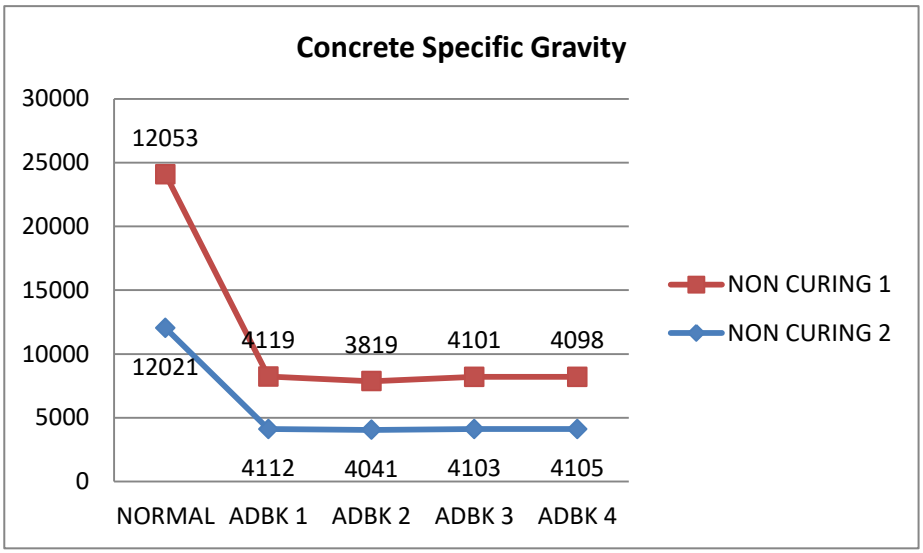
In lightweight concrete (ADBK 4) the treatment is not soaked (non-curing) concrete density of 775 kg/cm$^3$, decreased 66% from normal concrete and with compressive strength of 22 kg/cm$^2$, decreased 93.04% of the compressive strength of normal concrete, While the fc'/weight ratio is lightweight concrete (ADBK 4) not soaked (non-curing) 35.22.

**Table 3** Average Gravity and Compressive Strength Average age of 28 days

| **Test object** | **Age** | **Care** | **Specific gravity Average (kg/cm$^3$)** | **Compressive Strength Average (kg/cm$^2$)** | **fc' / Weight** |
|---|---|---|---|---|---|
| Normal | 28 | CR | 12.021 | 313 | 7,2 |
| | 28 | CR | 12.053 | 316 | 7,1 |
| ADBK 1 | 28 | CR | 4.112 | 11 | 70,54 |
| | | NC | 4.119 | 12 | 64,75 |
| ADBK 2 | 28 | NC | 4.041 | 16 | 47,62 |
| | | NC | .3.819 | 16 | 45,06 |
| ADBK 3 | 28 | NC | 4.103 | 16 | 48,37 |
| | | NC | 4.101 | 16 | 48,37 |
| ADBK 4 | 28 | NC | 4.105 | 22 | 35,22 |
| | 28 | NC | 4.098 | 22 | 35,13 |

*Source:* Narotama University laboratory test results

In Table 4, the highest value of quality with specific gravity is obtained in the specimen (ADBK4) with an average compressive strength of 22 kg / $cm^2$ and a specific gravity of 4,105 $kg/cm^3$.




**Picture 1.** Concrete Specific Gravity at 28 days

In Table 4, the highest value of quality with specific gravity is obtained in the specimen (ADBK4) with an average compressive strength of 22 kg / cm2 and a specific gravity of 773 kg / cm3.

## CONCLUSIONS

Based on the results of research and discussion, the following conclusions can be drawn:
1. The results of the cylinder compressive strength test that have been carried out that the composition of the material that is done with the mix design that is addition 5M, foam agent, coconut shell can affect the compressive strength of lightweight concrete and the specific gravity of light concrete is very significant. The more mixing of the material with lightweight concrete affects the compressive strength of lightweight concrete and the weight of concrete in the concrete age of 28 days. net compressive strength of normal age 28 days decreased by compressive strength 96.20% of the compressive strength of normal concrete of 313 kg / $cm^{2.}$

2. The compressive strength of concrete is getting weaker along with the greater use of addition 5M, foam agent, coconut shell with the method not soaked. The highest compressive strength of lightweight concrete is achieved by (ADBK 4) concrete with cement content of 3 kg, sand 3.25 kg, addition 5M 3%, foam agent 15 milliliters, coconut shell 1% at 22 kg / $cm^2$. Regarding increasing the composition of Additon 5M, Foam Agent, Coconut Fiber also affects the quality of lightweight concrete.

3. Weight test results of lightweight concrete not immersed, can be seen the weight of concrete age 28 days not soaked (ADBK 2) with an additional content of 5M 10%, foam agent 15 milliliters, coconut shell 1% with a weight of 721 kg / $cm^3$.

In order to produce research that will later become better in further research the authors suggest paying attention to the following matters:

1. Based on the conclusions above after conducting research and conducting test tests In the early stages of material preparation, especially fine aggregates, washed aggregates and already in SSD state, it should be placed in a place that can truly maintain SSD conditions until the aggregates are ready for use.

2. In order to get the right mixing further research needs to be done on the properties of lightweight concrete such as trial and error.

3. The method of making foam agent must be noticed and ensure that the foam produced is in accordance with the provisions.

4. Coconut shell should not be included in the mix design, coconut shell should be included in subsequent studies in a normal concrete mix design, because the coconut shell settles on the surface during the drying process in the cylinder.

5. It should be noted in the water content when using added ingredients such as additive additon 5M, the accident rate on water is quite high.

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