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EXPERIMENTAL STUDY OF THE INFLUENCE USE OF BEESWAX AGAINST THE MECHANICAL AND THERMAL PROPERTIES OF CONCRETE

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ABSTRACT

The economy of the whole world developed so quickly, encourage increased consumption of energy gradually. Energy consumption in the building sector has also increased with the demands of society in thermal comfort in the room. With the hot weather, the influence of the temperature in the room will rise. Some things that need to be reviewed in the manufacture of concrete in the place are the price is relatively low, easy to obtain, has high compressive strength, and has resistant to any environmental conditions. However, some problems still need to be resolved in the development of the Phase Change Material (PCM) composite that has a stable form. The proposed PCM has a thermal comfort temperature (16-26 ℃). The main purpose of this research was to investigate the influence of addition beeswax as a water-resistant mixture on the mechanical and thermal properties of concrete. In this research, the cement used was ordinary Portland Cement and replaced some of its Weight with paraffin wax in the mixture. The results of the research with the use of 10, 20 and 30% beeswax in a mixture of a concrete show that the increase in the content of Beeswax resulted in a decrease in the compressive strength of 22% and an increase in heat absorption by the concrete between without PCM with the Concrete-PCM is obtained by 10%.

Keywords: *Beeswax; Concrete; Heat absorbent.*

1. INTRODUCTION

The economic growth that quickly around the world encourage increased energy consumption. The energy consumption of the building sector is also increased with the demands of society in the thermal comfort in the room. At this time, building energy savings are highly dependent on the thermal envelope of the building [1].

The building envelope consists of opaque components (e.g. walls) and a fenestration system or translucent components (e.g. windows) that separate the interior of the building from the outside environment [2]. The building envelope protects against the influence of the external environment that is not desired, such as heat, radiation, wind, rain, noise, and pollution. The building envelope has an important role in reducing energy consumption for cooling and lighting. One of the best ways to improve the thermal performance of a building envelope is to use thermal energy storage materials [3-5]. The intended thermal energy storage is Phase Change Material (PCM).

PCM could absorb or release large amounts of latent heat when changing phases from solid to liquid state or otherwise, and has been commonly used in thermal energy storage systems [6–8]. The main purpose of this research was to evaluate Beeswax as a PCM airtight mixture on the mechanical and thermal properties of concrete. In this research, the cement used was ordinary Portland Cement and was partially heavy with paraffin wax in the mixture.

2. METHODS

The materials used in this research, such as:

a. Cement used is Portland cement (type I) produced by PT. Andalas Semen in 1 pack of 40 kg
b. Coarse aggregate in the form of broken stones taken from the factory (asphalt mixing plant).
c. Fine aggregate in the form of Beeswax
d. Fine aggregate in the form of good quality sand.
e. The water used is PDAM water.

The materials testing conducted at the laboratory of Provincial Public Works Service Langsa, such as:

a. Analyze sieve of coarse aggregate, fine aggregate (sand) and Beeswax
b. Check the Weight of the type and impregnation of coarse aggregate and fine aggregate (sand)
c. Examination of the organic content in coarse aggregate and fine aggregate (sand)
d. Testing slump test

The concrete mixing method used in this research is the Indonesian National Standard Method SK.SNI.T-15-1990-03. The planning of the compressive strength of concrete planned is **FC 'more than 20 MPa** [9-11].

The manufacture of the test object that planned is a cube-shaped measuring **15 cm x 15 cm x 15 cm 24** pieces cubes of concrete are shown in Table 1.

Table 1. The Number of The Test Object for Compressive Strength Testing

Concrete Compression Test	Code	Number of Samples
Concrete mixed Beeswax 0%	BCB 0%	6
Concrete mixed Beeswax10%	BCB 10%	6
Concrete mixed Beeswax 20%	BCB 20%	6
Concrete mixed Beeswax 30%	BCB 30%	6
Cube Total		24

Curing is carried out so that the next hydration process does not experience interference. If this happens, the concrete will have cracks due to rapid water loss.

This curing is intended not only to get high compressive strength of concrete but also intended to improve the quality of concrete durability, resistance to water, and stability of dimensions. The curing of the test object is carried out by means wetting (placing fresh concrete in water).

Then the concrete compressive strength and porosity are tested. Compressive strength and porosity testing are carried out in the laboratory Pekerjaan Umum dan Perumahan Rakyat (PUPR) Langsa City area. In this study, the age of the concrete tested was 7 and 28 days, respectively.

As for what will be reviewed from this research are:

a. Analyzing compressive strength and porosity of mixed concrete 0% Beeswax at the age of 7 and 28 days;
b. Analyzing compressive strength and porosity of 10% concrete mix Beeswax at the age of 7 and 28 days;
c. Analyzing compressive strength and porosity of 20% concrete mix Beeswax at the age of 7 and 28 days;
d. Analyzing compressive strength and porosity of 30% concrete mix Beeswax at the age of 7 and 28 days;

The concrete-PCM thermal performance test device is carried out in a room designed, as shown in Figure 1. A small test room with walls made of wood, the dimensions of the upper test room are 200 mm x 200 mm x 40 mm.

For a heat source is used power lamp of 500 W, placed at a distance of 600 mm from the sample. To keep the same and stable temperature, the in-use cover is hollow from hollow PVC material, which is coated with a transparent paper so that the source of the heat from the lamp can reach the sample. In this experiment, the concrete wall used was only one sample with a mixture of Beeswax into 10% concrete. The results obtained later can represent the thermal performance of concrete without PCM and with PCM.

Temperature measurements are carried out using a thermocouple, which is connected directly with the acquisition data. The test is done by heating the test sample for 3 (three) hours, then cooled by the temperature of the sample until it reaches ambient temperature.

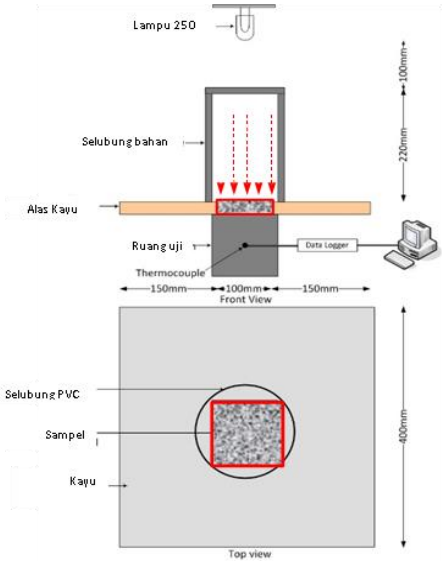

Figure 1. Concrete-PCM Thermal performance testing device

3. RESULTS AND DISCUSSION

From the results of the test weight type of Weight obtained Type with the condition of Saturated Surface Dry (SSD), the average is of 2.77 and can be classified as aggregate normal because its value is still in the allowable limits i.e. 2.2 – 2.7. Water absorption (absorption) obtained from the test results is 1.46%. This number shows that the aggregate's ability to absorb water is 1.46% of the dry weight of the aggregate.

From the results of the gross aggregate specific gravity test, the SSD Specific Gravity is 2.64 gram / cm3 and can be classified as an average aggregate because the value is within the allowable limit of 2.2-2.7 gr / cm3. Water absorption obtained from the test results is 1.20%. The number shows that the aggregate's ability to absorb water from absolute dryness to saturation of the face is 1.20% of the dry weight of aggregate.

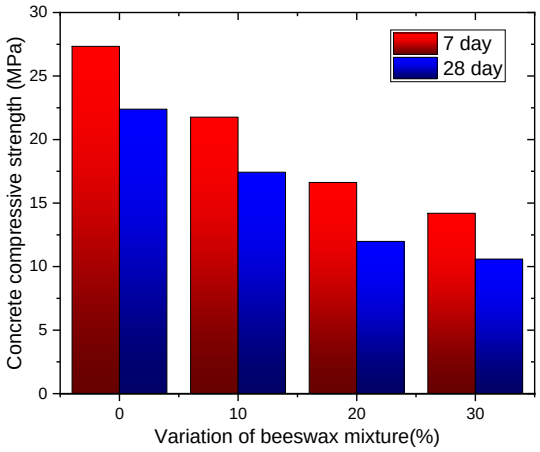

Figure 2. Graph of Compressive Strength

Figure 2 is a compressive strength graph for concrete 7 and 28 days. The x-axis is the composition of PCM (%), and the y-axis is the compressive strength of concrete (MPa). Based on these graphs, it can be explained that the compressive strength of normal concrete for the composition of 0% (without PCM) at the age of 7 days was initially 22.39 MPa. When added with beeswax 10, 20, and 30%, the compressive strength decreased by 17.43, 11.98, and 10.59 MPa, respectively. The influence of changes in concrete compressive strength also occurs for the normal concrete age of 28 days. The compressive strength of normal concrete for the composition of 0% (without PCM) at 28 days was 27 MPa. **When added with PCM 10, 20, and 30%, the compressive strength of concrete is also reduced to 21.76, 16.62, and 14.19 MPa**. The reduced compressive strength of concrete, both 7 and 28 days, is due to the lower density of Beeswax than concrete. Low density also affects viscosity if low viscosity affects shear stress and will automatically affect compressive strength.

Figure 3 is the thermal Performance of concrete-based PCM Beeswax with the addition of Beeswax. The thermal performance of the samples in the space of a small wooden be evaluated by monitoring the temperature variations in the inner surface of the panel and the middle part of the room during the test period ± 3 hours. The results of this test are used as a comparison for the storage of thermal energy in buildings.

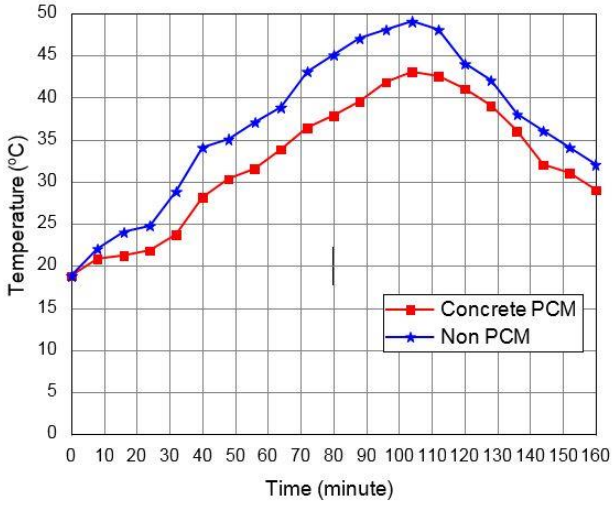

Figure 3. Temperature Change Graphic of The Test Sample

The calculation of thermal energy storage density calculated from bee-concrete wax panels is 30.75 MJ / m3. The maximum temperature at the center of the room and on the inner surface of the sample without PCM obtained 33.1 ^{o}C and 45.3 ^{o}C. For samples with PCM obtained 28.4 ^{o}C and 37.8 ^{o}C. The test results also show the temperature difference at the maximum sample center point is 4.7 ^{o}C, while the surface of the sample is 7.5 ^{o}C. Therefore, concrete samples with PCM can reduce the temperature in the room during the heat absorption process by PCM obtained by 10%.

4. CONCLUSION

The mechanical and thermal properties of concrete using Beeswax have been successfully tested. The results of concrete mechanical properties testing with the addition of 10, 20, and 30% beeswax mixtures resulted in a decrease in the compressive strength of the concrete both the concrete age of 7 and 28 days. Overall the decrease in mechanical properties of concrete due to the addition of the beeswax mixture is 22%, while the results of the thermal properties of concrete added to the beeswax mixture can reduce the temperature in the room. So that the concrete-PCM performance is better compared to concrete without PCM. The efficiency of heat absorbent in concrete due to the addition of PCM is obtained by 10%.

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