The analysis of strength for lightweight concrete brick with adding solid crude palm oil

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Abstract. The use of lightweight brick as a wall of a building is one alternative to be able to reduce the weight of a building. The lightweight brick used is a combination of cement, sand, water, and other materials that can make the brick lighter. Along with the development of the era of light brick making, it was developed by combining with the material in the form of waste. One waste that can be used is solid for oil palm. Solid is silt from the rest of the process of making palm oil. This solid existence if not utilized properly will become an environmental problem and also affect the health conditions of people around them. The texture of the solid is like the ground when it is dried in an oven and can be fused with mortar and water in a lightweight brick. The use of solid as additional stirring material in lightweight bricks is with variations of 0%, 0.5%, 1%, 1.5%, 2% and 2.5% by weight of cement. The use of solids on a lightweight brick mortar can give a compressive strength of 0.545 MPa for a variation of 0%; 0.415 MPa for variations of 0.5%; 0.915 MPa for variations of 1%; 1.985 MPa for variations of 1.5%; 0.879 MPa for 2% variation and 0.813 MPa for 2.5% variation, and the optimal variation is 1% variation with compressive strength of 1.985 MPa.

1. Introduction

The development of the current population requires a solution to the needs of dwellings with limited land, one of which is by undertaking vertical construction (multi-story buildings). Multi-story building planning also needs to implement innovations to reduce the weight of buildings without ignoring the strength of structural elements in buildings [1]. The use of lightweight concrete to be one solution by replacing coarse aggregate with clay will have a mild effect on the mixture one of which is by using lightweight bricks for wall pairs. There are several types of lightweight bricks that circulate in the market, one of which is a lightweight brick Cellular Lightweight Concrete (CLC). The use of waste needs to be added to the light brick mixture to reduce environmental pollution and can be of economic value, one of which is the use of Crude Palm Oil (CPO) sludge oil which has been left alone by the Oil Palm Factory.

From the production of palm oil in 2004, it is estimated that the production of POME (Palm Oil Mill Effluent) is 32,257 - 37,633 million tons [2]. Sludge is a waste that is produced from the pressing process of oil palm fruit in Factory which is squeezed and then entered in the clarification process to remove moisture, pulp, and dirt. These waste and feces are solid waste and liquid waste. Solid waste from the process is sludge. In general, sludge is only used as a fertilizer for oil palm plantations for the oil palm plantation land itself, but this much sludge has not been used to its full potential.
Sludge material that has been dried and then crushed has a shape that resembles cement. Sludge is a material that is easily obtained from the location of the Factory waste disposal site, especially when the Factory is in the production process. Sludge is expected to provide added value to the quality of CLC lightweight bricks in the form of well compressive strength. Utilization of sludge is intended to be able to increase the added value and its value as an added raw material for light brick CLC and can also overcome the negative impact of industrial waste pollution on the environment [3]. CLC lightweight brick compressive strength ranges from 1.5 to 3.0 Mpa depending on its density. In addition, adding coconut fiber to a lightweight brick mixture can increase the flexural strength of 13.4% and 16.1% [4]. In other studies, the use of rice husk ash can provide benefits with lower costs and go green [5].

2. Material

2.1. Portland Composite Cement (PCC)
Portland Composite Cement (PCC), also called portland composite cement, is a hydrolysis binder that is milled together with slag portland with one or more inorganic materials, or the result of mixing portland cement powder with other inorganic powder materials. These inorganic materials include blast furnace slag, pozzolans, silica compounds, limestone with total inorganic content of 6% - 35% of the mass of Portland composite cement [6]. PCC cement properties:

- Has low to moderate hydration heat.
- Resistant to sulfate attack.
- The initial compressive strength is less, but the final strength is higher.

PCC cement is Portland cement which falls into the Blended Cement category or mixed cement. This mixed cement is made or designed because it needs certain properties that are not possessed by type I portland cement. To get certain properties in the mixed cement, additives such as Pozzolan, fly ash, silica foam is added during the manufacturing process. Judging from the properties possessed by the PCC Cement, the cement can be used as an alternative or substitute for type II, IV or V. portland cement.

2.2. Foam Agent
Foam agent is a concentrated solution of a surfactant material, which if you want to use must be dissolved with water. Surfactant is a substance that tends to be concentrated in the interface and activates the interface [7]. Foaming Agent is used as a developer when mixed with other mixtures into lightweight bricks, foaming agent reacts with calcium hydroxide Ca (OH) 2 or inactive lime with water and forms hydrogen. Hydrogen gas expands and multiplies the volume of the mixture for light bricks (creating bubbles up to more than 1/8 inch in diameter) up to two times and also accelerates the development of ingredients dough.

2.3. Sludge
The use of waste is one solution to get cheap building materials [8]. The results of research into the use of waste for construction materials will be able to provide homes for people with low incomes. Palm sludge is a solid waste generated from processing Fresh Fruit Bunches in Factory using a decanter system [9]. Besides, the use of recycled aggregates will become environmentally friendly concrete because it becomes an economically valuable material [10]. Sludge comes from two sources namely from the oil purification process (Clarification) which usually uses a decanter and from a processing installation liquid waste. Sludge from decanter is oil impurities mixed with other impurities. The content of the chemical composition of palm oil sludge waste can be seen in Table 1.
Table 1. Chemical composition of palm sludge waste.

| Properties       | Kg/Ton (dry condition) |
|------------------|-------------------------|
| 1. Ash           | 240.00                  |
| 2. Nitrogen (N)  | 27.03                   |
| 3. Pospat (P)    | 2.54                    |
| 4. Kaliam (K)    | 15.50                   |
| 5. Kalsium (Ca)  | 14.20                   |
| 6. Magnesium (Mg)| 7.36                    |

Another understanding of sludge is solid, is one of the solid waste from the processing of crude palm oil. Solid usually has been separated from the liquid so that it is a solid waste. Solid comes from mesocarp or palm fibers that have undergone treatment at the factory. The decanter can remove 90% of all solids from sludge and 20% of dissolved solids from palm oil. Laboratory analysis results show that palm sludge contains 81.65% dry matter which contains 12.63% crude protein, 9.98% crude fiber, 7.12% crude fat, 0.03% calcium, 0.003% phosphorus, 5.25% hemicellulose, cellulose 26.35%, and energy 3454 kcal/kg [11].

2.4. Sand
Fine aggregate is all the grains pass through the 4.80 mm filter [12]. Fine aggregate for concrete can be in the form of natural sand, natural fractions of rock, or in the form of artificial sand produced by a stone-breaking machine commonly called stone ash. Fine aggregate must not contain mud more than 5% and do not contain organic substances that can damage concrete. Its silence is to fill the space between coarse aggregate grains and provide elasticity. Sand roughness can be divided into four groups according to their gradations, namely coarse sand, sand rather coarse, fine sand, and rather fine. In some countries, there are already many who use sand apart from nature such as the use of dust ash from mining which is considered more environmentally friendly [13].

2.5. Water
Water is an important basic material for making concrete but the price is the cheapest. The water used must be clean water from dirt and chemicals that can affect the quality of concrete. The use of water for concrete should meet the water requirements as follows: Does not contain mud (other floating objects) more than 2 grams/liter, does not contain salts that can damage concrete (acids, organic substances) more than 15 grams/liter, does not contain chloride (Cl) more than 0.5 gram/liter, does not contain sulfate compounds more than 1 gram/liter. Water used for the treatment or immersion of concrete can be used the same water for mixing concrete where the water used does not leave deposits and chemicals that can damage the concrete. Good water used for concrete mix is that which can be drunk directly or water that must undergo a certain process [14], including the use of water to cast concrete through the recycling process will not affect the performance of the concrete [15].

3. Methods
The process of making this lightweight brick using a 5 cm x 5 cm x 5 cm cube mold by giving a percentage of the use of sludge of 0%, 0.5%, 1%, 1.5%, 2% and 2.5%. The specimens that have been finished are dried for 24 hours and removed from the printed cube for the next process of curving by wrapping in plastic to maintain the moisture content in the test specimens. After 7 days, the compressive strength was tested on each specimen with 5 specimens for each percentage of sludge use. Solids used are solids that have been dried in an oven and then mashed to become like cement ash.
4. Results and discussion

The specimens were subjected to a 7-day curing process to maintain the water content in the test specimens, after which a compressive strength test was carried out to obtain the quality of lightweight bricks using solid as an added material. The results of the compressive test are shown in Table 2.

| % Solid | Weight (gram) | Weight Average (gram) | Compressive Strength (Mpa) | Compressive Strength Average (Mpa) |
|---------|--------------|-----------------------|---------------------------|----------------------------------|
| 0       | 112.63       | 112,213               | 0.554                     | 0.545                            |
|         | 111.10       |                       | 0.527                     |                                  |
|         | 112.91       |                       | 0.554                     |                                  |
| 0.5     | 107.39       |                       | 0.360                     | 0.415                            |
|         | 105.24       |                       | 0.443                     |                                  |
|         | 99.48        |                       | 0.443                     |                                  |
| 1       | 135.93       | 119,050               | 1.275                     | 0.915                            |
|         | 101.05       |                       | 0.721                     |                                  |
|         | 120.17       |                       | 0.748                     |                                  |
| 1.5     | 130.32       | 125,293               | 2.159                     | 1.985                            |
|         | 132.73       |                       | 2.023                     |                                  |
|         | 112.83       |                       | 1.774                     |                                  |
| 2       | 97.23        |                       | 0.721                     | 0.879                            |
|         | 112.46       |                       | 0.970                     |                                  |
|         | 112.29       |                       | 0.946                     |                                  |
| 2.5     | 90.44        | 89,040                | 0.804                     | 0.813                            |
|         | 90.30        |                       | 0.887                     |                                  |
|         | 86.38        |                       | 0.748                     |                                  |

Based on Figure 1, show that the magnitude of variation in the use of solids in a light brick mixture with an optimal value is at a variation of 1.5% with a weight of 125,293 grams and the variation with the lowest value is a variation of 2.5% with a weight of 89,040. This shows that after passing the optimal limit value of solid content added to the light brick mortar, the effect becomes lighter so that it will also affect compressive strength as shown in Figure 2.
Figure 2. Diagram of the correlation of % solid use with compressive strength.

Based on Figure 2 show that the percentage of use of solids in a light brick mixture with an optimal value of 1.5% with a compressive strength of 1.985 MPa and variations with the lowest compressive strength is 2.5% with a compressive strength of 0.813. After passing the optimal value in the use of solid there is a decrease of up to 40.95% due to the influence of compounds in the solid.

5. Conclusion
Based on the results of testing the use of solid in a lightweight brick mixture can provide an increase in compressive strength with an optimal variation of 1.5% with a compressive strength value of 1.985 MPa, when it has passed the optimal value of use with a further variation value of 2% and 2.5% a decrease in weight and compressive strength value of 40.95, the weight loss of the test object is linear to the compressive strength test results.

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