The utilization of stone ash on cellular lightweight concrete

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Abstract: Lightweight concrete brick is a brick which made of cement, sand, water, and foam as the basic composition. This brick are divided into 2, based on the foam used such as AAC (Autoclave Aerated Concrete) that use aluminium paste and CLC(Cellular Lightweight Concrete) that use foaming agent from BASF as its foaming material. In this trial, the lightweight brick that are ging to be use are the CLC with foaming agent as its foaming material with the mixture of stone ash that are produced by the Stone Crusher with specific gravity 2666 kg/m³ as their partly sand substitution. In this research, the stone ash variant that are used are 10%, 15%, and 20% from the amount of sand that planned before. After casting, the result of the 10% will receive a reduction of compressive strength while an increasing in absorption as 25.07% and 39.005% and the 15% variant will receive a reduction of compressive strength as much as 65.8% and a reduction of absorption as much as 17.441% and the 20% variant will receive a reduction of compressive strength as much as 67.4% while an increasing of absorption as much as 17.956%.

1. Introduction
The use of bricks as a building material (nonstructural) has long been used throughout the world. The use of bricks in Indonesia has been widely used as a building wall. Almost all buildings in the city and surrounding areas have been using bricks as a building wall. The bricks within the field of construction are a non structural element, in which the bricks in the building do not accept / withstand the load. The bricks in the building are categorized as dead loads, because if the bricks receive the load there will be a crack.

Broadly speaking, the bricks are divided into 2 types, conventional bricks and concrete bricks. Conventional brick is a red brick made of clay that is dried or burned as a drying process, while concrete bricks are bricks that use cement, sand, water, foaming agent as the material in this research. Lightweight concrete bricks have some advantages over conventional bricks. On the mounting side, concrete bricks are quicker to install because the size of lightweight concrete bricks has larger dimensions than conventional bricks, which can save installation time. Concrete bricks also have fire resistant properties, water resistant, and lighter than conventional bricks.

By the making process, concrete bricks are divided into two, namely: AAC (Autoclaved aereted concrete)/ALC(Aereted Light-weight concrete) and CLC (Cellular Light-weight concrete). In this research we use stone ash in the manufacturing of lightweight concrete bricks CLC type which has a high compressive strength but has an economical price and environmentally friendly.

Stone ash is a waste of stone crushing from stone crusher machine. The use of stone ashes is usually used as a filler in flexible pavement, rockfill type dam, etc. In this study, I used stone ash as a substitute material for a mixture of lightweight concrete bricks because the stone ash has very fine grains and is easily bonded by cement and for aggregate gradation variations in lightweight concrete bricks. There are several stages on making stone ash on stone crusher machine. In the first stage, the crushed stone is inserted into the primary crusher, then insert it into the secondary crusher and at the final stage insert it into the tertiary crusher. Where ash stones are obtained after passing through tertiary crusher.

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2. Literature Review
Concrete is very commonly used as a building material. Concrete is generally composed of several constituents of fine aggregate (sand), gravel (coarse aggregate), portland cement, and water with a combination of comparisons of each material. Where the mixed cement and water will become a paste material that serves as a binder while fine aggregates and coarse aggregates serve as fillers. When all the mixtures are mixed in accordance with the planned composition will harden like a rock, where the process occurs due to the hydration process (chemical reaction between water and cement).

The quality of the concrete can be influenced by several factors, like the quality of the material from the constituent material, the composition ratio, the way of stirring, the way of treatment, and the way of treatment during the hardening process.

Strength, durability and other concrete properties depend on the nature of the base material, the value of the material composition, the way of stirring and the way of processing during the concrete mixing, the method of compaction, and the way of treatment during the hardening process.

According to (Tri Mulyono, 2005) as a construction material, concrete has advantages and disadvantages, the advantages of concrete are:
1. The plan quality can be adjusted according to the plan.
2. The age of concrete is higher (if not experiencing a greater load of the plan quality).
3. Easily formed according to the needs of construction.
4. Maintenance / treatment costs are small.

The disadvantages of concrete are:
1. Concrete has a low tensile strength, making it easy to crack. Therefore, it is necessary to be given reinforced steel, or gauze reinforcement (meshes).
2. Concrete is difficult to be perfectly waterproof, so it can always inserted by the water, and water carrying salt content can damage the concrete.
3. The shape that has been made is difficult to change.

2.1 Fresh Concrete
A good fresh concrete is the one that can be stirred, transported, poured, compacted, no tendency for segregation (separation of gravel from mortar) and bleeding (separation of water and cement from mortar). This is because segregation and bleeding will make the obtained concrete bad.

2.2 Definition of Lightweight Concrete Brick
The development of construction especially in Indonesia has been growing rapidly. One of the developments is a lightweight concrete brick. Lightweight concrete brick is a brick that has density of conventional brick (red brick).

2.3 Stone Ash
Stone ash is an aggregate that acts as a filler. Stone ash used in this experiment is taken from AMP factory located in Galang area (North Sumatera) and already through a crushing process from stone crusher machine. Usually this stone ash is often used for asphalt mixtures, but nowadays the road construction using asphalt is decreasing so that the role of stone ash in the construction is taken over by sand. The collection of sand in the manufacture of construction is using a lot of sand that can damage the environment in the sand dune area. This stone ash is formed from the stone crusher machine which is produced on tertiary crusher.

Stone ash used in this research is produced from AMP factory which has gone through crushing process on stone crusher machine, where the stone ash used is passes filter No.200 and stuck in pan. This stone ash has a density of 2666 kg / m³. The reason for using stone ash which passes filter No.200 is to be able to fill or become a filler in lightweight concrete brick which aim to improve the quality of concrete.
3. Research Method
Research steps were employed in this research depicted in Figure 1. Provision and inspection of materials were performed at first place, following mixing decision and 14 days test. If the result is satisfying, the sample is manufactured, followed by 28 days treatment. Test results were analysed and conclusion was take.

4. Results

4.1 Testing of compressive strength and specific gravity
Testing of compressive strength of lightweight concrete brick was done at age 3, 7, 14, 21, 28 days with the intention to get a picture of the development of the compressive strength of lightweight concrete brick using stone ash as additional material and compare it with the compressive strength of lightweight concrete brick without using stone ash. Table 1 shows that the use of stone ash in a mixture of lightweight concrete bricks showed a significant result in terms of compressive strength. The data is plotted at Figure 1.
Table 1. Compressive (Pressure) strength and specific gravity (weight)

| Sample 1 |   |   |   |   |   |   |   |   |   |   |   |   |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|
|         | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 |
| 3%      | 8,450 | 8,060 | 8,300 | 118,800 | 98,400 | 88,300 | 6,200 | 104,607 | 5,776 | 1,856 |
| 7%      | 7,910 | 8,150 | 8,030 | 118,000 | 102,000 | 128,800 | 6,200 | 135,150 | 3,765 | 1,800 |
| 14%     | 7,563 | 7,499 | 7,682 | 150,800 | 150,000 | 154,300 | 7,556 | 152,170 | 7,900 | 1,428 |
| 21%     | 7,553 | 7,140 | 7,610 | 162,300 | 65,400 | 100,000 | 7,524 | 162,567 | 9,204 | 1,420 |
| 28%     | 7,507 | 7,090 | 7,900 | 163,400 | 65,500 | 102,200 | 7,486 | 163,407 | 9,256 | 1,415 |

Sample 2

|   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 |
| 3% | 8,400 | 8,670 | 8,520 | 69,200 | 69,900 | 68,200 | 8,550 | 69,000 | 6,800 | 1,644 |
| 7% | 8,187 | 8,263 | 8,207 | 118,500 | 112,200 | 110,000 | 8,245 | 110,000 | 6,953 | 1,557 |
| 14%| 8,155 | 8,168 | 8,200 | 120,000 | 122,000 | 118,700 | 8,174 | 120,000 | 6,511 | 1,543 |
| 21%| 7,882 | 8,052 | 7,900 | 120,400 | 122,300 | 119,800 | 7,945 | 120,833 | 6,841 | 1,500 |
| 28%| 7,661 | 7,019 | 7,807 | 121,000 | 123,000 | 120,400 | 7,824 | 121,033 | 6,904 | 1,476 |

Sample 3

|   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 |
| 3% | 7,513 | 7,460 | 7,622 | 46,000 | 43,300 | 39,800 | 7,545 | 43,390 | 2,448 | 1,424 |
| 7% | 7,346 | 7,272 | 7,407 | 46,000 | 46,700 | 41,100 | 7,388 | 45,970 | 2,580 | 1,364 |
| 14%| 7,220 | 7,316 | 7,200 | 57,200 | 56,200 | 56,000 | 7,282 | 54,767 | 3,103 | 1,286 |
| 21%| 7,507 | 7,294 | 7,356 | 56,100 | 57,300 | 52,300 | 7,532 | 55,313 | 3,124 | 1,278 |
| 28%| 7,008 | 7,019 | 7,064 | 55,000 | 55,300 | 52,900 | 7,082 | 54,230 | 3,014 | 1,264 |

Sample 4

|   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 | BU 1 | BU 2 | BU 3 |
| 3% | 8,225 | 8,263 | 8,228 | 35,400 | 37,000 | 34,300 | 8,235 | 35,607 | 2,010 | 1,555 |
| 7% | 8,110 | 8,100 | 7,990 | 40,000 | 40,100 | 38,000 | 8,015 | 45,035 | 2,572 | 1,517 |
| 14%| 7,900 | 7,900 | 7,900 | 52,400 | 52,300 | 52,000 | 7,920 | 52,217 | 2,056 | 1,495 |
| 21%| 7,640 | 7,646 | 7,700 | 53,500 | 52,900 | 52,700 | 7,622 | 53,068 | 3,004 | 1,439 |
| 28%| 7,294 | 7,294 | 7,304 | 55,600 | 55,400 | 55,900 | 7,292 | 55,420 | 3,014 | 1,265 |

Figure 1. Compressive strength and specific gravity

The absorption test result is enlisted in Table 2 and plotted in Figure 2.

Table 2. The absorption results

| Variation 1 | Dry Weight | Wet Weight | Absorption Value |
|-------------|------------|------------|-----------------|
| 14          | 14,052     | 14,023     | 14,052          |
| 21          | 14,052     | 14,023     | 14,052          |
| 28          | 14,052     | 14,023     | 14,052          |

| Variation 2 | Dry Weight | Wet Weight | Absorption Value |
|-------------|------------|------------|-----------------|
| 14          | 14,052     | 14,023     | 14,052          |
| 21          | 14,052     | 14,023     | 14,052          |
| 28          | 14,052     | 14,023     | 14,052          |

| Variation 3 | Dry Weight | Wet Weight | Absorption Value |
|-------------|------------|------------|-----------------|
| 14          | 14,052     | 14,023     | 14,052          |
| 21          | 14,052     | 14,023     | 14,052          |
| 28          | 14,052     | 14,023     | 14,052          |

| Variation 4 | Dry Weight | Wet Weight | Absorption Value |
|-------------|------------|------------|-----------------|
| 14          | 14,052     | 14,023     | 14,052          |
| 21          | 14,052     | 14,023     | 14,052          |
| 28          | 14,052     | 14,023     | 14,052          |
Figure 2. Absorbtion plots

5. Conclusion
Based on the research that has been done, it can be concluded that:
1. The use of stone ash as sand substitution in lightweight concrete brick can decrease the quality of lightweight concrete brick.
2. The use of stone ash up to 15% of the amount of sand is still within the safe limits of use.
3. Curing process should be done when lightweight concrete brick is 7 days old.
4. The quality of lightweight concrete brick depends on the foaming agent used.
5. Samples that have been removed from the mold should be stored in a room that is protected from sunlight.
6. The cost of production of Cuban Light Concrete Type CLC is the most expensive between Red Brick and Lightweight Concrete Brick Type AAC Grand Elephant.

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