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Development of Bricks Based on Limboto Lake Sediment As An Eco Friendly Building Material

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Abstract
The use of soil or clay in bricks making process can become a new problem for environment. Meanwhile, the problem of shallowness of Limboto lake due to the massive sedimentation that needs an immediately tackling. This research is aimed to cope with those two problems. This research used the sediment the river mouth of Alo-Pohu as red bricks which consist of three various experiment media; bricks of sediment Limboto lake; bricks made with the volume comparison of one sediment of Limboto lake and one part of clay; bricks made by comparison one part of the sediment and two parts of soil. Clay taken from the area of the bricks manufacturing in Jalan Bengawan Solo in Gorontalo city. The bricks arranged based on the certainty in ASTM C1314-02a of each 5 (five) specimen which then conducted compression test. The experiment result is gained with the value of 3,59 MPa (35,9 kg/cm2) for red bricks from sediment. The average compression strength of bricks that use material with the comparison 1 : 1 is 4,18 MPa (41,8 kg/cm2) with both damage type are conical. The average compression strength of the bricks use material with the comparison 1 : 2 is 7,38 MPa (73,8 kg/cm2) based on SNI 15-2094-1991 in the best bricks classification which is B2.

Keywords : Limboto lake, sediments, bricks.

1. Background

Bricks, as a material building, have been known since human civilization entered an era that led humans to a safe and comfortable residence compared to previous era. Previously, ancient humans occupied dwellings in the form of caves, large trees and huts - simple huts made of wood and leaves as walls and roofs. According to historical records, the use of bricks have been known since 2000 BC. This can be traced from the legacy of ancient Egyptian civilization in the form of human residential buildings that have used bricks. In China, it is believed that, before the construction of a giant wall in about 200 BC, the use of clay that was burned both as pottery and jars as well as building materials has existed since the Chou dynasty in 1100 BC.

In Indonesia, bricks are estimated to become known in the 13th century or around 1280 AD. This can be seen from the historical heritage of Jago Temple which is located in Malang Regency, East Java. This temple was built using bricks and some other parts still used andesite rocks. The entry of Islam into Indonesia in the 15th century brought the development of the use of bricks to become more

popular at that time. This can be seen that from some of the oldest mosques built during the development of Islam. Entering the Dutch colonial era from the beginning of the 17th century until the mid-20th century, the use of bricks as building material was common things. This can be seen from several Dutch heritage buildings that still exist today. Until now, bricks are a popular material as building materials throughout Indonesia.

As a raw material for making bricks, large-scale clay exploitation can create a new problem for the environment. An area in Gorontalo City where the land is used as a base material for briks, there is a large hole of about 1 hectare with an average depth of about 10 meters. This phenomenon has an adverse effect because it can disrupt the environmental ecosystem and impossible to do continuously.

On the other hand, the sedimentation problem of Limboto Lake requires immediate countermeasures. Increasing population and socio-economic pressures have resulted in widespread use of natural resources, such as opening agricultural land to steep slopes and protected forests and conversion from agricultural land to non-agricultural use. These activities can result in damage to forest, land and water resources. Utilization of Limboto Lake sediments as raw material for bricks making is expected to overcome and can provide another solution to the environmental problems in Limboto Lake.

The focus of the observation of this study is to find out; the compressive strength, the failure type of bricks using sediment from Limboto Lake as raw material and specific gravity in each comparison of raw materials for brick makers. At the very least, through this research it is hoped that it will be a new alternative income for residents who are around the river into Limboto Lake or as an alternative solution to environmental problems, especially the problem of siltation of Lake Limboto.

2. Materials and Method

The sediment material used in this study was taken from the Alo-Pohu River which is one of the biggest contributors to sediment for Limboto Lake. The study used 3 (three) variations of test specimens consisting of; 5 (five) pieces of specimens with pure lake sediment as a raw materials, 5 (five) pieces of specimens with a ratio of raw material to 1 part volume of lake sediment and 1 part volume of clay that is often used by brick makers, 5 (five) pieces of test specimens with a ratio of raw material to 1 part volume of lake sediment and 2 parts volume of clay. The clay used which is often used by brick makers located around on Jalan Bengawan Solo, Gorontalo City. The entire test object will be tested for Compressive Strength based on ASTM C 1314 - 02a (Standard Test for Testing of Wall Material Press Strength).

The use of volume comparisons on brick making is based so that brick makers are easier to work on and in applying the results of the research can be immediately adjusted to the conditions in the community. The implementation of brick making was assisted by brick makers around Jalan Bengawan Solo.

3. Research Stage

Preparation stage begins with the procurement of materials as well as specimens, the preparation stage as follows: 1) Preparation of materials needed to make brick specimens, namely Lake Limboto sediment; 2) Lake Limboto and Soil Sediments that will be used first are examined Specific Gravity, Aggregate Gradation and Aterberg Limits in the Soil Test Laboratory of the State University of Gorontalo.

Printing of bricks tested by brick makers. Bricks are made in 3 (three) models, namely bricks made from Lake Limboto sediments and bricks made from lake sediments and the land commonly used by brick makers with two 1: 1 in volume comparisons

After the bricks are ready to be used and then taken to the Structural and Material Laboratory of the State University of Gorontalo to make a standard form construction ready to be tested in accordance with ASTM C-1314-02a guidelines (Figure 4.3), the mortar is the comparison of volume of 1 cement and 1 fine aggregate.

Figure 1 The Construction of Standard Test Form

After one week of age and the species has been considered sufficiently hard the test can be carried out, the test equipment used is Compression Testing Machine (CTM) with a capacity of 2000 kN.

Compressive Strength (f'm)
The compressive strength of specimens is calculated based on the formula:

$$f_m^{'} = \frac{P_{maks}}{A_c} \qquad \text{.....1)}$$

Where;
$f'm$: The Compressive Strength of Bricks (Mpa or kg/cm2)
P_{maks} : Maximum Load (N or kg)
A_c : Average Cross-sectional Area (mm^2 or cm2)

In this compressive strength test ASTM C 1314 - 02a provides a correction factor according to the dimensions of the specimens shown in Table 3.1;

Table 3.1. The Correction Factor of Bricks Compressive Strength

hp/tp	**1,3**	**1,5**	**2,0**	**2,5**	**3,0**	**4,0**	**5,0**
Correction Factor	**0,75**	**0,86**	**1**	**1,04**	**1,07**	**1,15**	**1,22**

Where ;
hp : height of specimen
tp : the smallest width in lateral direction

Failure Types of Bricks
ASTM C 1314 – 02a has clasified in 7 (seven) the failure types of bricks specimen; 1) Conical failure in the cone form type; 2) Conical and shear failure type; 3) Conical and Split failure type; 4) Tension failure type; 5) Semi-Conical failure type; 6) Shear failure type; 7) Separation of part failure type.

The data obtained from testing are classified into two types, namely data from the initial testing of material and data from compressive strength testing. These data are collected based on the type of test object, type of test, results of testing and observations made during the test. The result data from the initial test are processed to determine the characteristics of the material as secondary data in this study. While the data from the testing of Brick Compressive Strength were processed to identify the quality and classification of bricks according to the existing regulations and then compared for each specimen and used as a basis for conclusions.

4. Results and Discussion

Prior to the specimen are tested, the raw material test was carried out. This test is intended to determine the characteristics of the material. The average specific gravity of clay and sediment are around 2.49 and 2.52, respectively. The atterberg limits include plastic and liquid limits. Plastic soil limit is around 25.67% moisture content and liquid limit is around 31.10% moisture content. The sediment plastic limit cannot be determined because this is because the sediments are sandy material, while the Liquid Limits are around 28.43%. For gradation analysis of soil granules has finer grains than granules of lake sediment.

The specific gravity of the brick made from Lake Limboto sediment material is 1341 kg/m3, then for brick type with a material ratio of 1: 1 is 1432 kg/m3 and for the brick with a material ratio of 1: 2 is 1471 kg/m3.

4.1 Compressive Strength of Bricks

In pure sediment bricks, the type of collapse sediment that is identified as dominant occurs is type 2, although there is a small portion of destruction following a type 1 destruction pattern but in general the type of conical destruction is most important. Likewise the type of collapse that occurs in bricks with a ratio of 1: 1 (comparison of volume of 1 sediment and 1 soil), in general the type of collapse that occurs in general is conical in shape with a crushed form which tends to be powder.
Another thing happens to the brick with a 1: 2 collapse (comparison of volume of 1 sediment and 2 soil), in this test the collapse that occurs is the separation of parts of the test object even though the actual model of conical collapse is still visible, as well as the form of destruction tends to be like large flakes, this shows that the specimen is more compact and harder.

4.2 Compressive Strength

From the results of the examination of the average compressive strength the largest obtained in the material mixture of 1: 2 which is equal to 7.38 Mpa, then the value of the material mixture of 1: 1 is equal to 4.18 Mpa and the smallest value on the brick that is the raw material all of them use material from Lake Limboto sediments which is around 3.59 Mpa.

With the variation in the brick forming mixture there was an increase of 16.45% in the mixture of 1: 1 and 105.67% in the mixture of 1: 2 when compared to the brick made from Lake Limboto sediment entirely.

When compared with the brick requirements listed in SNI 15-2094-1991 the test materials whose raw materials use Lake Limboto sediment material and with a mixture of materials 1: 1 are in class A2, which is a minimum requirement of non-bearing bricks and can be used in a place that being outside and without a protective layer or in class 25.

For specimens with a mixture of material 1: 2 are in the best class, namely class B2, which is a minimum requirement for bricks that can carry loads and can be placed in areas that are not protected from weather or in class 50.

5. Conclusion

From the results of the bricks compressive strength testing can be obtained the following conclusions: 1) The amount of compressive strength of pure sediment bricks from Lake Limboto is 3.59 Mpa, compressive strength of bricks using a material with a ratio of 1: 1 (ratio of volume 1 of lake sediment and 1 soil) is 4.18 Mpa with the type of poisoning conical, the compressive strength of a brick using 1: 2 is 7.38 Mpa with the type of destruction of the part of the test specimen in destruction on this specimen in the form of debris; 2) Compressive strength of bricks whose raw materials use Lake Limboto sediment material and with a mixture of material 1: 1 in class A2, and compressive strength of bricks with a mixture of material 1: 2 in the best class, namely class B2; 3) There was an increase in compressive strength of the bricks by 16.45% in the mixture of 1: 1 and 105.67% in the mixture of 1: 2 when compared to the brick made from Lake Limboto sediment; 4) The lightest type of brick weight is made from Lake Limboto sediment material which is 1341 kg / m3, then followed for brick type weight with a material ratio of 1: 1 which is equal to 1432 kg / m3 and the specific gravity of the brick with a material comparison 1: 2 is 1471 kg / m3.

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