THE USE OF PUMICE AS RAW MATERIAL FOR CEMENT BRICK

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ABSTRACT

Pumice in the Tidore Islands City has not been utilized optimally, only as a pile material. In this research, pumice was used as a basic material in the manufacture of cement brick which in the local language was called Batu Tela. In this study, an experimental study was conducted to determine the compressive strength and shear of cement masonry walls with pumice base material. The four types of specimens used in this study were pumice-based masonry bricks with plaster (BAP), without plastering (BATP). Cement brick control with plastering (BCP) and without plastering (BCTP). A cement brick made from pumice stone, in the process of refining is given a pressure of 4.00 MPa. Comparative bricks were purchased directly from local businessmen. The pressure exerted in the process of making control bricks is not measured, only based on the strength of the labour force. From the results of the study, the compressive strength of BATP and BPTP were 19.33 MPa and 5.15 MPa respectively. The Strength of pumice-based cement brick is 73.35% larger than control brick. The compressive strength of BAP and BCP were 35.38 MPa and 29.48 MPa respectively. The strength of cement bricks made from floating sand is 16.67% greater than control bricks. The use of plastering on both types of pairs gives an effect of an average strength increase of 63.95% respectively, or the strength of bricks of floating sand cement was 73.35% higher than that of market bricks. The compressive strength of BAP and BCP are 35.38 MPa and 29.48 MPa, respectively, or the strength of bricks of floating sand cement is 16.67% greater than that of market bricks. The use of plastering on both types of pairs gives an effect of an average strength increase of 63.95%.

Keywords: Pumice, Brick, Masonry.


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1. INTRODUCTION
Indonesia is an earthquake-prone area, especially North Maluku. The use of light walls will be beneficial because it can reduce the weight of the structure. In general, Indonesian people build houses for separation walls using basic materials are wood and brick. The use of each material is closely related to the basic materials available, the cost and quality of the planned structure, because the building structure is one of the determinants of the quality of the building structure.

In the Ternate area, generally for the wall material of the community using cement brick is a mixture of cement with sand which in the local language is called Batu Tela. This cement brick material certainly has a greater weight than using bricks. To reduce the weight of this cement brick, lighter materials are used, namely pumice.

Some studies use alternative materials to replace sand as fine aggregate or by adding other materials to the cement brick making process. Maulana, states that dolomite flour can be used as a substitute for sand in brick making [1]. Pumice mortar has a better structure than river sand mortar and beach sand in reducing the chloride ion diffusion rate [2]. The addition of gypsum waste in the concrete block can increase the compressive strength, pull the split brick [3]. The effect of the addition of fly ash and conplast on floating sand mortar and river sand results in greater compressive strength than normal mortar [4]. Giving pressure to the process of making cement bricks with pumice base material produces cement bricks with lighter weight than cement bricks with basic sand / not pumice [5].

2. RESEARCH METHODS
This research is an experimental study with the following stages:
- Material retrieval
- Material preparation
- Testing material characteristics
- Manufacture of specimens (cement brick)
- Test specimens
- Data analysis.

Pumice cement brick using fine aggregate proportions and Portland cement 1 PC: 4 PS. Fine aggregates of pumice and cement are mixed using a mixer. The results of the mixing of fine aggregate with cement are called mortar. Mortar is put in a mould and put under pressure. Pressure is applied using a Hydraulic Concrete Manual of 4.00 MPa. Mould tools and the production of cement bricks from pumice as in Figure 1.
Compressive strength testing was carried out using manual compressive strength with a capacity of 200 kN. This test is carried out based on the specification standards SNI [6]. Test object model for compressive strength test as shown in figure 2. Analysis of compressive strength with Equation 1. Flexural strength analysis with the Equation 2.

\[
f = \frac{P}{A}
\]

(1)

Where:
- \(P\) = maximum load, kN
- \(A\) = cross-sectional area, \(\text{mm}^2\)

\[
f_t = \frac{3PL_0}{2bh^2}
\]

(2)

Where:
- \(P\) = maximum load, kN
- \(L_0\) = the spacing between the intercepts, mm
- \(b\) = the width of the test object in mm and \(h\) thick or the height of the test specimen, mm
3. RESULTS AND DISCUSSION

3.1. Mortar Compressive Strength

Mortar test specimens are 50 mm x 50 mm x 50 mm. The test object is pressurized monotonically until it breaks. The compressive strength of mortar obtained from the results of dividing the maximum compressive load with the cross-sectional area of the cube. The compressive strength unit is N/mm². The results of the mortar compressive strength test are presented in Table 1.

<table>
<thead>
<tr>
<th>Specimens</th>
<th>Maximum load (kN)</th>
<th>Compressive strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>42.50</td>
<td>17.00</td>
</tr>
<tr>
<td>B2</td>
<td>40.50</td>
<td>16.20</td>
</tr>
<tr>
<td>B3</td>
<td>40.00</td>
<td>16.00</td>
</tr>
<tr>
<td>Average</td>
<td>41.00</td>
<td>16.40</td>
</tr>
<tr>
<td>Sd</td>
<td>3.240</td>
<td>1.296</td>
</tr>
<tr>
<td>COV</td>
<td>4.27%</td>
<td>1.71%</td>
</tr>
</tbody>
</table>

The average maximum load for the three mortar specimens is 41.00 kN. The average compressive strength of mortar from the three specimens was 16.40 MPa with a standard deviation and coefficient of variation (COV) of 3.240 and 4.27%, respectively.

The production of cement bricks from pumice as shown in Figure 4a. Cement bricks from the market are shown in Figure 4b.

Visually it can be seen that the pumice brick produced in the laboratory has a smoother and denser surface compared to cement bricks from the market, market bricks have a larger cavity. Absorption of cement bricks from pumice on a loading of 25 kN of 4.37%, absorption of cement bricks from the market by 12% [7]. This indicates that bricks from the market have more cavities than cement bricks from pumice.
3.2. Flexural Strength of Cement Bricks

The flexural strength of the brick is determined by the modulus of rupture obtained by placing the brick on a simple pedestal and given a point load in the middle of the span until the brick is broken/damaged.

Test results of brick tensile strength can be seen in Table 2. The average maximum load for the six specimens is 4.00 kN and the average flexural strength of the brick (modulus of rupture) is 5.04 MPa with a standard deviation value and 0.48 and COV value of 3.30%.

<table>
<thead>
<tr>
<th>Specimens</th>
<th>Maximum load (kN)</th>
<th>MoR (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>2.50</td>
<td>0.30</td>
</tr>
<tr>
<td>B2</td>
<td>4.50</td>
<td>0.54</td>
</tr>
<tr>
<td>B3</td>
<td>5.00</td>
<td>0.60</td>
</tr>
<tr>
<td>B4</td>
<td>3.00</td>
<td>0.36</td>
</tr>
<tr>
<td>B5</td>
<td>5.00</td>
<td>0.60</td>
</tr>
<tr>
<td>B6</td>
<td>4.00</td>
<td>0.48</td>
</tr>
<tr>
<td>Average</td>
<td>4.00</td>
<td>5.04</td>
</tr>
<tr>
<td>Sd</td>
<td>5.740</td>
<td>0.480</td>
</tr>
<tr>
<td>COV</td>
<td>27.50%</td>
<td>3.30%</td>
</tr>
</tbody>
</table>

3.3. Compressive Strength of Cement Bricks

The test results of the compressive strength of cement masonry from pumice (BA) with cement bricks on the market (BP) as shown in Figure 5.

![Figure 5 Compressive strength of cement brick from pumice](image-url)
Based on Figure 5 it can be seen that Bata Semen from Pumice (BA) has an average compressive strength of 275.3% compared to cement bricks from the market (BP). Cement brick in the market in the manufacturing process is provided manually without measuring the size of the load. Cement brick from pumice stone in the manufacturing process is loaded with a pressure tool so that the cement brick produced is denser. From Figure 5 it can be concluded that in the cement brick making process, the given load is measured so that the quality of cement brick can be determined according to SNI.

![Figure 7 Average compressive strength.](image)

Figure 6 shows the strength of cement masonry from pumice and cement brick from the market by adding a cover layer of 5 cm thick plastering to each pair type.

From the results of the research, the compressive strength of BATP and BPTP were 19.33 MPa and 5.15 MPa, respectively, or the strength of bricks of floating sand cement was 73.35% higher than that of market bricks. The compressive strength of BAP and BPP are 35.38 MPa and 29.48 MPa, respectively, or the strength of bricks of floating sand cement is 16.67% greater than that of market bricks. The use of plastering on both types of pairs gives an effect of an average strength increase of 63.95%.

4. CONCLUSION

Giving pressure to the process of making cement bricks with floating sand base material can increase strength up to 73.35% compared to market bricks.

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