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PROCESSING AND UTILIZATION OF PUMICE AS AN ALTERNATIVE MIXED MATERIAL IN MAKING CONCRETE BRICKS (PAVING BLOCKS) TO INCREASE COMMUNITY INCOME

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ABSTRACT

Aceh Besar Regency, specifically Mesjid Raya District, boasts promising geological conditions, both in terms of rock type and distribution. This allows for the abundance of highly economically valuable mining resources. However, the utilization of these mining materials has not been optimized to date. One such mining resource is pumice . This pumice is abundantly available in Paya Kameng Village in considerable quantities. However, the villagers have so far only used it as a supplementary building material without any effort to improve its usefulness. Therefore, attempts are being made to utilize it as a raw material in the industrial and construction sectors, such as in the manufacture of concrete blocks. Concrete blocks (paving *blocks*) are a type of non-structural concrete that can be used for roads, parking lots, sidewalks, parks, and other purposes. Concrete blocks are made by mixing Type I Portland cement , water, and aggregate as filler. Aggregates or fillers account for 75% of the total volume of concrete, so the properties of the aggregates have a significant impact on the behavior of hardened concrete. The aggregate that is often used is sand.

Keywords *: pumice stone , concrete stone , paya kameng*

A. INTRODUCTION

The development of the industrial sector has led to the need to search for alternative materials to replace those that have been used so far .

Concrete bricks using pumice as aggregate represent a step toward discovering alternative materials to the current use of sand. Cement is typically used as a binder in concrete mixes, but given the rising price of cement, this service involves reducing the percentage of cement in the mix and using quicklime as an alternative binder.

This community service project has two intended goals: a general goal and a specific goal. The general goal is to maximize the use of pumice as an aggregate for concrete bricks. The specific goal is to create and encourage the community to utilize the potential of pumice resources in their area for the building materials and construction industry. This activity is expected to foster business diversification, which will indirectly increase local incomes.

If this community service activity can be implemented, the community can gain many benefits, including:

1. By utilizing this pumice stone, the village community's business sources will increase, which will lead to an increase in the community's own income.
2. The use of sand for concrete brick aggregates can be gradually reduced, so that the ecology of rivers/waters can be maintained.
3. You will get concrete brick material with pumice aggregate with better quality and with sand aggregate.

B. LITERATURE REVIEW

Pumice is a type of light-colored rock containing foam made of glass-walled bubbles and is also known as a volcanic silicate rock. Based on geology, pumice is classified as an igneous rock, namely a rock that occurs from the solidification of a liquid and incandescent silica solution called magma (Kunrad, 1992). Its current use is widely used as a building material, road (concrete aggregate), a mixture in making tiles, building decorations, and others (Hamid, 1993).

The physical properties of pumice are important to know as a requirement to be an aggregate in the formation of good concrete bricks. These physical properties include specific gravity, absorption, volume weight and sieve analysis. Based on SNI (Indonesian National Standard) No. S-16-1990-F (1990) for lightweight aggregates used in making concrete, the specific gravity must meet 1.0 - 1.8 gr / cm ^{3} . Absorption is the percentage comparison between the weight of water absorbed by the aggregate in a saturated surface dry condition with the weight of the aggregate in an oven dry condition. Based on SNI No. S16-1990-F, the maximum absorption for lightweight concrete aggregates is 20%. While the volume weight is the ratio of the weight of the aggregate as much as the contents of the container to the volume of the standard container. The aggregate volume weight is reviewed in two conditions, namely loose volume weight and solid volume. Based on SNI No. S-16-1990-F, the maximum loose volume weight for lightweight concrete aggregates is 1100 kg / m ^{3} (SN1, 1990).

Mixed Design

Concrete mix design is carried out to determine the composition of each material including aggregate, binder and water for 1 m3 of concrete. In concrete technology, concrete mix in structural concrete construction is usually carried out based on weight while in non-structural concrete, mixes are used in volume ratios. Planning the mix composition, whether based on weight or volume, is carried out after the materials to be used in the concrete mix have been examined for their properties and meet the required provisions.

Based on ACI 211.1-77 the standard concrete density is 2.4 gr/cm3 so by knowing this standard concrete density, the total mass of material required for every 1 m3 of concrete can be obtained . The amount of water required for concrete depends on the type of concrete to be planned. Determining the amount of water based on the ratio of water to cement in 1 m3 of concrete is called the Water Cement Factor (FAS). This excludes water absorbed by aggregates or other materials. Based on the Special Specifications of the Engineering Department of Public Works, to make non-structural concrete, a water cement factor of 0.65 is required (Bina Marga, 1999).

C. MATERIALS AND IMPLEMENTATION METHODS

Problem Solving Framework

Based on the results of the field survey, it was shown that the pumice found at the location was 5 cm - 20 cm in size. Therefore, it was necessary to show the public how to process pure pumice for the needs of making concrete bricks. In addition, the public was shown the comparison of concrete bricks with pumice aggregate and those with sand aggregate. Before the concrete was cast, the pumice was first crushed (*crushed*) to obtain a fine aggregate with a maximum sieve of 4.75 mm. After the crushing was carried out, the physical properties of the pumice as aggregate were examined. Only then was it molded with the addition of a mixture of quicklime, type I Portland cement and water.

Therefore, in this service, it is necessary to introduce a practical pattern in making a mixture of concrete brick material with pumice aggregate accompanied by an explanation of the economic value that can be obtained and the results of this effort.

Problem Solving Realization

The implementation of the Science and Technology Application program is carried out in accordance with the contract. In the first month, preparations and design of concrete stone making equipment are carried out. Pumice stone samples/materials are collected in the second month. Meanwhile, mixture design, specimen preparation and curing, and compressive strength testing are carried out in the third to fifth months. Furthermore, in the sixth month, observations, discussion of results, and evaluation of the results are carried out, followed by a report.

Target Audience

Based on data from the Department of Mining and Energy , Aceh Besar region has quite high pumice reserves , amounting to
30,900,000 tons. Meanwhile, the demand for concrete bricks is currently increasing in line with rapid development. Therefore, this material holds considerable promise for development in increasing the income of local villagers , particularly in Paya Kameng Village, which boasts substantial reserves .

Methods Used

This community service activity will focus on the core activity of processing existing pumice for concrete production. This will also include providing information on the advantages and economic value of pumice to increase community income.

This activity will be conducted in the field, introducing the process of making concrete bricks. Brief theories about pumice will also be presented to increase public knowledge. The planned method for this activity is as follows:

1. Pumice stone extraction and location
2. Cleaning and cleaning dirt in the form of wood, soil, etc.
3. Crushing process until smooth .
4. Fine aggregate is then dried
5. Cast the concrete bricks according to the desired shape .
6. Comparison with the strength of sand aggregate concrete bricks .

To evaluate/prove the strength of these pumice aggregate concrete bricks, their compressive strength was tested using a standard compressive strength tester. Then, they were directly compared to the concrete bricks currently in use, which use sand as a mixing material. The volume weight and the lighter weight of these concrete bricks were also evaluated compared to the sand aggregate concrete bricks. All these evaluations were conducted based on SNI No. S-16-1990-F standards.

D. RESULTS AND DISCUSSION

Concrete Brick Mix Design Results

The concrete brick mixture design is carried out by taking the analogy of the ACI Standard Method 211.1-77 for type I portland cement and a water cement factor of 0.65 (regardless of the presence of other binders) based on references and Special Specifications of the Directorate of Engineering Development, Department of Public Works, Highways for non-structural concrete, but in the implementation the amount of water used is not fixed, this occurs due to the influence and absorption of water by quicklime so that the amount of water needed is determined by trial *and error* with a mixture viscosity that can be seen visually. The calculation of the concrete mixture design produces a material composition for 1

cm^3 of concrete stone as shown in Table 2.

Table 4.1. Material Composition for 1 cm3 of Concrete Brick

Type	Pumice	Calcium oxide	Cement	Water
I	85% 1275 gr 812.10 cm^3	5% 75 gr 163.04 cm^3	10% 150 gr 120 cm^3	6.5% 97.5 grams 300 cm^3
	6.7	1.35	1	2.5
II	80% 1200 gr 764.33 cm^3	2 0/ 52.5 grams 114.13 cm^3	10% 150 gr 120 cm^3	6.5% 97.5 grams 200 cm^3
	6.3	1	1	2
III	70% 1050 gr 688.78 cm^3	13.5% 202.5 grams 440.22 cm^3	10% 150 gr 120 cm^3	6.5% 97.5 grams 300 cm^3
	5.7	3.7	1	2.5
IV	60% 900 gr 573.25 cm^3	23.5% 352.5 gr 766.30 cm^3	10% 150 gr 120 cm^3	6.5% 97.5 grams 385 cm^3
	4.7	6.4	1	3.2
V	50% 750 gr 477.70 cm^3	33.5% 502.5 gr 1092.39 cm^3	10% 150 gr 120 cm^3	6.5% 97.5 grams 550 cm^3
	3.9	9.1	1	4.6
VI	40% 600 gr 382.16 cm^3	43.5% 652 gr 1418.47 cm^3	10% 150 gr 120 cm^3	6.5% 97.5 grams 710 cm^3
	3.2	11.8	1	5.9

Information:
[grey box] = Composition of material in volume

Compressive Strength Testing

Before conducting the concrete compressive strength test, each sample was weighed first to determine the weight of the concrete brick cube and to determine the compaction of each test object during casting. The average cube test object weight for each casting is shown in Table 4.2 below.

Table 4.2. Weight of Concrete Brick Test Specimens

Type	Average Test Specimen Weight of Concrete Bricks (gr)
I	274.2
II	275.96
III	256.7
IV	252.64
V	234.28
VI	220.90

Discussion

The results of the aggregate examination in the laboratory prove that the pumice aggregate as a lightweight aggregate used in this activity meets the requirements as a concrete forming material. The results of the compressive strength test on the mixture of pumice, quicklime and cement show that the optimum compressive strength is shown in the mixture composition of 80% pumice, 3.5% quicklime and 10% cement or in the mixture composition in volume 6.3: 1: 1, which is 89.348 kg/cm². The minimum value is obtained in the mixture composition of 40% pumice , 43.5% quicklime and 10% cement or in the mixture composition in volume 3.2
: 11.8 : 1, which is 3,360 kg/cm². For more details on the average compressive strength test results for each mixture composition on the cube test specimen and the concrete brick control test specimen, see Table 4.3.

Table 4.3. Compressive Strength Test Results of Cube Test Specimens and Concrete Brick Control Test Specimens

No	Mixed Code	Composition of Pumice Mixture: Quicklime : Cement	Compressive Strength (kg/cm²)
1.	Type I	85% : 5% : 10%	56,296
2.	Type II	80% : 3.5% : 10%	89,348
3.	Type III	70% : 13.5% : 10%	39,590
4.	Type IV	60% : 23.5% : 10%	8,900
5.	Type V	50% : 33.5% : 10%	6,194
6	Type VI	40% : 43.5% : 10%	3,360
7.	Control Test Object		86,578

The results of the average compressive strength test can also be seen in graphical form to see the linearity of the data produced and each mixture composition.

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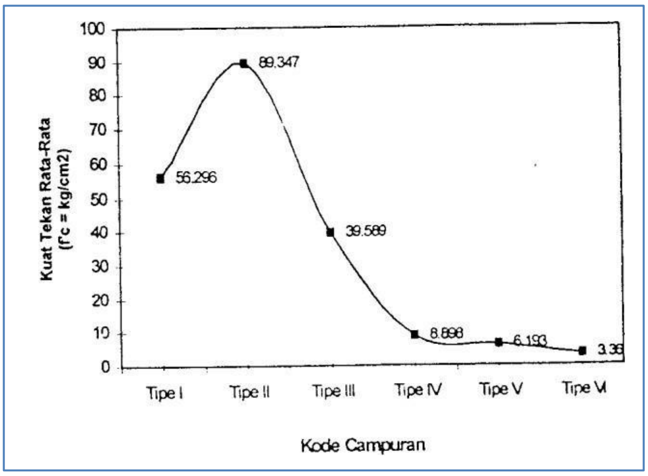

Figure 4.1. Relationship between average compressive strength and mixture code

From Table 4.1 and Figure 4.1 it can be seen, with increasing composition of quicklime causes a decrease in the compressive strength of the concrete bricks produced so that it can be concluded that quicklime is not very suitable for use as a raw material in making concrete bricks. Meanwhile for pumice, the increasing composition of pumice proves that the compressive strength produced is higher, this is evidence that pumice meets the requirements as a good concrete forming aggregate.

Based on the level of effectiveness and efficiency, concrete bricks made from pumice, quicklime, and cement meet the requirements for grade D concrete bricks, with a mixture composition of 80% pumice, 3.5% quicklime, and 10% cement with a resulting compressive strength of 89.348 kg/cm². The obtained compressive strength value is also close to the compressive strength value of control test objects that are already on the market at 86.56 kg/cm². In addition to the compressive strength that has met the requirements for grade D, producing concrete bricks with pumice aggregates has advantages and aspects of reducing transportation costs. Industrial mining materials that have a value per unit cause the volume of mining materials that must be transported/moved to be the same as the volume mined. This situation causes the transportation costs to be very high. Floating barns that have a volume weight of 0.995 - 1.196 gr/cm ^{3} cause the resulting concrete bricks to be lighter so that they can reduce transportation costs by 25% - 50%. This is proven by the weight of the concrete brick cube test object produced in this activity with a mixture composition of 80% pumice: 3.5% quicklime, 10% cement of 275.96 gr compared to the weight of the control test object on the market between 582 gr and 640.0 gr.

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E. CONCLUSION AND SUGGESTIONS

Conclusion

From this activity, it can be concluded that the compressive strength of the concrete bricks produced meets the quality requirements for concrete bricks used for garden purposes and other purposes (quality D), namely for a composition of 80% pumice, 3.5% quicklime and 10% cement of 89.348 kg/cm². Thus, pumice meets the requirements as an aggregate for building materials industry materials in this case concrete bricks.

Suggestion

For further activities, it is very necessary to carry out more activities .
This aims to empower rural communities to revive small-scale building materials industries, in this case concrete bricks. It is also recommended that a detailed explanation of the economic value be provided based on applicable economic principles .

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