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The Utilisation of Zeolite To Eliminate The Price and Cost of Cement

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ABSTRACT

The efficient cost of economic needs is the fundamental aspects to support the survival of an individual. Generally, the cost of the building in the residential community still utilise costly building materials and the installation costs are relatively expensive. Then, the technology of the bricks has been shifted to be the lightweight bricks. The lightweight bricks have better strength, lighter, faster installation and environmentally friendlier. Even though the lightweight bricks has many advantages, such as faster installation, the price of lightweight brick is still expensive. Therefore, to overcome the costly problem, this research proposes the using of zeolites to replace the cement to reduce the production cost of bricks which also causes the elimination of lightweight brick price. This paper used the experiment method which evaluated by two way ANOVA to test the comparison of Zeolite composition with Fly Ash and Ca (OH) 2. In this case, we utilised zeolites containing silica by using the composition of 20%, 40% and 60%. Before using Zeolite, we activated Fly Ash with the composition of the ratio by 65% Fly Ash and 35% Zeolite; also 50% Fly Ash and 50% Zeolite. In 65% Zeolite, we employes 35% Ca (OH), and the 50% Zeolite contains 50% Ca (OH). Thus, there are 15 compositions including the control composition. Each composition yields 10 specimens.

Keywords *Zeolite, Cement, compressive strength, Cost*
Paper type Research paper

INTRODUCTION

There are of various kinds of economic needs as fundamental aspects to support the survival of the individual. The fast-growing of economic and population caused the increasing needs for housing developments.

According to Abraham Maslow, human needs are likened to the form of a pyramid where the most basic needs for humanity are at the bottom. The most basic needs include the need for food, drinks, clothing and shelter. If seen in general, the high cost in the procurement of shelter still uses building materials made of materials that have a relatively high price.

For example, the red bricks and brickworks are the main ingredients of the wall. Redbrick made of clay has the potential to damage the environment and remove the nutrients in the soil that can affect the quality of the plant. In addition, red brick has a high water absorption that allows the fragility of the wall in a relatively short period of time. With the advancement of technology has found a lightweight brick that has better strength, lighter, faster installation and environmentally friendly, so many people are switching to use lightweight bricks.

The main ingredients for making CLC type light bricks are sand, cement, water and foam (foam) [1], [2]. However, in the manufacture of lightweight bricks many use cement so that the cost of production is relatively expensive compared with red brick and brick. With the phenomenon as above, we need a solution to minimize the cost of light brick production by using natural materials that are widely available in Indonesia either in whole or in part. These natural materials include zeolites.

Zeolite is a natural mineral whose formation is not by the combustion process so as not to produce CO2. This material also contains high silica about 53% and is one of the compounds in Portland cement making so hopefully with the zeolite the use of Portland cement can be suppressed. The longer the brick hardening process, the greater the power generated. With the use of zeolite as a substitution of cement, it is expected that the use of cement can be suppressed so that the production cost can be minimized to the best quality with the same strength results when using whole cement as a binder. Zeolite can be used when it is activated, in this research as its activation material used with Fly ash as recomended by [3].

LITERATURE REVIEW

Lightweight brick is a material that resembles concrete and has a waterproof and fire properties, strong, durable. Despite having many advantages, in fact, the use of red brick is still the main choice for the community. Conventional bricks have basic materials such as clay (clay), which is used as one of the building materials that become the main component in a building structure, especially wall construction [4]. However, along with technological developments that are increasingly advanced, making the construction experts create the latest innovation that is expected to be an alternative for the community to gain greater benefits from the use of higher quality products. As quoted from [5] lightweight concrete is a substitute for conventional brick and brick, which is a lightweight brick. This brick is quite smooth, light and has a good level of flatness. This lightweight brick was created to be able to lighten the structural load of a construction building, accelerate the implementation, and minimize the rest of the material that occurs during the wall installation process takes place. According to [6]–[8], basically lightweight concrete is made by incorporating air in its composition, in the following manner: a. No-Fines Concrete. B. Lightweight Aggregate Concrete. C. Aerated Concrete. Meanwhile, according to [6] CLC light brick is a cellular concrete that experienced the curing process naturally. CLC is a conventional concrete by using air instead of coarse aggregates (gravel). In the process of making it used a very stable organic foam and no chemical reaction when mixing the dough. In this case, foam/foam serves as a medium for wrapping air.

METHOD

Place and Time of Implementation

The place of execution of this research was conducted at the Laboratory of Materials Technology and Concrete Construction Faculty of Engineering Department of the Civil Engineering University of Widyagama Malang. The study was conducted in May 2017.

Preparation Equipment and Materials

For the purposes of this study, the equipment and materials used are as follows:

1. Equipment: Cup, A set of sieves, Scales, Oven, Mold of the specimen, Foam Maker, Pycnometer (measuring cup), Spoon, Species, shovel, mortar mixer and Other tools.
2. Material: Agregat Halus (Pasir)cor Hitam, Semen Portland (PC type 1), Air PDAM, Zeolit Trenggalek, Fly ash dan Ca(OH)2.
3. Sample: The zeolite used in this study is a fine-shaped sieve passing 200. This zeolite mixing is carried out by 20%, 40% and 60% of the weight of portland cement used for the specimens, with each mixture consisting of 10 specimens. So that the total of all test specimens consists of 150 pieces.

Material Inspection

1. Water content.
2. Specific gravity and absorption of fine aggregates (sand) and additives (zeolites).
3. The weight of fine aggregate content (sand) and additives.
4. Sieve Analysis.

Mixing and Testing

To get a good light brick, the way of making and the basic requirements that need to be considered as follow. The mixture between portland cement and sand uses a 1: 1.5 mix ratio. The mixture of cement and sand while for 1 part of cement itself is still divided again with additional material that is zeolite and additives for zeolite activation plus water then put the dough in milling machine after flat stirring add again with foam Agent to give cavity on the dough so that become more light.

How to check by taking 1 liter of dough and weigh the weight of the dough is 0.9 kg to 1 kg then the dough is ready in print. The lightweight brick moulding process is done manually by pouring the dough into a mould that was previously smeared with oil to keep it from sticking in the mould and already make sure it does not have a hole to prevent the dough from thawing out. Lightweight brick ready to print, leave it for 1 day after dried out of the mould. 2.5 Data Collection After a 28-day light brick, a sample test for compression test was conducted for each mixed composition (15 treatments), each treatment of 10 specimens. So, the total sample of 150 pieces.

Statistical Data Analysis Method

Strength Analysis Press

A. Calculate the amount of compressive strength of lightweight brick (fc)

$$\sigma bi = \frac{P}{A} \quad (1)$$

Where
P = Lightweight Brick Press Style
A = Sectional area

B. Calculate the compressive strength of crushed averages σ bm

$$\sigma bm = \frac{\sum_i^n f'ci}{n} \quad (2)$$

Where

σ bm = Strong crushed averages

σ bi = Strong crushed each

n = Number of specimens

C. Standard deviation (S) s

$$S = \sqrt{\frac{\sum_i^n (\sigma_{bi} - \sigma_{bm})}{n-1}} \quad (3)$$

D. The voltage voltage is destroyed for n specimens (σ'bm, n)

$$(\sigma' bm, n) = \sigma bm - \frac{ti - S}{\sqrt{n}} \quad (4)[1]$$

E. Determining the characteristic voltage (σbk) σ',bk = σ'bm, n *1.64 (S)

DISCUSSION

Material Quality Testing
Results of Fine Aggregate Examination
The results of a fine aggregate examination can be labeled as follows:

TABLE I. Fine Aggregation Result

Examination	Check up Result	ASTM Standard
Water content (%)	3.85	-
Weight content	2.49	2.5-2.7
Absorption rate	2.93	1-2
Weight content (g)	1.32	Max 1.6
Fine Modulus	4.26	2-4

Data Collection
Light Brick Dimension Data
In this observation, the data obtained by observing directly the object under study so that it can be known :

1. Sample Size
   i. Lightweight Brick (P) = 10 cm
   ii. Lightweight Brick (L) = 10 cm
   iii. Lightweight Brick (T) = 10 cm

V= PxLxT = 1000 cm³

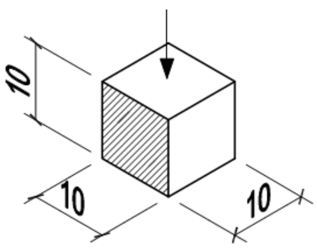

Figure 1 Dimensions of Lightweight Bricks

Discussion Data Processing
Based on the existing data processing followed by data analysis by calculating the Content Weight, crushed stress and compressive strength characteristics.
Calculation of Heavy Weight Weight
Computation Calculation for composition 0.80 PC: 0.13 Si: 0.67 CaOH: 1.5 PS data obtained as follows:

Weight = 1.04kg
Volume = 1000 cm³

$$Weight\ Content = \frac{Weight}{Volume} = \frac{1.04\ kg}{1000cm^3} \quad (5)$$

TABLE II. WEIGHT FILL ANY COMPOSITION OF PC CEMENT REPLACEMENT WITH ZEOLITE + CaOH

No	Composition	Average		
		Weight (Kg)	Weight of contents (Kg/cm^3)	Weight of contents (g/cm^3)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	1.04	0.00104	1.04
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	1.01	0.00101	1.01
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	0.87	0.00087	0.87
4	0.60 PC : 0.20 Z : 0.20 CaOH : 1.5 PS	1.07	0.00107	1.07

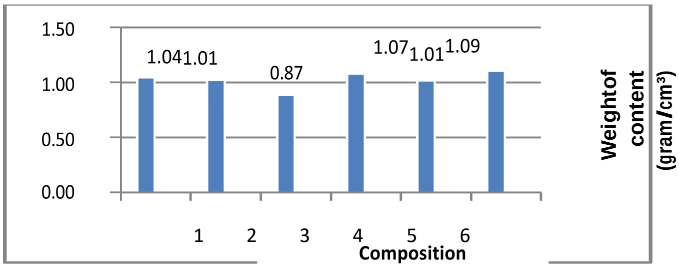

Figure 2. Relation of pc cement replacement composition with zeolite + CaOH to Weight

TABLE III. WEIGHT FILL ANY COMPOSITION OF PC

No	Composition	Average		
		Weight (Kg)	Weight of contents (Kg/cm^3)	Weight of contents (g/cm^3)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	0.99	0.00099	0.99
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	0.87	0.00101	0.87
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	0.90	0.00087	0.90
4	0.60 PC : 0.20 Z : 0.20 CaOH : 1.5 PS	0.95	0.00107	0.95
5	0.40 PC : 0.40 Z : 0.20 CaOH : 1.5 PS	0.93	0.00087	0.93
6	0.40 PC : 0.30 Z : 0.30 CaOH : 1.5 PS	0.95	0.00107	0.95
	AVERAGE	0.93	0.00093	0.93

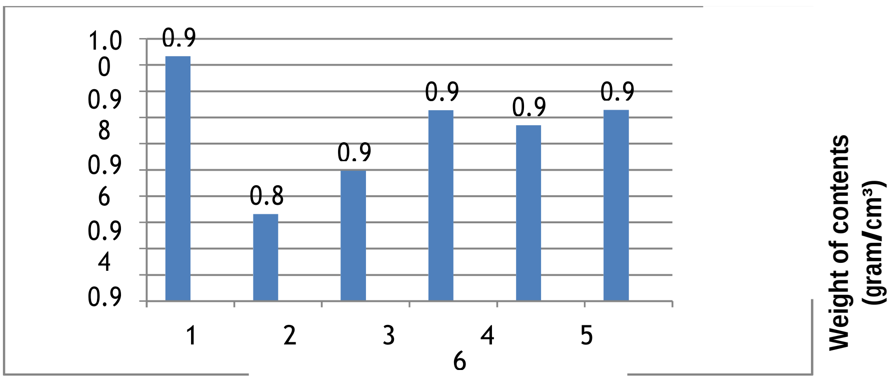

Figure 3. Relation of pc cement replacement composition with zeolite + CaOH to Weight Lightweight brick content.

From the calculation of the weight of lightweight brick content with Fly Ash activation obtained 16.03% lighter than the lightweight brick control, while with the activation of CaOH 8.56%.

TABLE IV. WATER ABSORPTION OF EACH CEMENT REPLACEMENT COMPOSITION WITH ZEOLITE+CaOH

No	Composition	Water Absorption (%)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	30.68
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	35.61
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	21.16
4	0.60 PC : 0.20 Z : 0.20 CaOH : 1.5 PS	25.64
5	0.40 PC : 0.40 Z : 0.20 CaOH : 1.5 PS	26.37
6	0.40 PC : 0.30 Z : 0.30 CaOH : 1.5 PS	26.89
	AVERAGE	**27.72**

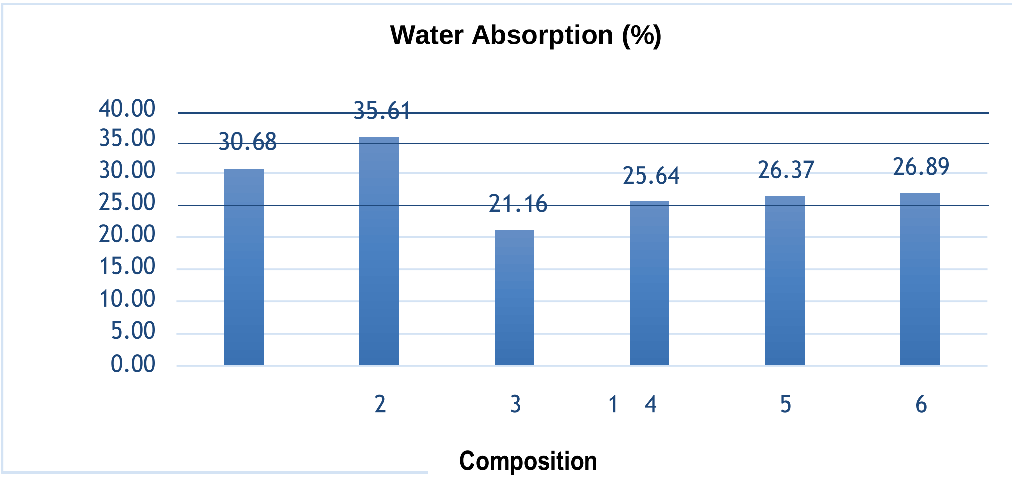

Figure 4 Relation of composition of each cement replacement composition with zeolite + CaOH to water absorption.

TABLE V. WATER ABSORPTION OF EACH CEMENT REPLACEMENT COMPOSITION WITH ZEOLITE+CaOH

No	Composition	Water Absorption (%)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	30.68
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	35.61
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	21.16
4	0.60 PC : 0.20 Z : 0.20 CaOH : 1.5 PS	25.64
5	0.40 PC : 0.40 Z : 0.20 CaOH : 1.5 PS	26.37
6	0.40 PC : 0.30 Z : 0.30 CaOH : 1.5 PS	26.89
	AVERAGE	**27.72**

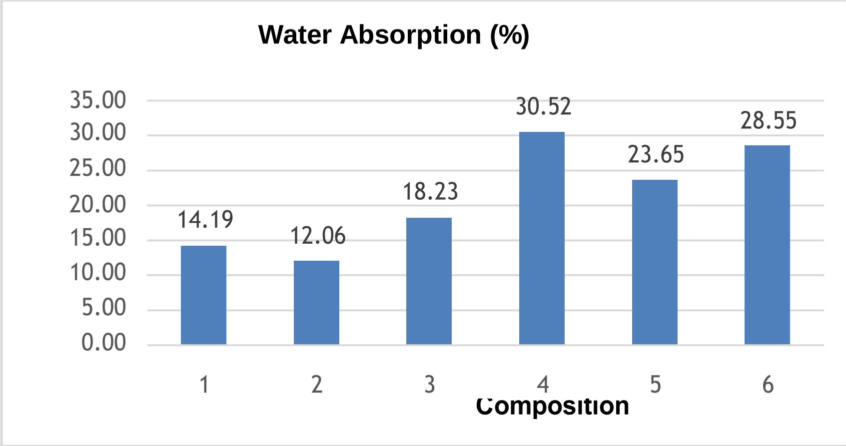

Figure 5. Relation of composition of each cement replacement composition

Crash Voltage Calculation

Examples of crushed voltage calculations Composition A1 Area cross-section (A) = 10 cm x 10 cm = 100 cm²

$$Crushed\ Voltage = \frac{style(P)}{Extents(A)} = \frac{727.35}{100} = 7.27\ KN/cm^2$$

For the next calculation can be seen in the following table:

TABLE VI. MEAN COMPRESSIVE STRENGTH OF EACH CEMENT REPLACEMENT COMPOSITION WITH ZEOLITE+CaOH

No	Composition	STRONG PRESS OF AVERAGE (Kg/ cm²)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	7.29
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	6.49
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	6.15

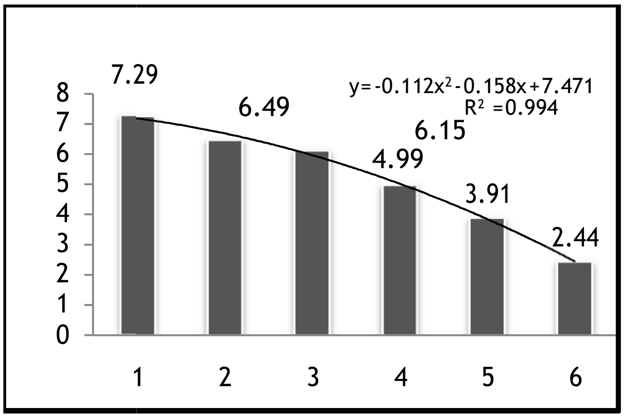

Figure 6. Relation of Zeolite + CaOH replacement composition with compressive strngth.

TABLE VII. MEAN COMPRESSIVE STRENGTH OF EACH CEMENT REPLACEMENT COMPOSITION WITH ZEOLITE

No	Composition	STRONG PRESS OF AVERAGE (Kg/ cm^2)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	7.47
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	6.31
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	5.55
4	0.60 PC : 0.20 Z : 0.20 CaOH : 1.5 PS	4.82
5	0.40 PC : 0.40 Z : 0.20 CaOH : 1.5 PS	3.75
6	0.40 PC : 0.30 Z : 0.30 CaOH : 1.5 PS	3.47
	AVERAGE	**5.21**

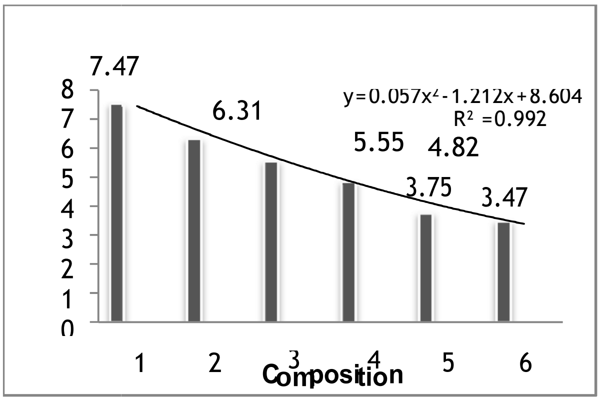

Figure 7. Relation of Zeolite + CaOH replacement composition with compressive strength.

TABLE VIII. MEAN COMPRESSIVE STRENGTH OF EACH CEMENT REPLACEMENT COMPOSITION WITH ZEOLITE+ Fly Ash

No	Composition	STRONG PRESS OF AVERAGE (Kg/ cm^2)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	7.47
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	6.31
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	5.55
4	0.60 PC : 0.20 Z : 0.20 CaOH : 1.5 PS	4.82
5	0.40 PC : 0.40 Z : 0.20 CaOH : 1.5 PS	3.75
6	0.40 PC : 0.30 Z : 0.30 CaOH : 1.5 PS	3.47
	AVERAGE	**5.23**

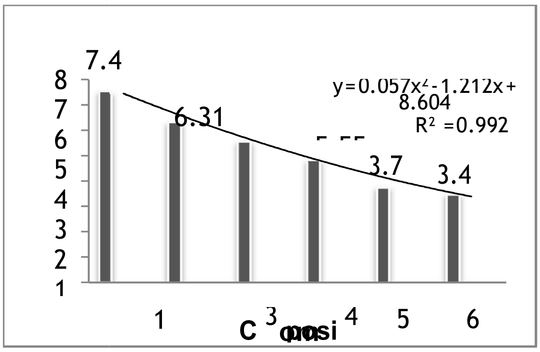

Figure 8 Relation composition of Zeolite replacement + Fly Ash with strong Press.

From the calculation of the above table with 20% reduction of cement with 65% zeolite and 35% CaOH obtained compressive strength reduced hamya 10.11% while replaced with 65% zeolite and FA 35% lightweight brick strength only reduced 7.89%. So it can be concluded that the replacement of cement with zeolite can be recommended.

TABLE IX. COMPARISON OF CEMENT REPLACEMENT WITH ZEOLITE + CaOH TO COST

No	Treatment	Fa	Comparison of costs Zeolit	Price (IDR)	Difference (IDR)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	40.00	238.00	278.00	75.50
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	65.00	128.00	247.00	106.50
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	85.00	476.00	561.00	-29.00
4	0.60 PC : 0.20 Z : 0.20 CaOH : 1.5 PS	125.00	350.00	475.00	57.00
5	0.40 PC : 0.40 Z : 0.20 CaOH : 1.5 PS	125.00	714.00	839.00	221.50
6	0.40 PC : 0.30 Z : 0.30 CaOH : 1.5 PS	190.00	532.00	722.00	338.50

From the calculation result from the above table with 20% reduction of cement with 65% zeolite and 35% Fly ASh obtained cost difference between the use of cement with Zeolite Activation of Rp. 75.50 cheaper than using Zeolite Activation.

TABLE X. COMPARISON OF CEMENT

No	Treatment	Fa	Comparison of costs Zeolit	Price (IDR)	Difference (IDR)
1	0.80 PC : 0.13 Z : 0.67 CaOH : 1.5 PS	160.00	238.00	278.00	75.50
2	0.80 PC : 0.10 Z : 0.10 CaOH : 1.5 PS	260.00	128.00	247.00	106.50
3	0.60 PC : 0.27 Z : 0.13 CaOH : 1.5 PS	340.00	476.00	561.00	-29.00
4	0.60 PC : 0.20 Z : 0.20 CaOH : 1.5 PS	500.00	350.00	475.00	57.00
5	0.40 PC : 0.40 Z : 0.20 CaOH : 1.5 PS	500.00	714.00	839.00	221.50
6	0.40 PC : 0.30 Z : 0.30 CaOH : 1.5 PS	760.00	532.00	722.00	338.50

From the calculation results from the above table with a reduction of 20% cement with 65% zeolite and 35% CaOH obtained cost difference between the use of cement with Zeoilt Activation of Rp. 44.50 cheaper Use of Cement. So It can be concluded from the second calculation table with the use of cement, Fly As and CaOH more efficient use of Fly Ash.

CONCLUSION

Based on the results of research on the effect of Portland cement replacement with Zeolite Against Strong Brick Pressed brick and analysis of test results it can be concluded as follows:

(1) The more powerful zeolite activation between the ratio of 1 zeolite: 1 Additional Material with 2 zeolites: 1 Auxiliary materials on the manufacture of lightweight brick is a ratio of 2 zeolites: 1 Supplementary Material.

(2) The use of cement, Fly As and CaOH is more efficient use of Zeolite and cement replacement with zeolite can be recommended because it is cheaper. Use of Activated Zeolite.

This study recomends to use preparation tools with very petrified to get the data in accordance with the desired. In addition, there will be necessary to get more accurate data then Required repetition of samples and more treatment. Also, the accuracy in the production process test and measurement of crushed voltage are requisite to identify the impact of data obtained.

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