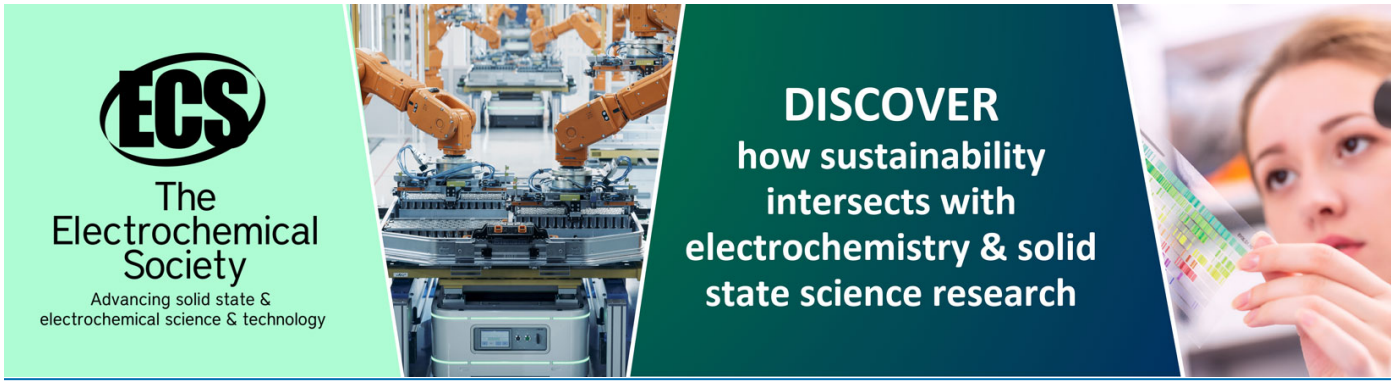
The use of glass powder in making batako



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The use of glass powder in making batako

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Abstract. Along with the increase in construction materials, innovation is needed to lessen the use of them, and one of them is by using cement [1]. In this research, it is reduced by glass powder; the reason for using it as the substitution of cement is that some chemical elements in cement are similar to those in glass powder such as SiO2, A12o3, Fe2O3, and CaO. The glass powder used was the one who passed sieve no. 100 and was hampered in sieve no. 200. It passed sieve no. 200 with its composition of 0%, 10%, 15%, 20%, 25%, and 30% from the volume of the use of cement. The specimen would treat within 28 days before the testing of compressive strength, water absorption, and tensile strength [2]. The variation which produced optimum result would mix with the foaming agent as the material for reducing the weight of the specimen. After that, the test of compressive strength, water absorption, and tensile strength on the installment of batako walls were done. The data analyzed by using SNI 02-0349-1989[3] reference about concrete brick for wall installment. The variation of 20% of glass powder passing sieve no. 200 gave optimum result. A specimen of the variation on glass powder of 20% which passed sieve no. 200 and the foaming agent was higher than the compressive strength of the specimen which used glass powder substitution of 0% of passing sieve no. 200 and foaming agent. The compressive strength of batako walls which used the batako construction with glass powder substitution of 20% of passing sieve no. 200 and the foaming agent was also higher than the compressive strength of the assaying object which used glass powder substitution of 0% of passing sieve no. 200 and foaming agent.

1. Introduction

Batako is a construction material which made of the mixture of cement, sand, and water which are put into a standard mold [4]. It used as an alternative substitution of brick for making walls. Today, building construction in Indonesia increases rapidly; therefore, the need for construction materials is also increasing. People in Indonesia use bricks as the material for installing walls. As the result of increasing development in construction, the need for bricks also rapidly increases; therefore, alternative materials for installing walls as the substitution of bricks are needed, and one of them is batako. Today, batako is used by many people because it is easily made, without being burned up like bricks. It has bigger than a brick so that installing walls will be faster. The effect is that many people now use batako instead of bricks which eventually there is a rising demand for batako in the market.

Batako constitutes a non-structural material for installing walls although it also has to fulfill the requirement for a standard of strength. It has the standard which has organized for the use and the making of batako which is embody, either directly or indirectly, in the Indonesian National Standard (SNI) 03-0349-1989 [3].

In this research, glass powder used as the substitution for cement. If it viewed from the similarity of chemical composition between cement and glass powder, it assumed that glass powder could used as the substitute of cement [5]. It has chosen because its chemical elements were similar to those of cement like silica (SiO2), Na2O, and CAO of 60%. It could see in the Table of Portland Cement Elements [4] and the Table of Glass Powder Elements (MIPA Chemistry Laboratory, USU). It expects that the use of glass powder can decrease the use of cement so that it will produce more efficient value.

Table 1. Portland Cement Elements

Elements	Portland Cements
SiO_2	20% - 25%
Al_2O_3	7% - 12%
Fe_2O_3	7% - 12%
CAO	60% -65%

Table 2. Glass Powder Elements

Elements	Glass Powder
SiO_2	97.0080%
Al_2O_3	0.1273%
Fe_2O_3	0.0026%
CAO	0.1084%

The glass is a material which is very difficult to decompose; its decomposition will take million of years. The use of glass powder as the material supplement for batako is aimed either to reduce raw materials of cement for making batako or the impact of environmental damage caused by glass waste. The reuse of glass waste is also one of the methods of reducing it in the environment [6]. It is recycled to become glass powder which will use as the substitution for cement in making batako. The goal of the research was to apply glass powder for using cement and foaming agent as the materials for reducing the weight of batako, to find out compressive strength, absorption, tensile strength, and compressive strength of wall installment.

2. Research Method

This used an experimental method which analyzed the composition of using glass powder in batako. It was aimed to find out the influence of glass powder as the substitution on the amount of using cement in water absorption, compressive strength, and tensile strength [7]. The research design in batako was as follows: testing object would make with the mixture ratio of 1Pc:7Ps in which glass powder as the substitution would put into by reducing some parts of the cement. The variation of the proportion was 0%, 10%, 15%, 20%, 25%, and 30% of glass powder of the weight of cement with two variations of glass grains: glass grains with ϕ passing sieve no. 200 and glass grains with ϕ sieve no. 100 and hampered on the sieve no. 200. The variation of the most optimum result would add with the foaming agent in the mixture of 1:20 (for water weight) to find out compressive strength, absorption, and compressive strength of batako wall installment. The making of the specimen and the procedure of quality testing was by the Indonesian National Standard (NSI) 03-0349-1989.

2.1 Materials

The materials for installing walls were Portland cement, sand, water, and glass powder. Portland cement was Type I Portland Cement [8] with the trade mark, Semen Padang, with the package of 50 kilograms per one sack. The sand used in this research taken from The Wampu River quarry, Binjai. The water which used as the mixing material was taken from the Laboratory of Engineering Materials, Civil Engineering Department, the Faculty of Engineering, University of Sumatera Utara.

2.2 Glass Powder

This research used glass powder which mixed with batako where it obtained from the waste of used drinking glass bottles which had been cleaned up, smashed to pieces, and crushed by pounding [5]. The glass was sifted with sieves no. 100 and no. 200.

3. Research Result

3.1 Batako Compressive Strength Testing

Batako used as the specimen was the one which had 28 day-treatment with two variations of glass powder supplement: glass powder which had passed sieve no. 100, was hampered on sieve no. 200, and sieve no. 200. The specimen was a cube which had been taken during the process of batako die casting and compressed until the maximum load was able to be held back by the batako cube. The result of the testing could see in Picture 1 below:

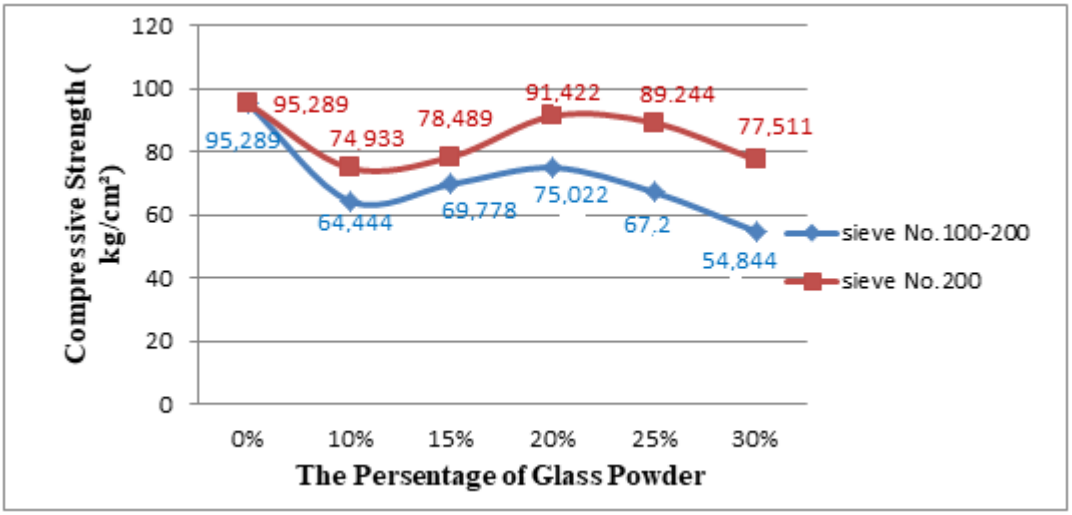

Figure 1. Graph of Compressive Strength

3.2 Tensile Strength Testing

The specimen in the form of briquette used as to test the tensile strength. It taken during the process of die casting which was given maximum load until the specimen broke. A 28 day-old specimen had two variations of glass powder supplement: glass powder which had passed sieve no. 100, was hampered on sieve no. 200, and sieve no. 200 The result of the testing could be seen in Picture 2 below:

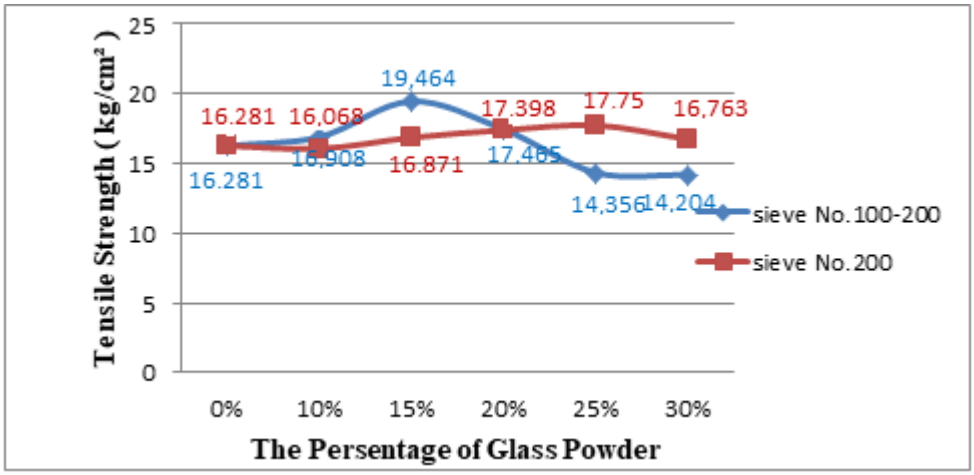

Figure 2. Graph of Tensile Strength

3.3 Absorption Testing

A specimen of 10 x 20 x 40 cm as a size of batako was used for the test. A 28 day-old specimen soaked within 24 hours; then it was weighed to get its weight when it was still wet. After that, it was put into an oven and let it be there for 24 hours to get its weight when it was dry.

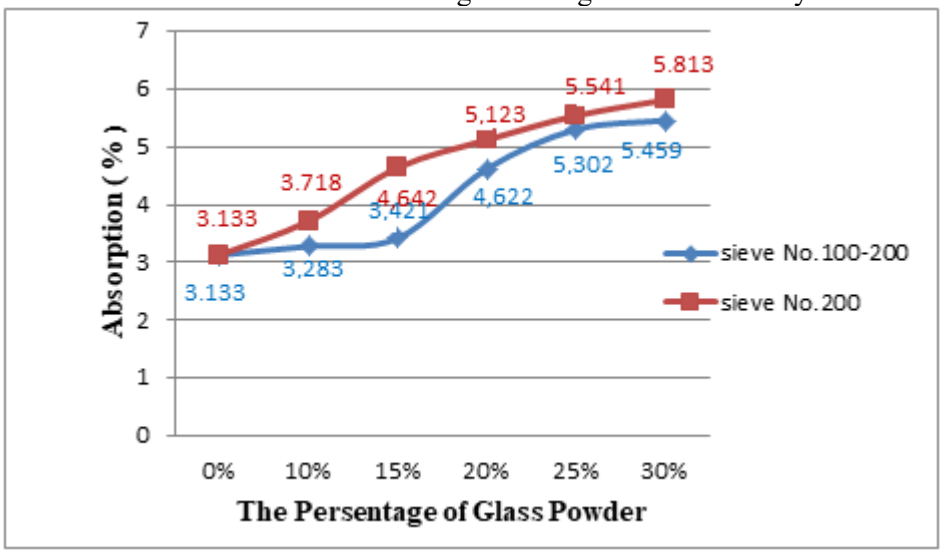

Figure 3. Graph of Absorption

3.4 Optimum Variation Testing (glass powder of 20% which passed sieve no. 200)

The result of assaying absorption, the compressive strength of the sample, cylinder, and wall installment, using glass powder substitution which passed sieve no. 200 with the composition of 0% and 20%, intended to reduce the volume of cement and foaming agent as the reductive substances of the sample load presented in Table 3, Table 4, Table 5 as follows:

Table 3. Comparison of the Mean Absorption of Batako Specimen and Glass Powder Substitution which Passed Sieve no.200 and Foaming Agent with Standard of Quality

No.	Glass Powder Supplement	Mean of Wet Weight (Kg)	Mean of Dry Weight (Kg)	Mean of Water Absorption (%)		Quality
				Assaying Object	SNI 03-0349-1989	
1	0% + Foaming Agent	11.788	10.158	11.715	25	1
2	20% + Foaming Agent	12.354	10.639	16.401	25	1

Table 4. Comparison of Mean Absorption of Cylinder Specimen and Glass Powder Substitution which Passed Sieve no. 200 and Foaming Agent with Standard of Quality

No.	Glass Powder Supplement	Mean of Wet Weight (Kg)	Mean of Dry Weight (Kg)	Mean of Water Absorption (%)		Quality
				Assaying Object	SNI 03-0349-1989	
1	0% + Foaming Agent	2.240	1.738	29.901	35	2
2	20% + Foaming Agent	2.612	2.366	11.404	25	1

Based on Table 3 and Table 4 for the value of water absorption in batako, it was found that there was the difference in water. The smallest mean of water was in the cylinder sample with the mixture

of glass powder of 20% and foaming agent of 11.404%, while the value of the largest average water absorption found in the cylinder sample by using the foaming agent of 29.901%.

Table 5. Comparison of Mean Compressive Strength of Batako Specimen and Glass Powder Substitution which Passed Sieve no.200 and Foaming Agent with Standard of Quality

No.	Glass Powder Supplement	Mean Dial Reading (KN)	Comp. Strength Area (cm^2)	Mean Comp. Strength (Kg/cm^2)		Quality
				Assaying Object	SNI	
1	0% + Foaming Agent	69.8	291.4214	23.952	21	4
2	20% + Foaming Agent	87.6	291.4214	30.060	21	4

Table 6. Comparison of Mean Compressive Strength of Cylinder Specimen and Glass Powder Substitution which Passed Sieve no.200 and Foaming Agent with Standard of Quality

No.	Glass Powder Supplement	Mean Dial Reading (KN)	Compressive Strength Area (cm^2)	Mean Compressive Strength (Kg/cm^2)		Quality
				Assaying Object	SNI	
1	0% + Foaming Agent	19.8	78.5	25.223	25	4
2	20% + Foaming Agent	3.7	78.5	40.382	40	3

Based on Table 5 and Table 6 for the value of compressive strength in batako and cylinder specimen, it was found that there was the difference in the value of compressive strength. The smallest mean of compressive strength was found in the batako sample with the foaming agent of 23.952 kg/cm^2, while the greatest value of compressive strength found in the cylinder sample with glass powder of 20% and foaming agent of 40.382 kg/cm^2.

Table 7. Comparison of Mean Compressive Strength in Walls with Glass Powder Substitution which Passed Sieve ø200 and Foaming Agent with Standard of Quality

No.	Glass Powder Supplement	Dial Reading (PSi)	Mean Compressive Strength (Kg/cm^2)		Quality
			Assaying Object	SNI 03-0349-1989	
1	0% + Foaming Agent	360	25.2	25	4
2	20% + Foaming Agent	650	45.5	40	3

Based on Table 7 for the value of compressive strength in batako walls, it was found that there was the difference in the value of compressive strength. The smallest value of compressive strength was found in batako walls with the foaming agent of 25.2 kg/cm^2, while the greatest value of compressive strength found in batako walls with the use of glass powder for cement substitution of 20% and foaming agent of 45.5 kg/cm^2.

4. Conclusion

From the result of the research, it could conclude that

1. Compressive strength (0%) was without glass powder substitution of 95.289 kg/cm^2 and included in the classification of batako level I.
2. Maximum compressive strength with glass powder substitution ø which passed sieve no. 200 found in the percentage of 20% at 75.022 kg/cm^2, included in the classification of Quality III.

3. Maximum compressive strength for glass powder substitution ø which passed sieve no. 200 found in the percentage of 20% at 91.822 kg/cm^2, included in the classification of batako level I, and minimum compressive strength found in the percentage of 10% at 74.933 kg/cm^2, in the quality II.
4. Tensile strength (0%) was without glass powder substitution of 16.268 kg/cm^2.
5. Maximum tensile strength for glass powder substitution ø which passed sieve no. 100 and hampered on sieve no. 200 found in the percentage of 15% at 19.464 kg/cm^2, and minimum tensile strength was found in the percentage of 30% at 14.205 kg/cm^2.
6. Maximum tensile strength for glass powder substitution ø which passed sieve no. 200 was found in the percentage of 25% at 17.75 kg/cm^2, and minimum tensile strength was found in the percentage of 10% at 16.068 kg/cm^2.
7. Water absorption for normal batako (0%) was without glass powder substitution of 3.133%.
8. Maximum water absorption for batako with glass powder substitution ø which passed sieve no. 100 and was hampered on sieve no. 200 found in the percentage of 30% at 5.495 kg/cm^2, and minimum absorption found in the percentage of 10% at 3.28%.
9. Maximum water absorption for batako with glass powder substitution ø which passed sieve no. 200 found in the percentage of 30% at 5.813%, and minimum absorption found in the percentage of 10% at 3.283%.
10. All specimen passed the classification of batako level I, based on absorption smaller than 25%.
11. Absorption of the batako specimen which used glass powder substitution of 20% with the foaming agent of 16.401% and cylinder of 11.404%, was included in the classification quality I.
12. The compressive strength of batako sample which used glass powder substitution of 20% and foaming agent of 30.060 kg/cm^2, was included in the classification of quality IV, while cylinder specimen with the compressive strength of 40.382 kg/cm^2, was in the quality III.
13. The compressive strength of batako walls which used glass powder substitution of 20% and foaming agent found in 650Psi in dial reading or 45.5 kg/cm^2.

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