Effect of Composition Variation and Size of Red Sand Grain to Concrete Quality

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Abstract. This study aims to determine the effect of variations in composition and size of red sand grains on the quality of concrete. Concrete is made in the form of cubes 15 x 15 x 15 cm with the standard SNI K-175 with a composition of 1: 2: 3 cement mixture with FAS 0.5. In this study, variations in the composition of red sand (fine aggregate) were made by 0%, 5%, 10%, 15%, 20% of the weight of the fine aggregate used and the variation of red sand grain size of 80 mesh, 100 mesh, 120 mesh. After the concrete is 24 hours old, the mold is opened and given the code number as desired and treated in a water bath. After going through the immersion period 28 days later the pressure strength was tested and the XRD test. From the results of the study obtained the mechanical properties of the maximum concrete pressure strength test at a composition of 5% along with a decrease in the size of the red sand grain size (80 mesh, 100 mesh, 120 mesh) with pressure forces of 31.9 MPa, 35.4 MPa, and 35.5 MPa, respectively. This goes beyond the force of pressure set by the Indonesian National Standard Agency. XRD testing on concrete after smoothing, from the results of the XRD test obtained elements such as SiO2, Ca (OH) 2, CaO and Ta2O5 show that the graph shows a high silicon intensity value. Addition of red sand fine aggregate has an impact on improving the quality of concrete (the strength of pressure from SNI k-175 becomes K-400).

Keywords: 80 mesh red sand, 100 mesh red sand, 120 mesh red sand, compressive strength, water absorption, XRD

1 Introduction

Red sand is excavated sand from Padang Bulan village, Kota Pinang Subdistrict, LabuhanBatu Selatan District, which has very fine grains and lighter weight than ordinary galan sand. This red sand is often used by the community as a road agency. In 1972 PT. AIR BAH uses this red sand as a road body by dumping this red sand and compacting it with cylindrical trucks. Until now the road is still strong and only eroded little by little every year. LabuhanBatu Selatan red sand is used as an ingredient in making concrete because it has ingredients such as SIO2 (Silicon Oxide), TaO2 (Tantalium Oxide), FeNi (Iron Nickel), Fe2C (Iron Carbide) and high red sand silicon intensity values [1]. In previous studies with X-ray diffraction and thermal characterization showing evolution in all time systems, in systems A and B no small SiO was present and sulfate had reacted fully to the amount revised almost 73% had been deposited into the hydration phase [2]. SiO2 is one of the chemical elements contained in Portland cement, so this element makes it possible to obtain a stronger concrete mixture [3].

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Research (Agustina, 2012) about the effect of adding red sand volume to rock celltan harbor to density, water absorption, and concrete compressive strength with variations used 50% red sand and 50% ordinary sand produced a compressive strength of 32 MPa. Research (Harahap, 2013) on the effect of red sand characterization on rock port on mechanical properties (SEM test, X-ray diffraction, impact test) of concrete, with 20%, 505 red sand variations, 70% of the fine aggregate used resulted in bending at 20% 16.4 MPa, at 50% at 18.6 MPa, and at 75% by 16.2%. Research (Nasution, 2017) about the effect of red sand grain variations on the southern port to increase the strength of concrete, obtained that the minimum compressive strength at the addition of 120 mesh is an average of 13.36 MPa, and from the test the absorption of water occurs a decrease in concrete with the addition of red sand on the size 80 mesh and 120 mesh which is 50%. It can be concluded that variations in sand grain size are more effective in reducing water absorption.

Based on the description above, the problem is that the aggregate bonds are not strong. To improve aggregate bonds there are several methods that can be done, including the method of the Indonesian National Standard (SNI), the American Society for Testing and Materials (ASTM), the American Association of State Highway and Transportation Offical (AASHTO). The most appropriate method used in this study is SNI 03-2834-2000 which refers to the making of K-175 concrete. Variations that affect the strength of the concrete pressure in terms of aspects of the size of the red sand grain size and composition of red sand, while other factors such as the way of compaction and maintenance during the hardening process are used in the ways of the Indonesian National Standard (SNI). The SNI used in this study are SNI 15-2049-2004 (Portland Cement) [4], SNI 03-2834-2000 (Procedures for making and maintaining concrete) [5], SNI 03-1974-1990 (Testing compressive strength) [6]. In this study the implementation is divided into several stages. The first stage of preparation, the stage of testing the material, the testing phase of the test object, the stage of data processing.

Based on the background description above, the researchers were interested in conducting research using LabuhanBatu Selatan red sand which varied 0%, 5%, 10%, 15% and 20% and ordinary sand 100%, 95%, 90%, 85% and 80% then the red sand is also varied the size of the granules with a variation of 80 mesh, 100 mesh, 120 mesh is expected to be smaller the size of the sand grains, the sand will be stronger with cement and water so as to improve the quality and strength of concrete.

2 Experimental.

2.1 Material

The materials used in this study are Portland type I cement from PT. MuliaSakti Perkasa, fine aggregates (red sand and ordinary sand), coarse aggregates, water. This red sand was obtained from PadangBulan Village in Kota Pinang sub-district, South Labuhan district.

2.2 Instrumentation

The equipment used includes an analytical balance sheet, bucket, measuring cup, cement spoon, compactor stick, screen sieve (80, 100, 120 mesh), concrete mold, molen. Pressure strength analysis was carried out with the Compress Testing Machine with a capacity of 2000

K Newton. Phase analysis and structure were carried out with XRD Shimadzu type with My Cu wavelength of 1.540600 Å with a speed (Scan speed) of 2.0000 deg / min.

2.3 Sample testing

1. Pressure strength testing

The well-printed concrete and the concrete top surface are made with a shovel so that the flat top surface after 24 hours is opened from the mold and put into the water for the wiring process (water absorption). This specimen is tested by a compression test machine after 7 days or 28 days of treatment and drying based on the strength level to be determined. The load must be applied gradually and in the right interval until the specimen has cracked. The strength of the concrete is obtained from the load by cracking the specimen divided by the surface area of the specimen [7].

2. X-Ray Diffraction

X-ray diffraction is used to characterize crystalline material in determining lattice parameters and crystal structures. The principle of this X-ray diffraction method is the interaction of electromagnetic waves to effect the intermediary effect by comparing the structure size and wavelength of radiation. The above conditions are met if:

$$2d \sin \theta = n\lambda$$

Where:

d = distance between two lattice fields

θ = the angle between the rays comes with the normal plane

n = number which is called the refraction order

λ = X-ray wavelength used.

The equation $2d \sin \theta = n\lambda$, is called the Bragg condition and the angle θ is called the Bragg angle for X-ray irradiation in the atomic plane separated at a distance of "d" and "n" = 1, 2, 3, 4 [8]..

3 Result and discussion

3.1 Strength of concrete pressure

Concrete pressure testing is carried out after 28 days from casting and soaking. The amount of concrete pressure is influenced by the composition of the constituent material and the attachment of the cement paste to the aggregate. The form of the test sample in this study is cube shaped 15 cm x 15 cm x 15 cm. The results of concrete pressure strength testing with variations in the composition of red sand 0%, 5%, 10%, 15%, 20% and variations in size of 80 mesh red sand grains, 100 Mesh and 20%.

From the table above it can be seen that the composition of 5% red sand is more optimal compared to other compositions, with the pressure strength rising linearly along with the decrease in the size of the red sand grains (80, 100, 120 mesh). For more details can be seen in the graphic below:

Table 1.of test results of the strength of concrete pressure 80, 100 and 120 mesh.

Red Sand (Mesh)	Sample Code	Average Surface Area (m2)	Load Press average (KN)	Pressure Power average (Mpa)
	A_{11}, A_{12}, A_{13}	0.0225	556.9	24.75
	B_{11}, B_{12}, B_{13}	0.0225	717.9	31.90
80	C_{11}, C_{12}, C_{13}	0.0225	777.9	34.57
	D_{11}, D_{12}, D_{13}	0.0225	621.4	27.62
	E_{11}, E_{12}, E_{13}	0.0225	522.7	23.23
	A_{21}, A_{22}, A_{23}	0.0225	546.3	24.28
	B_{21}, B_{22}, B_{23}	0.0225	796.6	35.40
100	C_{21}, C_{22}, C_{23}	0.0225	878.0	34.97
	D_{21}, D_{22}, D_{23}	0.0225	614.3	27.29
	E_{21}, E_{22}, E_{23}	0.0225	596.9	26.52
	A_{31}, A_{32}, A_{33}	0.0225	504.0	22.4
	B_{31}, B_{32}, B_{33}	0.0225	798.6	35.49
	C_{31}, C_{32}, C_{33}	0.0225	751.8	33.41
120	D_{31}, D_{32}, D_{33}	0.0225	613.4	27.26
	E_{31}, E_{32}, E_{33}	0.0225	453.4	20.15

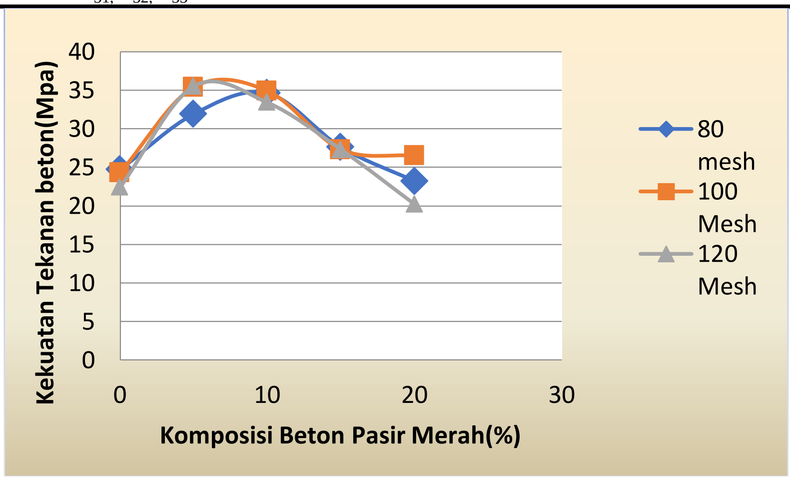

Fig 1. Graph of overall strength of concrete pressure on variations in composition and variation of red sand grains.

Figure 1.above shows that variations in composition and variations in butian size of red sand affect the value of the strength of the concrete pressure. 80 mesh red sand granules have maximum average pressure strength at 10% red sand composition which is 34.6 MPa while 100 mesh red sand granules have maximum average pressure strength at 5% red sand composition which is equal to 35.4 MPa and on concrete with a size of red sand granules 120 mesh has the maximum average pressure strength in the composition of 5% red sand which is 35.5 Mpa. This means that the composition of 5% red sand is a concrete mixture that is more optimal than the composition of 10% red sand, this can be seen from the results of testing the strength of concrete pressure which shows that the composition of 5% red sand has a linear increase in pressure strength along with the decrease in grain size. red (80 mesh, 100 mesh,

120 mesh) respectively: 31.9 Mpa, 35.4 Mpa and 35.5 Mpa. This is caused by the composition of 5% red sand can cover the cavities in the concrete so that the water trapped in the concrete is only a little which means it can shrink the porosity of the concrete so that it will increase the strength value of the concrete. While the addition of 10% red sand composition does not always experience an increase in the strength of the concrete pressure due to uneven mixing so that the mixture is not mutually binding.

Based on PBI 1971 it was found that K-175 - K <250 quality concrete had an average pressure strength of 15 - <20 MPa, while the concrete quality of K-250 - K <400 had an average pressure strength of 20 - <35 MPa. The data obtained in the study has a pressure strength of 18 <40 MPa using the concrete composition K-175 produced with medium quality concrete. This goes beyond the force of pressure set by the Indonesian National Standard Agency.

3.2 X-Ray diffraction

The data obtained were analyzed using the Match v1.10 software. The following are the results of diffraction patterns of concrete samples without red sand mixture (A22), with a size of 80 mesh red sand grains (C13), red sand granules with a size of 100 mesh (B23), concrete with a size of 120 mesh of red sand (B33)

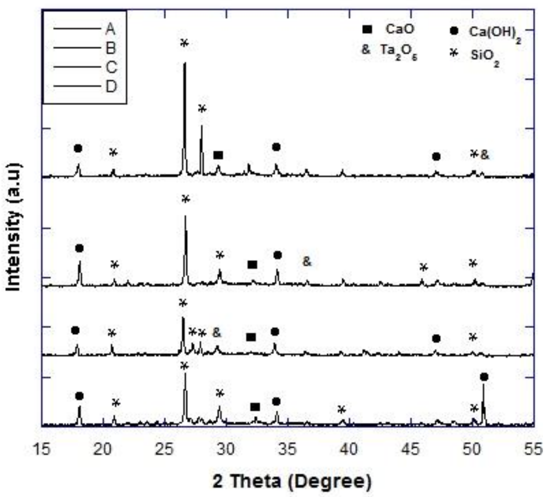

Fig 2. Diffraction patterns of samples (a) A22, (b) C13, (c) B23, (d) B33.

In the pattern of action Figure 2. (a) shows the formation of SiO2, Ca (OH) 2 phase, CaO. The optimum SiO2 phase is at an angle of 2θ = 26.65 ° with an intensity of 935.8 count second (cts) (which is given an asterisk) while the Ca (OH) 2 phase is at three angles, namely 2θ = 17.98 °, 2θ = 34.03 °, 2θ = 50.84 ° Ca (OH) 2 phase is an element that can have a negative impact on concrete [9]. At an angle of 2θ = 32.40 ° the CaO phase is formed. In the diffraction pattern of images 4.10 (b) the phases formed are SiO2, Ca (OH) 2, CaO, Ta2O5. The SiO2 phase experienced a peak shift of 0.21 to the left and the optimum at an angle of 2θ = 26.44 ° with an intensity of 994.1 the same thing also happened a peak shift in concrete B23, B33 respectively 2θ = 26.68 ° and 2θ = 26.65 ° and the intensity increases and the detected phase is SiO2 phase. The optimum Ca (OH) 2 phase at an angle of 2θ = 17.85 ° and experiencing a shift in concrete B23, B33 respectively 2θ = 18.00 ° and 2θ = 17.98 °, while the optimum CaO phase is at an angle of 2θ = 32.04 ° and also experiences a peak shift on concrete B23, B33 are 2θ = 32.19 ° and 2θ = 29.35 ° respectively. At an angle of 2θ = 29.28 ° the Ta2O5 phase is formed and in concrete B23, B33 also occurs the buds of the shoots become 2.5 = 36.58 ° and 2θ = 47.08 °. Based on Figure 4.10 it can be concluded that SiO2 has the greatest intensity compared to other elements contained in concrete. The effect of damage on concrete can be improved by adding 35-40% of SiO2-rich material [10]. In one study, it was confirmed that without the addition of SiO2 at the first high temperature the value of the strength of the concrete pressure decreases. And at the second critical temperature after the sample was evaluated with 35% -40% SiO2 achieved the best pressure strength results. [11]

The crystal structure formed in the samples A22, C13, B23, B33 is the same, namely in the SiO2 phase the crystal structure formed is hexagonal, in the phase of Ca (OH) 2 the structure of the crystal formed is hexagonal, and in the CaO phase the crystal structure formed is cubic , as for the Ta2O5 phase the crystal structure formed is orthorombic. To determine the volume fraction of SiO2, Ca (OH) 2, CaO, Ta2O5, the samples can be used below.

$$SiO_2(\%) = \frac{\sum SiO_2}{\sum SiO_2 + \sum Ca(OH)_2 + \sum CaO + \sum Ta_2O_5} \quad (1)$$

$$Ca(OH)_2(\%) = \frac{\sum Ca(OH)_2}{\sum SiO_2 + \sum Ca(OH)_2 + \sum CaO + \sum Ta_2O_5} \quad (2)$$

$$CaO(\%) = \frac{\sum CaO}{\sum SiO_2 + \sum Ca(OH)_2 + \sum CaO + \sum Ta_2O_5} \quad (3)$$

$$Ta_2O_5(\%) \frac{\sum Ta_2O_5}{\sum SiO_2 + \sum Ca(OH)_2 + \sum CaO + \sum Ta_2O_5} \quad (4)$$

This is presented in the comparison of the sample volume fraction of A22, C13, B23, B33.

Table 2. comparison of volume fractions in samples A22, C13, B23, B33.

No	Sample	Fraksi Volume (%)			
		SiO_2	$Ca(OH)_2$	CaO	Ta_2O_5
1	Sample 1 (A_{22})	50.29	44.73	4.98	-
2	Sample 2 (C_{13})	67.42	23.56	1.94	7.08
3	Sample 3 (B_{23})	69.12	24.96	2.54	3.36
4	Sample 4 (B_{33})	83.38	11.38	3.37	1.96

Table 2 shows that the volume fraction of SiO2 increases with the addition of red sand and decreases the size of sand grains on red sand. SiO2 is one of the largest chemical elements contained in cement and red sand, so that this element can make a stronger concrete mixture.

4 Conclusion

1. From the results of testing the strength of the pressure on the concrete with variations in composition and variations in the size of the red sand grains increase the pressure strength of the concrete. Optimal pressure strength and increase linearly in the composition of 5% along with a decrease in the size of the red sand grain size (80 mesh, 100 mesh and 120 mesh) with the strength of pressure in a row that is equal to 31.9 Mpa, 35.4 Mpa and 35.5 Mpa. This goes beyond the force of pressure set by the Indonesian National Standard Agency

2. From the results of the test, obtained the XRD test results there are elements of SiO2 (Silicon Oxide), Ca (OH) 2 (Calcium Hydroxide), CaO (Calcium Oxide), Ta2O5 (Tantalium Pentaoxide) graphs showing that silicon has the greatest intensity compared to other elements contained in concrete. The crystal structure formed is the same as in SiO2 phase and Ca (OH) phase 2, the crystal structure formed is hexagonal, in the CaO phase the crystal structure formed is cubic, and in the Ta2O5 phase the structure formed is orthorombic.**Table 1.** Table title. Table captions should always be positioned *above* the tables.

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