Characteristics of Concrete With Red Sand Mixture 80 Mesh Grain Size After Combustion

Mukti Hamjah Harahap[1*], Winsyahputra Ritonga[2], Nova Adelia[3]

[1] Physics Department, Medan State University, Medan, Indonesia

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Corresponding Author:
Author Name :
Mukti Hamjah Harahap
Winsyahputra Ritonga
Email :
mhfis08@gmail.com
winsyahputra@gmail.com

DOI:

Phone : +6285922254620

Abstract: Research has been done on the Characteristics of Concrete with a Mix of Red Sand Grain Size 80 Mesh Post-burning. This study aims to determine the characteristics of concrete with a mixture of red sand grain size 80 Mesh Post-burning on the compressive strength, porosity and structure of the concrete. The test object is a cube of 15 cm x 15 cm x 15 cm with concrete quality K-225. In this study, variations in the composition of 80 mesh size red sand were made of 0%, 2%, 3% and 4%. After the concrete is 24 hours old, the mold is opened and given a sample code and treated in an immersion water bath. After going through an immersion period of 28 days, the concrete was burned in an oven with temperature variations of 400°C, 550°C, 700°C and 850°C and tested. The test methods used are compressive strength, porosity and Scanning Electron Microscope Energy Dispersive X-Ray (SEM-EDX). From the test results obtained the maximum average compressive strength obtained in concrete with a mixture of red sand of 4% with a temperature of 550°C. From the results of the porosity test, there was a decrease in the concrete with the addition of red sand by 4%. From the results of the SEM test, the concrete structure with a mixture of red sand has fewer and smaller cavities. From the results of the EDX test on concrete with a mixture of red sand, Calcium (Ca) and Stibium (Sb) elements have increased intensity when compared to normal concrete. From the XRD test results obtained elements - elements SiO_2 (Silicon Oxide), $Ca(OH)_2$ (Calcium Hydroxide) and CaO_3 (Calcite) with the highest intensity is SiO_2.

Keywords : Red Sand, Post Burn, Porosity, Compressive Strength, SEM- EDX

Introduction

Concrete as a construction material has several advantages, including the ease of casting required by buildings and its ability to withstand heavy loads [1]. Compared to other materials, concrete is a building material that is relatively fire resistant. Because concrete is a material with low thermal conductivity, it can inhibit heat transfer to the concrete structure. Combustible concrete does not cause fires but absorbs heat and generates excessive heat which changes the microstructure of the concrete. The occurrence of a rather high temperature change, such as a fire, affects the concrete structure. A common symptom of construction fires is the surface of the structure is blackened or charred due to the high flame temperature, which affects the quality/strength of the concrete structure. use the structure. However,

The results of Putri's research [4] on concrete with a mixture of red sand, compressive strength with variations in composition and variations in the size of the red sand grains increase the compressive strength of concrete, but the results obtained have not found linearity. The optimum compressive strength is found in the red sand composition of 4% with a grain size of 80 mesh which is 32.3 MPa. The compressive strength data obtained has reached K-400 from K-225. This exceeds the strength of the pressure set by the Indonesian National Standards Agency.

The results of Pertiwi's research[3] show that concrete after burning with heating to 600°C causes a residual strength of less than or below 60%. This condition indicates that concrete that has been fired or heated above 600°C is unfit for reuse. At 400°C concrete firing, concrete strength of more than 35 MPa indicates a residual strength of more than 60%. This condition indicates that concrete that has been fired or heated at a temperature of less than 400°C is suitable for reuse, but with construction improvements.

The results of Ahmad's research [10] showed that in concrete of K 225 quality the compressive strength of concrete decreased with increasing temperature. Concrete that had been heated at a temperature of 200°C, the average compressive strength remained 85.83% of normal concrete. If burned to a temperature of 400°C, the average compressive strength remains 58.40%. This strength will continue to decrease until the remaining 35.08% at 600°C.

Based on the background described above, the problem in this study is the effect of temperature on the compressive strength of concrete due to combustion with variations in the composition of the addition of red sand and changes in the characteristics of the concrete affected by changes in temperature.

The goal achieved in this study was to determine the effect of temperature on the characteristics of post-combustible concrete (compressive strength, porosity and material elements).

Method

The method used in this study is an experimental study that refers to the quality of K-225 concrete. To determine the characteristics of post-combust red sand mixed concrete, compressive strength, porosity, Scanning Electron Microscope Energy Dispersive X-Ray (SEM-EDX) and X-Ray Diffraction (XRD) tests were carried out. The stages of the research are as follows:

Material Preparation

At this stage all the materials needed such as Type I Portland cement, sand, crushed stone, water and red sand are prepared in advance. In accordance with SNI standards [5] the mass ratio of the materials is 1 cement : 1.9 sand : 2.8 gravel with a FAS of 0.5. To find out the mass of each material, a mix design calculation is carried out using the density of the material used. The red sand used in this study has a composition variation of 0%, 2%, 3% and 4%.

Manufacture of Test Objects

At this stage, mixing all the ingredients is done manually with a shovel. First, the sand that has been added to the red sand is mixed with crushed stone until it is evenly distributed, then the cement is mixed into the mixture. Second, water is added little by little to the mixture with continuous stirring. Finally, the mixture is put into a cube mold of (15x15x15) cm. Then the surface is leveled and left for 24 hours.

Maintenance

At this stage the treatment is carried out by putting the sample into the soaking tub and then letting it sit for 28 days in the soaking tub. After soaking for 28 days the samples were taken out and dried for one day.

Sample Burning

Prior to testing, the samples were first burned in a furnace with temperature variations of 400°C, 550°C, 700°C and 850°C.

Testing

After the combustion stage is carried out, then the compressive strength, porosity, SEM-EDX, and XRD tests are carried out.

a. Strong Press

To determine the compressive strength of concrete, it is necessary to carry out tests that refer to SNI standards [6]. The tool used to test the compressive strength is the Compression Testing Machine (CTM).

b. Porosity

to determine the percentage of air voids from the sample. The tools used in this test are scales. The formula used is as follows

$$Porositas = \frac{M_{ssd} - M_b}{V \cdot \rho_{air}}$$

Mssd = Masssurface dry of test object (kg) Mb = Masspost-burn test object (kg)

V = Volumestest piece(m3)

ρ_{air} = density of water (kg/m3)

c. SEM-EDX (Scanning Electron Microscpe Energy Dispersive X-Ray)

To find out the microstructure of concrete, a Scanning Electron Microscope (SEM) test was carried out. This test is also carried out for surface examination and analysis which contains pore sizes in concrete samples.

d. XRD (X-Ray Diffraction)

To determine the phase angle, volume fraction, and crystals formed in the sample, X-Ray Diffraction (XRD) testing was carried out.

Result and Discussion

Compressive Strength Test

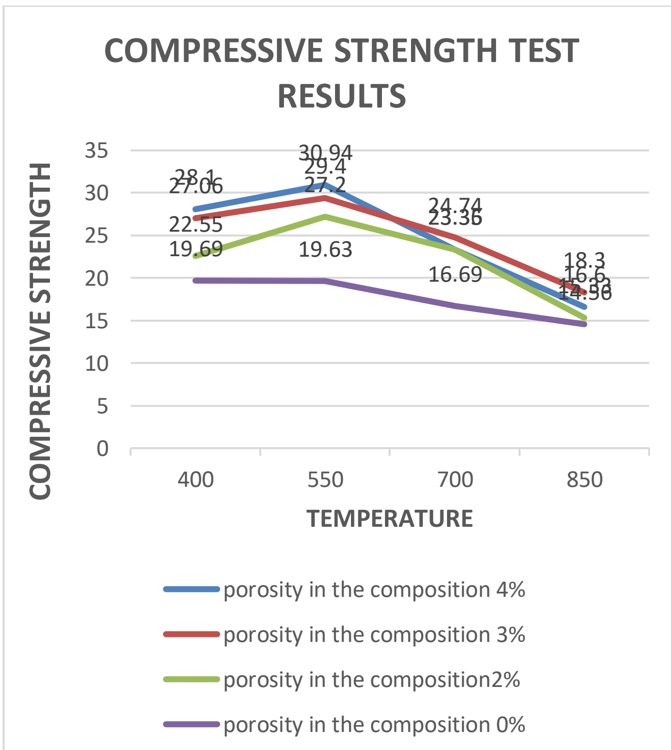


Figure 1. Graph of Comparison of Concrete Compressive Strength with Temperature Variations and Composition Variations

Based on Figure 1 above, at 400°C the optimum compressive strength is in concrete with 4% red sand mixture of 28.1 Mpa. At 550°C the optimum compressive strength is in a 4% red sand mixture of 30.94 MPa. At 700°C the optimum compressive strength is in a 3% red sand mixture of 24.74 MPa. At

850°C the optimum compressive strength is 18.3 Mpa in 3% red sand mixture. These results indicate that the 4% red sand mixture is the optimal mixture for concrete because at 550°C the sample has the most optimal compressive strength.This happens because the composition of 4% red sand is able to cover the voids in the concrete, only traps a little water in the concrete and increases the durability of the concrete.

Based on Putri's research [4] regarding red sand mixed concrete with a composition of 0%, 2%, 4%, 5%, and 6.5% and variations in grain size of 80 mesh, 100 mesh, and 120 mesh, the results of the highest compressive strength test values were in the composition 4% at 80 mesh size. In this study the concrete was not burned. To see the comparison of the compressive strength of concrete before and after burning it is presented in the following table.

Table 1. Comparison of Concrete Compressive StrengthBefore and After Burning

Composition	*Pressure Strength(MPa)*				
	Without Burning	400° C	550° C	700°C	850°C
0%	25.37	19.69	19.63	16.69	14.56
2%	27.98	10:55 p.m	27.20	23.36	15.33
4%	32.30	28.10	30.94	23.35	16.60

Based on PBI[7] it is known that concrete of quality K-175 – K<250 has an average compressive strength of 15
- <20 MPa, while concrete of quality K-250 – K<400 has a compressive strength of 18 - <35 MPa. The data obtained in this study has a compressive strength of 18 - <35 MPa using the K-225 concrete composition. This exceeds the strength of the pressure set by the Indonesian National Standards Agency.

Porosity

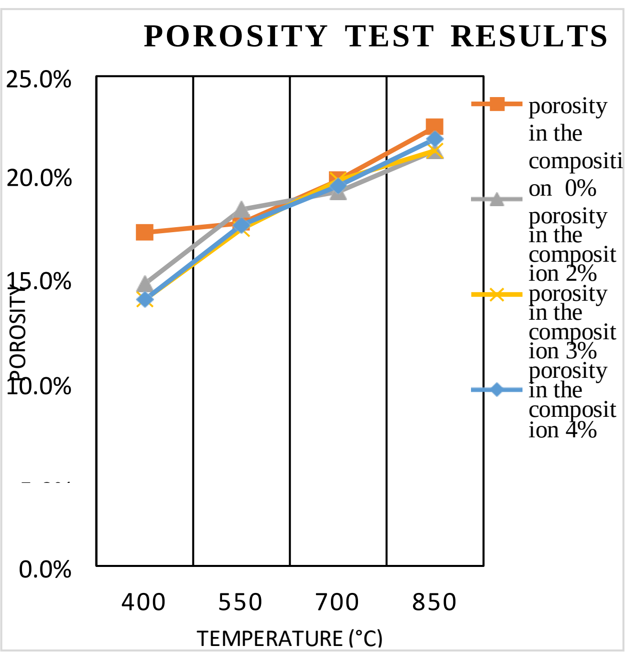


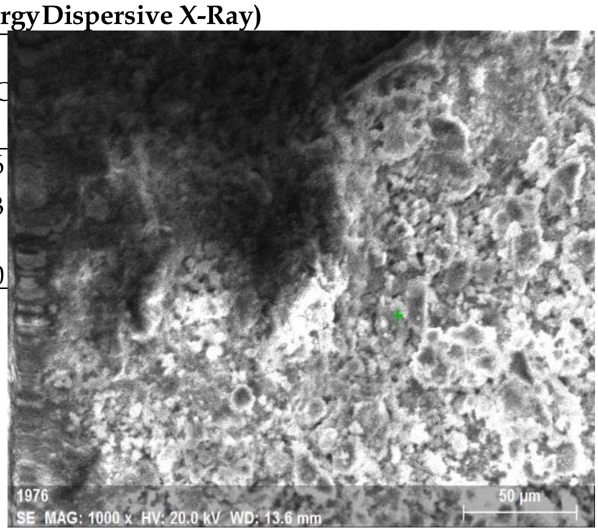
Figure 2. Graph Comparison of Concrete Porosity with Temperature Variation and Composition Variation

Concrete with a minimum porosity level will last longer than concrete with a maximum porosity value. From the graph in Figure 2 it is found that at 400°C the minimum porosity value is in a mixture of 4% and 3% of 13.6%. at 550°C the minimum porosity value is in a 3%

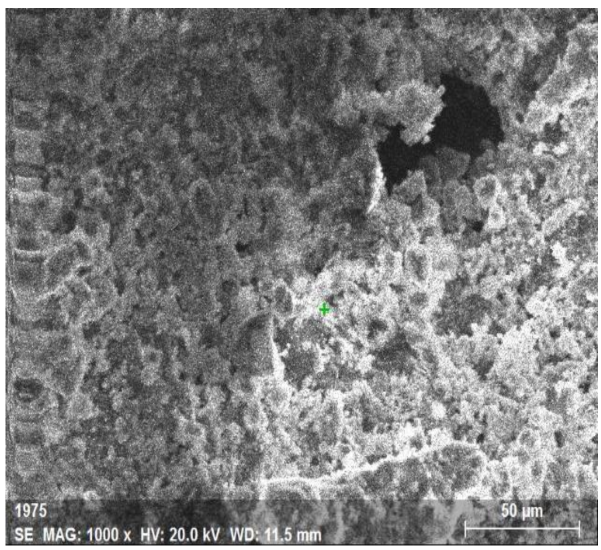
mixture of 17.2%. At 700°C the minimum porosity value is in a 2% mixture of 19.10%. and at 850°C the minimumporosity value is in a mixture of 3% and 2% of 21.2%.

From these results, it can be seen that red sand can reduce the porosity value of concrete. This is because the smaller grains will fill the pores between the larger grains, so the pores are getting smaller and the concrete has high compressive strength and small porosity [8].

SEM-EDX (Scanning Electron Microscope EnergyDispersive X-Ray)

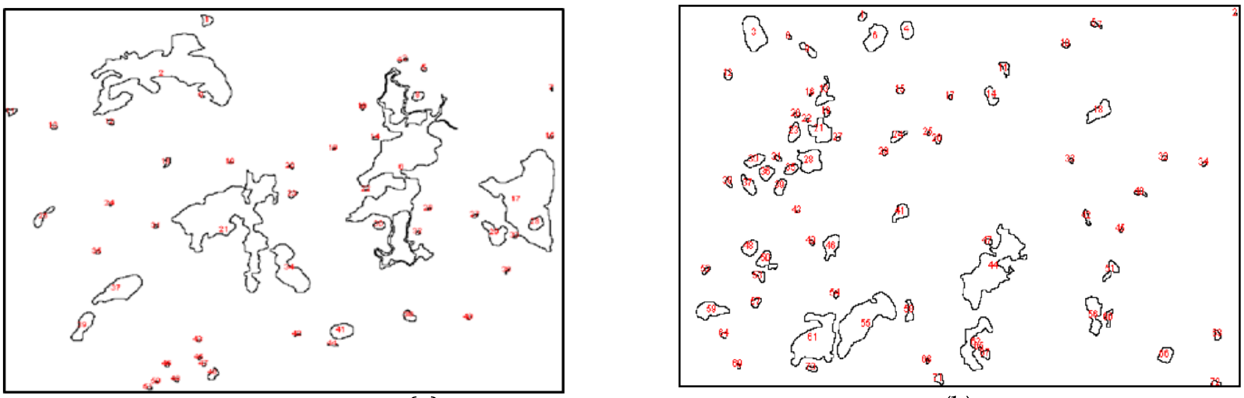


(a)



(b)

Figure 3. Photo of SEM test results on concrete samples
(a) Concrete mixed with red sand 0% at 550℃, (b) Concrete mixed with red sand 4% at 550℃

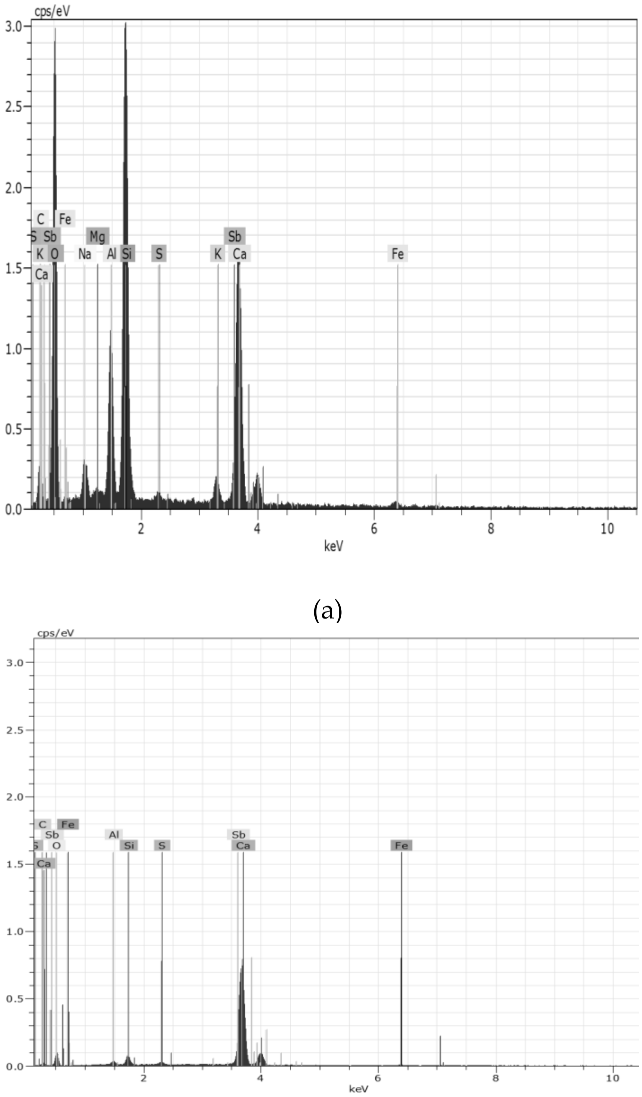


(a) (b)

Figure 4. Photo of pore analysis on a concrete sample (a) Concrete mixed with red sand 0% at 550°C, (b) Concretemixed with red sand 4% at 550°C

Pore analysis of the mixed particle positions in the concrete sample is shown in Figure 4. The above shows that the pores in images (a) and (b) appear to have different pore arrangements. In this morphology, the average pore sizes in figures (a) and (b) are 296,020 nm and 148,514 nm, respectively.

This shows that red sand can fill the spaces in the concrete which causes the pores to shrink and improves the quality of the concrete. The effect of temperature also affects the pores formed in concrete.



(a)

(b)

Figure 5. Characterization of EDX (a) 0% red sand mix concrete at 550°C, (b) 4% red sand mix concrete at 550°C

It can be seen in the table above, that the concrete without red sand mixture which is fired at 550°C contains the elements Ca, O, Sb and Si respectively 15.16%, 53.73%, 5.34% and 14.14%. And in concrete mixed with 4% red sand and fired at the same temperature, the elemental content of Ca, O, Sb and Si were 49.61%, 23.69%, 21.69% and 2.20%, respectively. Ca and Sb content increased with the addition of red sand to the concrete mixture at 550°C. The Ca element is one of the main elements that supports the strength of concrete [9].

XRD (X-Ray Diffraction)

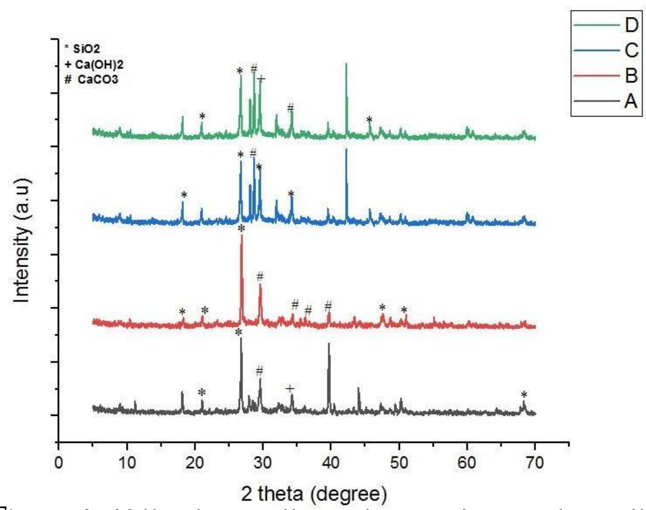


Figure 6. Diffraction pattern of concrete samples with 4% red sand composition at (A) 400°C(B) 550°C (C) 700°C and (D) 850°C

Table 2. Phase Angle Shift

Sample Code	formed phase		
	SiO2	Ca(OH)2	CaCO3
A	26.55	34.05	29.39
B	26.94	-	29.70
C	26.55	34.07	29.27
D	26.58	28.50	29.38

The same crystal structure formed in samples A, B, C,and D, namely the SiO2, Ca(OH)2, and CaCO3 phases which have a hexagonal crystal structure.

Table 3. Comparison of Volume Fractions

Sample Code	Volume Fraction (%)		
	SiO2	Ca(OH)2	CaCO3
A	57.2	13.2	29.6
B	69.7	-	30.3
C	76.7	16.4	6.9
D	47.9	14.2	37.9

From Table 3 it can be seen that the volume fraction of SiO2 is the largest compound. These compounds are compounds that make concrete stronger. According to Dewi's research [11] the addition of silica elements with high levels and quantities can increase the compressive strength value of concrete.In addition, SiO2 is an oxidized silica which, when heated, will melt and fill the emptyspace caused by evaporation from the combustion process [12].

Conclusion

Of all the samples, the best composition for post-combustible concrete at various temperatures was obtained from a red sand mixture of 4% with a compressive strength of around 30.94 MPa. The compressive strength results obtained showed an increase from standard K-225 to standard K-350 at 550°Cand decrease occurred at 850°Cbut still on the threshold of the K-225 standard.

In the post-combustion concrete porosity test with a mixture of red sand, the composition that has the smallest porosity value is found in concrete with a mixture of 4% red sand of 13.0%.

From the results of the XRD test, it was found that the elements SiO2 (Silicon Oxide), Ca(OH)2 (Calcium Hydroxide) and CaO3 (Calcite) with the highest intensity are SiO2 compared to other elements contained in concrete, the addition of silica (SiO2) with high content and quantity can increase the compressive strength of concrete.

Acknowledgments

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