Analysis of the Structure of Ceramic Materials of Clay, Mount Kelud Volcanic Ash and Sea Water

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Abstract. Based on the durability of ancient roman buildings that are 2000 years old and are always exposed to sea waves. In which there is a mixed reaction of volcanic rock with seawater. Indonesia has many active volcanoes, this is because Indonesia is located at the confluence of the Eurasian and Indo-Australian tectonic plates. One of the mountains formed in the area where the plates meet is still active, the mountain is Mount Kelud. Mount Kelud is a volcano in the province of East Java, Indonesia, which is classified as active. The existence of volcanic ash resulting from the eruption of Mount Kelud is quite potential as a ceramic material. So the purpose of this research is to make a ceramic construction made from clay, volcanic ash from Mount Kelud and sea water by the method of die pressing and sintering at a temperature of 1000°C. So it can be known how the physical properties, mechanics and especially the crystal structure formed from ceramic samples. The results of the research that has been carried out are that the highest density value is in the composition of a mixture of 50% volcanic ash and 50% seawater, the highest compressive strength value is also found in the composition of a mixture of 50% volcanic ash and 50% seawater, and from the XRD results, the structure The crystal formed is hexagonal with the phase formed is SiO2.

1. Introduction
Ceramics are basically very close to everyday life. Generally, in the manufacture of ceramics, it can be done by varying the ceramic raw materials and the shape of the granules added with water or without water, pressing and sintering. One of the building materials that can be used as an absorption wall is ceramic. Ceramic comes from the Greek "keramos" which means something that is burned from clay minerals that are dried in the sun and hardened by burning at high temperatures. The material for making ceramics in the form of clay is one of the materials whose uses are very beneficial for humans because the materials are easy to obtain and the finished products made of clay are very wide. So that in this study a building material was made in the form of construction ceramics. The mixed ingredients in the manufacture of this construction ceramic are Kelud mountain dust and sea water. In this study, a ceramic material was made as a raw material for clay soil by mixing Kelud mountain ash and sea water with conventional compression molding techniques. So that the mixture is expected to produce a ceramic material that has good physical and mechanical properties, characterization tests for construction ceramics include: physical properties (density, porosity and shrinkage), mechanical properties (compressive strength and hardness), surface morphology using SEM-EDX (Scanning Elecron Microscopy-Energy Dispersive X-Ray Spectrometer) and XRD (X-Ray Diffraction). The final results of this research are expected to be applied as construction ceramics or porous ceramics that are beneficial to the community and have economic value.
2. **Method**
First, the materials were collected (clay, Kelud mountain ash and sea water), then the clay was dried under the hot sun to remove its moisture content for 3 days. Then, the clay was ground or crushed using a mortar and mortar to make it smoother and then filtered the clay and Kelud mountain ash with a size of 200 mesh. Then the material is weighed with a total weight of 20 grams and then homogenized. After that it is printed on a cylinder size with a diameter of 5 cm and a thickness of 1 cm, the Die Pressing method. Then the sample was dried for 3 days to remove the moisture content and then burned at a sintering temperature of 1000°C with a holding time of 3 hours. After that the samples were cooled and tested on ceramic samples.

3. **Result**

3.1 **Volume Decrease**

![Figure 1. Volume Shrinkage vs Compotion Chart](image1)

The volume loss graph shows that the burn loss value for each variation of the construction ceramic mixture has increased and decreased. The higher the sintering temperature, the ceramic will undergo a high compaction process so that it will produce a relatively high volume loss value. The lowest burn loss value was owned by sample L20 of 8.64%, while the highest value of burn loss was owned by sample L90 of 26.30%.

3.2 **Porosity**

![Figure 2. Porosity vs Composition Chart](image2)
Low porosity indicates that the material has a solid alloy because the pores in the material are relatively lower, the L20 sample has the most optimum level of porosity.

3.3 Density

![Density vs Composition Graph](image)

**Figure 3.** Density vs Composition Graph

Density test data on samples using seawater solvents show that the L50 sample has the highest density. An increase in density indicates that the mass density of the sample is getting higher in each volume, or in other words the L50 sample has the strongest bond between particles because the mass density reaches its optimum point.

3.4 Hardness

![Compressive Strength Graphics vs Composition](image)

**Figure 4.** Compressive Strength Graphics vs Composition

From the test data on the compressive strength of the sample, the lowest compressive strength was found in the L70 sample with a value of 33.95 MPa, while the highest compressive strength was found in the L50 sample with a value of 77.83 MPa.
3.5 XRD

In the picture above, which displays the XRD diffraction pattern in the sample using seawater, it shows the same crystalline phase, namely SiO2, according to the peaks formed. However, there are some differences between the diffraction patterns formed, where the L10 sample produces several new peaks when compared to the L0 sample. Based on the data sheet obtained, the new peaks that appear still show the SiO2 phase. As the concentration of Mount Kelud ash decreases to 50% at L50 to 90% in the L90 sample, the peaks formed have decreased in intensity, this indicates that a reduction in the ash concentration of Mount Kelud by more than 10% will reduce the level of crystallinity in the sample.

As well as the crystal size can be determined using the Debye Scherrer equation. The largest crystal size was found in the sample L0 which was 162.57 nm, while the L10 sample had a significant decrease in crystal size to 33 nm. In sample L50, the crystal size increased again with the decrease in the concentration of Mount Kelud ash and along with the increase in the concentration of seawater. The crystal size again decreased in sample L90 with a relatively low decrease.
Table 1. Crystal size in ceramic samples using seawater

| Sample | Crystal size (nm) |
|--------|------------------|
| L0     | 162.57           |
| L10    | 33               |
| L50    | 45.44            |
| L90    | 41.23            |

4. Conclusion
The size of the crystal atoms in clay-based ceramics has been investigated with variations in the composition of Mount Kelud ash with seawater or aquadest of L0: 162.57 nm; L10: 33 nm; L50: 45.44 nm and L90: 41.23 nm.

The composition of Mount Kelud ash with seawater or aquadest in the sample can affect the physical and mechanical properties of ceramics. The optimum physical properties are indicated by the lowest porosity value, namely 18.03% in sample L80, while the optimum density is obtained at 2.14 x 103 Kg/m3 which is the highest density possessed by sample L50. The mechanical properties of the L50 sample also showed an optimum value of 77.83 Mpa.

The crystal structure and morphology of the sample have a significant influence on the mechanical strength of the ceramic. The crystal structure with hexagonal shape has relatively more optimal mechanical strength when compared to the monoclinic structure, this is because the crystal bonds in the hexagonal structure are stronger so that it has an impact on increasing the morphological structure formed.

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