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CHEMICAL CHARACTERISTICS OF VOLCANIC ASH IN INDONESIA FOR SOIL STABILIZATION: MORPHOLOGY AND MINERAL CONTENT

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ABSTRACT: Indonesia region which has approximately 83 active volcanoes are a source of wealth of this region. The last five years, active volcanoes in Indonesia, Mount Merapi, Kelud and Sinabung eruption issuing experiencing the abundant material. A volcanic ash from the eruption of volcanic material can be used as soil stabilization. Volcanic ash is a pozzolanic material which can be used as a soil stabilizing agent. However, it should be done the first step characterization testing of chemical properties, mineralogy and morphology volcanic ash from different sources. Accordingly, this paper presents results of a test chemical characteristics, mineralogy and morphology of volcanic ash in Indonesia derived from the Mount Merapi, mount Sinabung and mount Kelud using Scanning Electron Microscopy (SEM) and X-ray Diffraction (XRD). Based on specific gravity test results on some volcanic ash in Indonesia, it can be classified in light material category. Merapi, kelud and Sinabung volcanic ash has a different shape morphology. Merapi is a form of fibrous glass particles Contain elongated vesicles. While, the texture Sinabung is a berry-like glass particles show angular blocky forms and texture kelud are sponge like glass. The SEM-EDS test obtained Si content of the three types of volcanic ash ranges 45-60% and elements of Al ranges 14-20%. This can be a reference for further research on the utilization of materials of volcanic ash as a pozzolanic material in soil stabilization.

Keywords: Volcanic Ash; Morphology, Mineralogy

1. INTRODUCTION

Indonesia is an archipelago which is crossed by the equator and located between the continents of Asia and Australia and between the Pacific Ocean and the Indian Ocean. It is surrounded by the Eurasian, the Indo-Australian and the Pacific plate. In addition, this region is also the path of the Pacific Ring of Fire (Ring of Fire), which is a series of lines of active volcanoes in the world. Most of Indonesia region has approximately 83 active volcanoes which are owned natural wealth of this region.

Volcanic eruptions in Indonesia occurred several times in recent years. Several record the largest eruption in Indonesia, are the eruption of Mount Merapi, Which is located on the border of Sleman in Yogyakarta and district Magelang Central Java, in 2010. Mount Sinabung, located in Karo North Sumatra in January 2014 and Mount kelud located in Kediri, East Java,February 2014.

The eruption spews out volcanic material as abundant volcanic ash which becomes the natural resources that can be utilized for many interests. One of which, namely as a material in the field of geotechnical soil stabilization. Results volcanic material are contain chemicals and minerals varies depending on the rock formation. Volcanic ash is a volcanic materials consist of fine sized material falls at a distance in the hundreds and even thousands of km from the crater because it can be affected by the wind with a diameter of less than 2 mm.

Volcanic ash derived from different sources has different characteristics based on chemical properties, mineralogy and Morphology. Accordingly, in this paper presents the results of a test chemical characteristics, mineralogy and morphology of volcanic ash in Indonesia derived from the Mount Merapi, Mount Sinabung and Kelud using Scanning Electron Microscopy (SEM) and X-ray Diffraction (XRD).

2. CLASSIFICATION, MINERALOGY, CHEMICAL COMPOSITION OF VOLCANIC ASH.

The characterization and classification of volcanic ash has commonly been made on the basis of the mineralogical composition. However, there may be significant contradiction between the classification of volcanic ash based on mineralogical properties as compared to chemical composition (Shoji et al., 1975; Yamada et al., 1975). Because of the difficulty in classifying volcanic ash by mineralogy properties, Shoji et al. (1975) proposed a classification into one of five rock types based on total silica content: rhyolite, dacite, andesite, basaltic andesite, and basalt (Table 1).

The primary mineral composition of volcanic ash is typically characterized by first dividing

minerals into light (specific gravity [SG] < 2.8-3.0) and heavy (SG > 2.8-3.0) mineral categories. Light minerals dominate in volcanic ash with an abundance mostly ranging between 70 and 95% (Shoji, 1986; Yoshinaga, 1988). Within the light mineral category, the relative abundance generally follows: non colored volcanic glass >> plagioclase feldspars >> silica minerals (quartz, cristobalite and tridymite) ≈ mica.

The type of minerals in volcanic ash deposit depends on the chemical content of magma. Some minerals almost always contain Si, Al, K, Na, Ca, Mg and Fe. Yamada and Shoji (1983) divided volcanic glass particles (100-200 μm size range) into four categories: sponge-like glass particles are highly vesicular suggesting that these glasses were produced by violent explosions of highly viscous magma; fibrous glass particles contain elongated vesicles; curved platy particles are produced by the pulverization of glasses having relatively large vesicles; and berry-like glass particles show angular blocky or sub-angular blocky forms with low vesicular and contain crystallizes of plagioclase. Non-colored volcanic glass consists mainly of sponge-like particles, which are siliceous and highly vesicular. In contrast, colored volcanic glass in basaltic andesite and basaltic ashes contains only berry-like particles.

Table 1: Classification Volcanic Ash Based on Total Silica Content (Shoji et al, 1975)

Rock type	Rock	Total SiO2 %
Felsic	Rhyolite	100-70
(acidic)	Dacite	70-62
Intermediate	Andesite	62-58
	Basaltic Andesit	58-53.5
Mavic	Andesit	53.5-45
(Basic)		

3. RESEARCH METHODOLOGY

The third type of volcanic ash specific gravity determined in accordance with D854-02 In order to determine phase mineralogy and mineral composition of the samples contained in the volcanic ash carried Diffraction X-ray analysis (XRD) using copper radiation. Representative samples of volcanic ash through sieve No. 200 (0.075 mm). Steel slag particles are also examined under a scanning electron microscope (manufactured by Jeol, Model Personal SEM), to characterize the shape, angularity and surface texture.

3.1 Material and Equipment

In this research use several Volcanic ash material, outcome of volcanic eruption fire in Indonesia is Mount Merapi, Mount Sinabung and Mount kelud that passes sieve No. 200. The tool used to determine the chemical properties and morphology using Scanning Electron Microscopy (SEM)-EDS type JED-2300 tested in LPPT UGM. Volcanic ash mineralogy using X-ray Diffraction (XRD).

4. RESULT AND DISCUSSION

4.1 Specific Gravity

Volcanic ash samples used in this research are from three locations volcano. Specify gravity of volcanic ash samples after the test in the laboratory can be seen in Table 2 as follows:

Table 2: The Specific Gravity of volcanic ash

The Location of Volcanoes	Specific Gravity
Mount Merapi	2.64
Mount Kelud	2.57
Mount Sinabung	2.57

Based on test results specific gravity on some volcanic ash in Indonesia, it can be classified in light material category. Light minerals dominate in volcanic ash with an abundance mostly ranging between 70 and 95% (Shoji, 1986; Yoshinaga, 1988). Within the light mineral category, the relative abundance generally follows: non colored volcanic glass >> plagioclase feldspars >> silica minerals (quartz, cristobalite and tridymite) ≈ mica**.**

4.2 SEM Analysis

Scanning Electron Microscopy (SEM) is used to determine the structure of surface morphology of thin layers materials Volcanic Ash. Appliances working principle is the interaction between the electron beam that is imposed on the sample and the sample atoms. This form of SEM surface morphology of crystals formed. Based on the results of SEM at 2000 times magnification type texture on Merapi Volcanic ash is fibrous glass particles contain elongated vesicle. Type texture freely tiny particles adhere to each other or to the surface of large particles. broken glass and some blobs have irregular edges and jagged (Fig. 1).

Figure 2 shows type texture of Sinabung volcanic ash particles is berry-like glass particles show angular blocky forms with low vesicular and contain crystallizes of plagioclase. The texture of volcanic rock characterized by many cavities (known as vesicles) on the surface and inside. A cavity formed in the extrusion process in which the cavity is filled by the gas trapped inside or secondary minerals. This texture occurs on all scales of glass beads or glass layer. Many fragments large cavity showed great gas pressure produces a sharp and jagged shape.

Kelud type of volcanic ash particles are shown in Fig. 3 is sponge-like glass particles. The texture of volcanic rock characterized by many cavities (known as vesicles) on the surface and inside. A cavity formed in the extrusion process in which the cavity is filled by the gas trapped inside or secondary minerals. This texture occurs on all scales of glass beads or glass layer. Many fragments large cavity showed great gas pressure produces a sharp and jagged shape.

Table 3: Element Pozzolanic Material Content in Volcanic Ash

The location of Volcano	Total Si %	Total Al %	Total Ca %
Mount Merapi	51.31	19.53	7.80
Mount Sinabung	45.76	14.27	10.55
Mount Kelud	56.35	15.43	8.71

In addition to describing the morphology of volcanic ash, SEM-EDS can also find out the amount of element pozzolanic materials contents in volcanic ash**.**

4.3 X-Ray Diffraction Analysis

XRD analysis is a method that can provide information on the types of minerals contained in a material. Data from X-rays radiation in the form of the spectrum of X-rays diffraction detected by the detector and then diffraction data were recorded by the computer in the form of a graph peak intensity, which further analyzed the distance between the lattice planes crystal and compared with the laws of Bragg on a computer using specific software so can generate the data. XRD used in this research is qualitative and quantitative methods. Qualitative methods of data output from diffractogram were analyzed by comparing the diffraction patterns of Reference. While, the quantitative method is done by calculating the value of the peak and width of the top of the chart. From this we can calculate the phase composition of the constituent material. XRD test results of three samples of volcanic ash from different locations presented in Table 4 and Fig. 4.

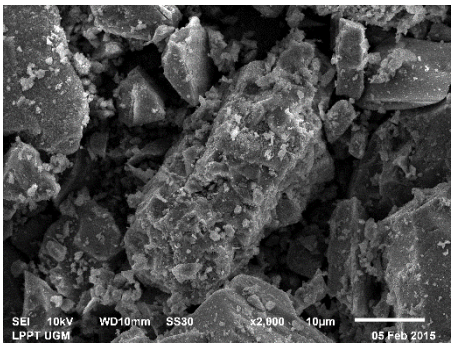


Fig. 1. Merapi Volcano Ash Morphology

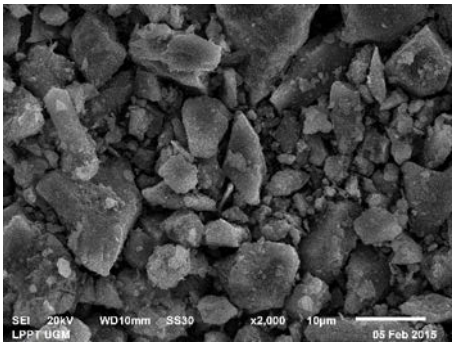


Fig. 2.Sinabung Volcano Ash Morphology

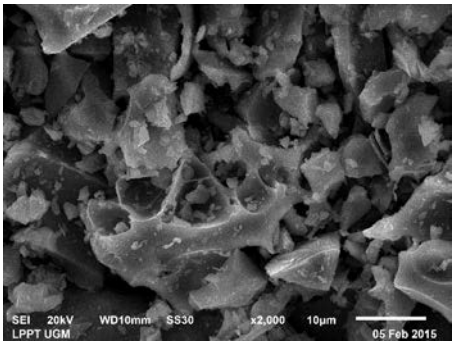


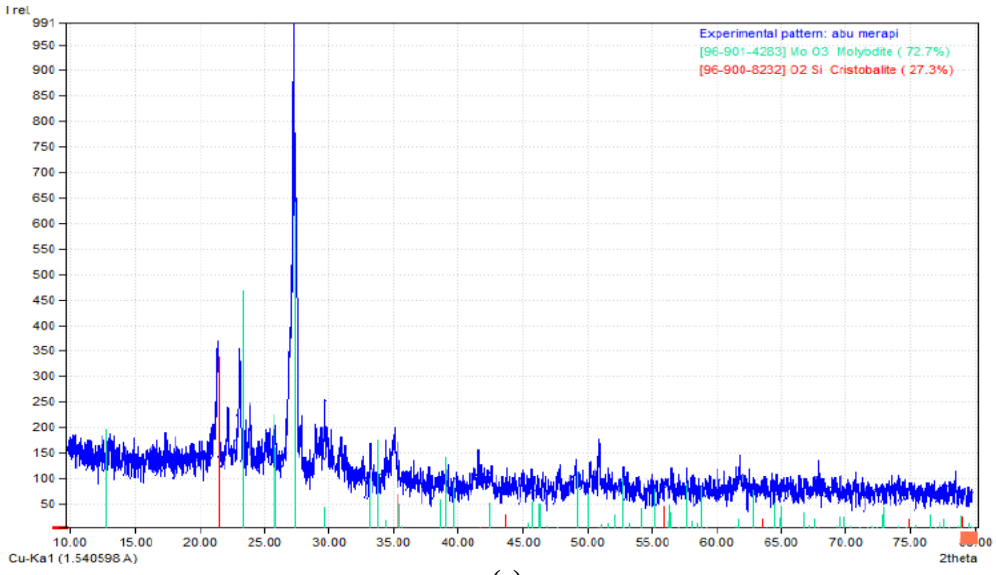
Fig.3. Kelud Volcano Ash Morphology

Table 4**:** Mineral composition of volcanic ash

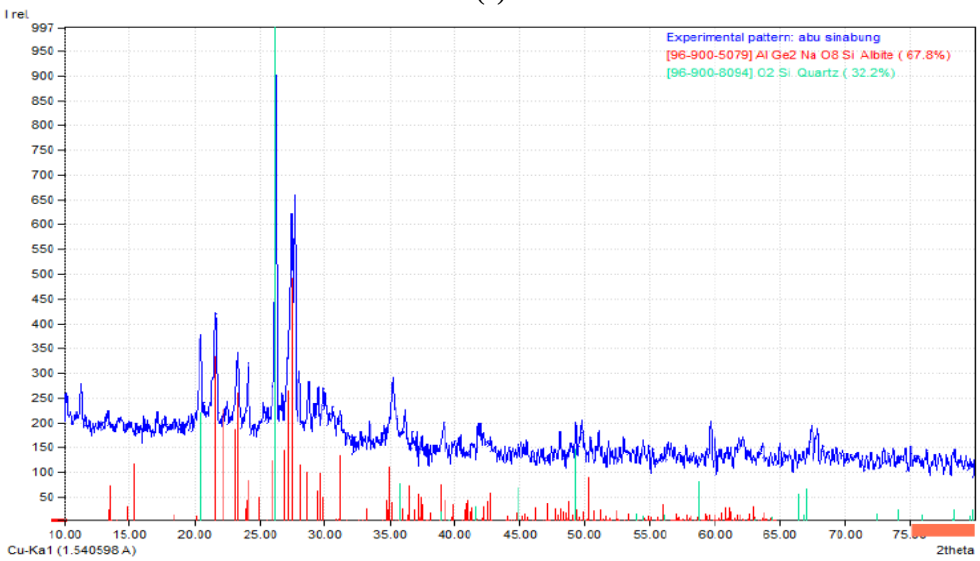
Origin of volcanic ash type	Mineral	Amount %
Merapi	Molybite	72.2
	Cristobalite	27.3
Sinabung	Albite	67.8
	Quartz	32.2
Kelud	Leucite	35.9
	Diopside-Subsilisic	34.9
	Almarudite	29.2

5. CONCLUSION

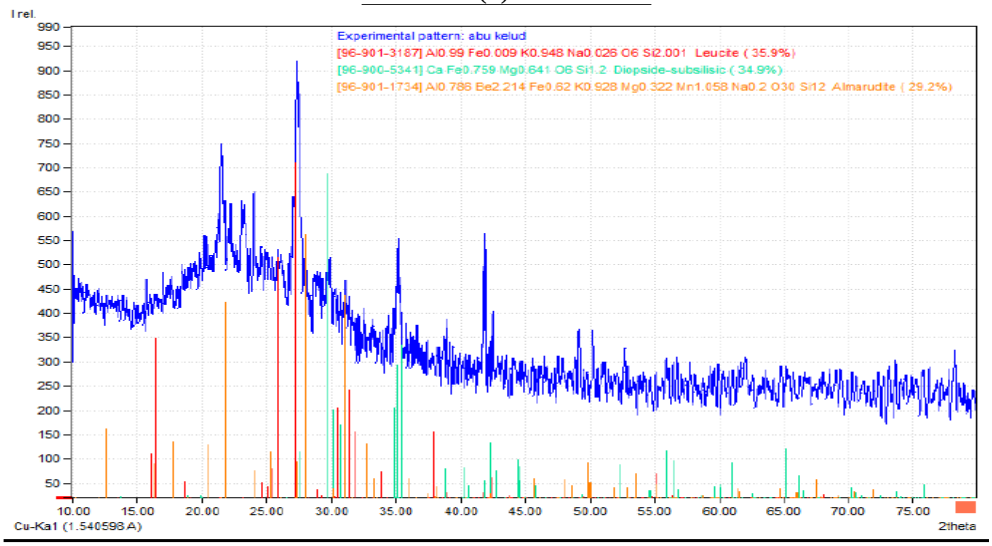
Chemical characterization of volcanic ash as soil stabilizator are presented, described and discussed. Specific gravity, mineral content using by XRD and morphology using by SEM test are presented. Based on specific gravity test results on some volcanic ash in Indonesia, it can be classified in light material category. Merapi, kelud and Sinabung volcanic ash has a different shape morphology. Merapi is a form of fibrous glass particles Contain elongated vesicles. While, the texture Sinabung is a berry-like glass particles show angular blocky forms and texture kelud are sponge like glass. The SEM-EDS test obtained Si content of the three types of volcanic ash ranges from 45-60% and elements of Al ranges from 14-20%. This can be a reference for further research on the utilization of materials of volcanic ash as a pozzolanic material in soil stabilization.



(a)



(b)



(c)

Fig.4 Volcanic ash diffraction graph :
(a) Merapi volcanic ash (b) Sinabung volcanic ash (c) Kelud volcanic ash

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