Assessment on the Potential of Volcano Ash as Artificial Lightweight Aggregates using Geopolymerisation Method

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Following the Yogyakarta earthquake on May 27th, 2006, the subsequent eruption of a volcano mud has been closely observed and analyzed by the geological community. The volcano mud, known as LUSI (LU-lumpur, SI-Sidoarjo), began erupting near the Banjarpanji-1 exploration well in Sidoarjo, East Java, Indonesia. LUSI offers a unique opportunity to study the genesis and development of a volcano mud. This paper summarizes the current knowledge about the potential of volcano ash as a raw material in geopolymer and as artificial aggregate. Previous experimental study shows that the volcano ash has a good performance when 5% and 10% OPC was replaced by volcano ash mixture. Volcano ash mixed with fly ash in certain composition has a potential to become a binder in geopolymer concrete. An effort to convert the volcano ash to artificial aggregate also shows good potential due to their specific gravity and water absorptions, and characterization of this material. The characterization of this material have been done through X-ray Fluorescence (XRF), X-ray Diffraction (XRD), Scanning Electron Micrograph (SEM), and Fourier Transform Infrared Spectroscopy (FTIR), and then compared to other materials. Sintered volcano ash showed good performance in terms of strength as a cement replacement material with OPC and fly ash. Volcano ash also showed good performance for porosity. This material has a potential as a raw material due to high compounds of SiO_2 and Al_2O_3 in producing geopolymer composites, and as new artificial aggregate to be used in concrete application.

Keywords: geopolymer, volcano Ash, lightweight aggregates, alkaline activator, XRF, XRD, SEM

Over the past 5 years, the volcano mud in Sidoarjo, East Java, Indonesia started to erupt on May 29th 2006 and has displaced 13,000 families with 30,000 people on this surrounding area. Controversy has begun whether the volcano mud was caused by drilling of the gas exploration well in the Porong area, Sidoarjo, East Java or due to the Yogyakarta earthquake that occurred at 05:54 am on the 27th May 2006 [1-3]. This eruption impacted an area of almost 3 square miles to a depth of 65 feet and thirty thousand people have been displaced which cost Indonesia \$3.7 billion in damages and damage control [4, 5]. For 2012, the government has earmarked an initial amount of Rp 734 billion (US\$80.01 million) to pay compensation for 61 hectares of the victims' land. For 2013, the government expects to spend another Rp 1.1 trillion to purchase 164 hectares and Rp 1.3 trillion for 201.5 hectares in 2014 [6].

Figure 1 shows the map of gas explosion that was occurred at Sidoarjo, East Java, Indonesia. Volcano mud still active and contains highest in volume, duration and spatial extent when compared to some of the world most prominent and active volcano mud as mentioned in [1] and reviewed in [7] As of June 2007, the average subsidence area was measured at 10.7 m [2]. Many efforts have been done to diminish damage. One of the efforts was by diverting the volcano mud to flow into nearby rivers and the ocean. Then, 300 kg concrete balls have been dropped in main conduits to tire the flow [1, 2, 4]. However, these efforts were not truly successful. Some researches have been done on utilizing the volcano mud as replacement material in producing concrete and geopolymer [8-10]. Some suitable compositions of the binders have been created and show good potential. Nuruddin et al. [9] stated that the concrete strength is affected by the percentage of LUSI mud inclusions. Study carrried out by Ekaputri [8] shows that the wet and dry LUSI mud mixed with fly ash-alkaline activator give the good performance of geopolymer concrete.

Previous research also shows the approaches to convert fly ash into aggregates as replacements for natural aggregates. The reason of this approach is due to the demand for aggregates are large and increasing continuously while the natural aggregate resource is depleting. Many countries like USA, UK, Poland, Russia and Germany are producing aggregates commercially under different trade names. Aggregate may count for 70-80% by mass of concrete. Aggregates can also be used as soil conditioners, water savers, and soil and sand stabilizers [11]. Furthermore, the use of artificial aggregates has shown reasonable costs and produce better quality compared to conventional aggregates [12]. Niyazi and Turan [13] have chosen fly ash mixed with bentonite and glass powder as raw material in lightweight aggregate production. Ramamurthy and Harikrishnan [14] used fly ash mixed with ordinary Portland cement (OPC), Na-

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