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## Analyze the proportion of volcanic ash of Sinabung volcano at the most optimum to get the compressive strength and tensile strength of concrete

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**Abstract.** The development of concrete as construction material is growing very rapidly followed by the needs of diverse communities. Based on the problems, we need knowledge and innovation to get a good quality concrete with low cost. In this study, volcanic ash of Mount Sinabung was chosen as an alternative material plus concrete filler. Materials derived from the bowels of the earth will be tested optimum levels that can be used to achieve the compressive strength and maximum tensile strength. The concrete to be tested is a concrete mixture design with  $f_c$  249 kg / cm<sup>2</sup> (K-300). The concrete mix design was done by reducing the use of cement and the addition of volcanic ash of Mount Sinabung (0%, 10%, 15%, 20%). Compressive strength is tested when it's 7, 14, and 28 days old. But, ultimate tensile strength is tested when it's 28 days old. From the test result, we get optimum percentage with volcanic ash from Mount Sinabung is 10% with compressive strength 19.689 Mpa and ultimate tensile strength 1.348 Mpa. However, material is still worthy to use as concrete because it is compressive and ultimate tensile strength that almost reach normal compressive and ultimate tensile strength. Moreover, the using of material as admixture for concrete can be used as an alternative to save the environment from pollution.

### 1. Introduction

The development of infrastructure is greatly improved as the country's development and human needs are increasingly diverse, especially concrete. Concrete has high strength, relatively cheap concrete price, cheap concrete maintenance cost, more durable concrete (durable), and the concrete workmanship process is relatively easier. Knowledge and innovation for concretion with good quality, but the cost of manufacture can be reduced as low as possible by utilizing the existing waste, such as volcanic ash mount Sinabung. The volcanic ash of Sinabung Mount is a material derived from the earth's stomach which until now has not been exploited to the maximum and is still regarded as a material that pollutes the surrounding environment that harms the community. Volcanic ash Sinabung volcano is a material of volcanic fall that is sprayed into the air during the eruption of Mount Sinabung, Karo regency, North Sumatra. From the results of research that has been done in Sucofindo laboratory on June 08, 2015, volcanic ash of Sinabung mountain has a high content of silicate material (SiO<sub>2</sub>), reaching 68.70%. Engineering of concrete manufacture by mixing volcanic ash of Sinabung mount as additional material that can be used to reduce the needed cement. This is caused by the small volcanic ash volumes of Sinabung that can fill the pores or cavities contained between aggregate and cement granules so that there will be strong bonds between one another. Goal from research is analyze the proportion of volcanic ash of Sinabung volcano at the most optimum to get



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the compressive strength and tensile strength of concrete with good results so as to put the optimal power cable. This research will still be continued for the development of electrical wiring planted in concrete. The power plant cultivation by utilizing the many Mount Sinabung Mount in Berastagi.

## 2. Research Methodology

The method applied in this study is experimental based on the literature review of the proportion of mix design and actual laboratory data on the samples tested. The research method is related to the making of cylinder-shaped concrete with volcanic ash added material from Sinabung mountain, starting from the preparation of raw materials to the explanation of the series of test / testing done so that the data will be continued in the processing and analysis phase. In general, the experimental process of the research to produce the required data that includes the preparation of raw materials, testing of raw materials, mix design, sample curing, and sample testing. The composition of the chemical compound of Portland cement can be seen in the Table 1.

**Table 1.**Composition of the Portland Cement Chemical Compound

Compound Name	Symbol	Weight Percent (%)
Calsium	CaO	64.67
Silica	SiO <sub>2</sub>	21.03
Alumina	Al <sub>2</sub> O <sub>3</sub>	6.16
Ferrit Oksida	Fe <sub>2</sub> O <sub>3</sub>	2.58
Magnesia	MgO	2.62
Alkali	K <sub>2</sub> O <sub>3</sub>	0.61
Alkali	Na <sub>2</sub> O	1.34
Sulfur Trioksida	SO <sub>3</sub>	2.03
Karbon Dioksida	CO <sub>2</sub>	-
Air	H <sub>2</sub> O	-

The method applied in this study is experimental based on the literature review of the proportion of mix design and actual laboratory data on the samples tested. The research method is related to the making of cylindrical concrete with volcanic ash of Sinabung mountain, starting from the preparation of raw materials to the explanation of the series of tests / testing conducted so that the data will be obtained that will proceed at the stage of processing and analysis. The making and testing of samples is done in the laboratory of construction materials technology of Civil Department of faculty of engineering UKI. The concrete compressive strength test was performed after the samples were 7, 14, and 28 days, while for concrete tensile strength test was performed after 28 day sample. In order to obtain good quality material, testing of the material must be performed before use in concrete. A concrete will have good quality if its constituent aggregates are of good quality and meet the applicable standards. In this case the test is only performed on coarse aggregate and fine aggregate. Implementation of the test is as follows: The scatter is arranged from the size of the largest hole to the smallest size according to the standard specifications that have been determined. After that the sand is inserted into a sieve from the top and then the screen is closed tightly then placed on top of the shake machine and installing the locking bolt and the

shake machine is turned on for 10 minutes, after which the sand wears are left on each sieve. Another test is the level of sludge to determine whether the sand can be used directly without washing it first (mud and soil need not be removed). Testing of organic content is done to know the percentage of ingredients contained in the sand organic which will be used whether aggregate can be used without the need to be washed first (organic material does not need to be removed). The design calculation of concrete mixture in this study used mixed design method for normal concrete in accordance with Indonesian National Standard 03-2834-1993. With the results obtained from laboratory experiments, an absolute concrete mixture design of 1 m<sup>3</sup> was obtained. The calculation of mixed concrete planning can be seen in Table 2.

**Table 2.**Concrete Mixed Planning

No.	Description	Value
1	Required compressive strength (cylindrical test specimen)	25 MPa
2	Standard deviation	7 MPa
3	Value-added ( <i>margin</i> )	11.5 MPa
4	The last average power	36.5 MPa
5	Type of cement	Portland Semen Type I
6	Type of aggregate : - Coarse - Smooth	Broken Stone Natural
7	The free cement water factor	0.51
8	The maximum cement water factor	0.6
9	Slump	30-60 mm
10	Maximum aggregate size	40 mm
11	Moisture free	170
12	The amount of cement	333.33 kg/m <sup>3</sup>
13	Maximum cement amount	333.33 kg/m <sup>3</sup>
14	Minimum cement quantity	-
15	Adjustable water cement factor	-
16	Large arrangement of grains	Gradation 2
17	Percent fine aggregate	35.5 %
18	Relative density	2,5
19	Weight of concrete content	2320 kg/m <sup>3</sup>
20	Combined aggregate rate	$2320 - 333.33 - 170 = 1816.67 \text{ kg/m}^3$
21	smooth aggregate content	$35.5\% \times 1816.67 =$

		644.918 kg/m <sup>3</sup>			
22	Croash aggregate content	1816.67 – 644.918 = 1171.752 kg/m <sup>3</sup>			
/ m <sup>3</sup>		Cement (kg)	water (kg)	smooth Aggr egate. (kg)	Croash Aggr egate. (kg)
		333.33	170	644.918	1171.752
/ 0.0053 m <sup>3</sup>		1.767	0.901	3.418	6.210

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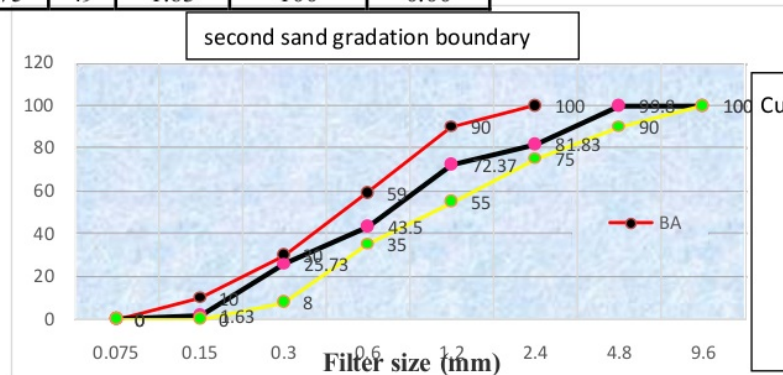
### 3. Results and discussion

#### 3.1. Material Testing Results

The result of filter analysis of fine aggregate can be seen on Tabel 3. Based on Table 3, it can be seen graph of fine aggregate gradation as shown in Figure 1. below this.

**Table 3.** Filter analysis of fine aggregate

Filter size			Stuck Aggregate		Cumulative Stuck Aggrega te	Cumulative lost Aggrega te
(mm)			(gram)	(%)	(%)	(%)
9.60			0.00	0.00	0.00	100
4.80			6.00	0.20	0.20	99.80
2.40			539	17.97	18.17	81.83
1.20			284	9.47	27.63	72.37
0.60			866	28.87	56.50	43.50
0.30			533	17.77	74.27	25.73
0.15			723	24.10	98.37	1.63
0.075	49	1.63	100	0.00		



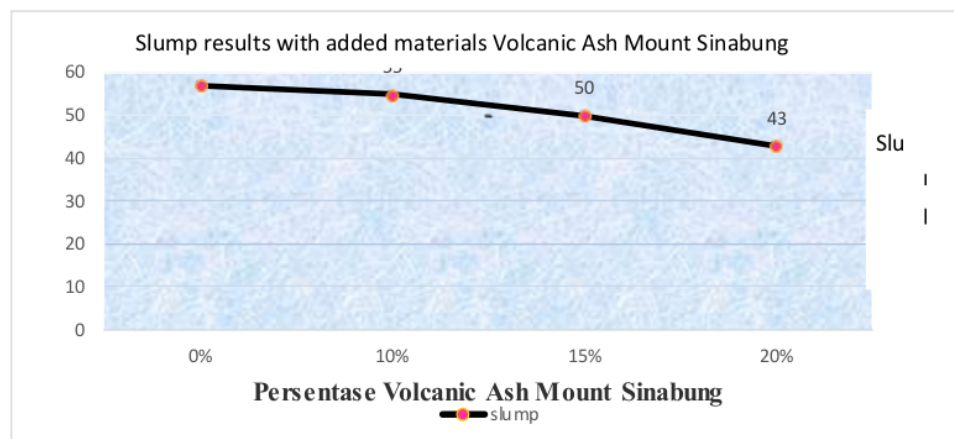
**Figure 1.** Graph of Aggregate Fine Gradation



The test results of slump value on concrete with added volcanic ash material Sinabung mountain can be seen in Table 4. Based on Table 4, hence can be seen graph relation of % usage of volcanic ash of mount Sinabung to slump value in picture 2. below this

**Table 4.**Slump Results With Additional Volcanic Ash Mount Sinabung

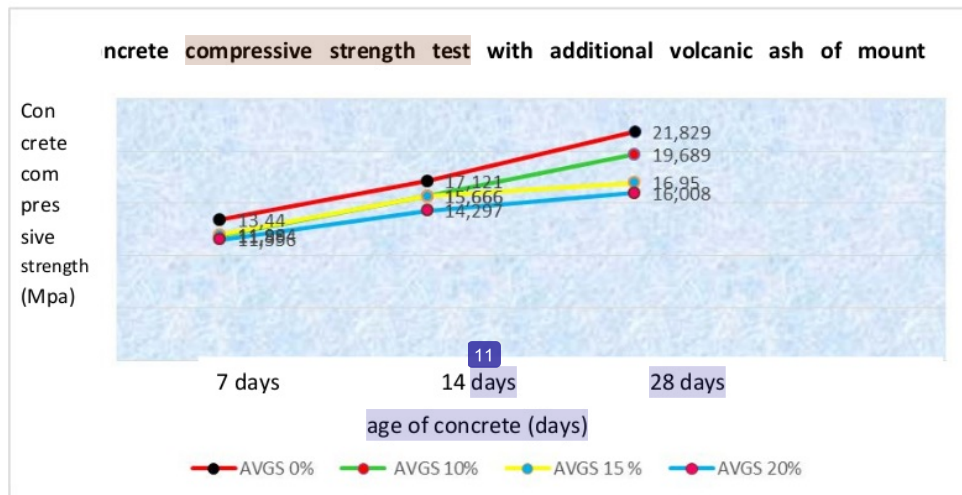
Percent of Volcanic Ash Mount Sinabung	Results Slump With Terms 30mm - 60mm
0 %	57
10 %	55
15 %	50
20 %	43



**Figure 2.** Graph of Mount Volcanic Volcanic Mount Relation with Slump

### 3.17 Analysis of Test Results

The concrete compressive strength with the volcanic ash of Mount Sinabung can be seen in Figure 3. the following.



**Figure 3.** Strong Relation Chart Pressure Concrete With Volcanic Ash Mount Sinabung

Relationship of volcanic ash application of Mount Sinabung with slump, it can be seen that the slump of concrete that does not use the added volcanic ash material of Mount Sinabung is 57mm, slump on the concrete using an additive by comparison or called Automated Guided Velocimeters (AGVS): AVGS 10% is 55mm, AVGS 15% is 50mm, and AVGS 20% is 43mm can be seen from figure 2. It can be seen that the slump value decreases with increasing volcanic ash level this is because the volcanic ash of Mount Sinabung absorbs less water so that the concrete workability using volcanic ash is higher. Value of compressive strength and tensile strength of concrete with added volcanic ash material of Mount Sinabung approaching normal concrete with 9.8% difference for compressive strength and 5.99% for tensile strength. Thus, the volcanic ash material of Mount Sinabung can still be used for concrete material although it has not reached the value of compressive strength and value of normal tensile strength of concrete. The advantages obtained are volcanic ash of Mount Sinabung that pollute the environment and disrupt public health can be gradually can minimally.

#### 4. Conclusion

From the above test report on the effect of usage and comparison to the influence of volcanic ash usage of Sinabung to the concrete, we can conclude as follows

- The volcanic ash of Mount Sinabung which is an environmentally acceptable waste or waste material is still suitable for concrete as a substitute for cement, as evidenced by the use of volcanic ash of Mount Sinabung only difference and 9.8% for compressive strength and 5.99% for tensile strength with concrete.
- From Figure 3, we can see the optimum level of volcanic ash application of Mount Sinabung on peak concrete mixture with compressive strength value 19,689 Mpa and value of tensile strength 1,348 Mpa



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