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ISREM 2015
University of Wijaya Kusuma Surabaya

INTERNATIONAL SEMINAR

Resources, Environment, And Marine In The Global Challenge

"The Role Of Science and Technology In The Basis Of Environment To Support Sustainable Resource Development"

DITERBITKAN OLEH:
Pusat Pengkajian Hukum dan Pembangunan (PPHP)
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PUSAT PENGKAJIAN HUKUM DAN PEMBANGUNAN

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WELCOME ADDRESS

Foreword of The Chair of Organizing Committee the 1st ISREM 2015

Assalammualaikum Warrahmatullahi Wabarakatuh
Good Morning.

On behalf of the Organizing Committee, we congratulate dating to the speakers, the invited guests and all participants of the first International Seminar Resource, Environment and Marine (ISREM) held by Wijaya Kusuma Surabaya University.

Through the International Seminar, it is expected that there is intertwined interaction, communication and exchange of current research information so as to generate concepts and new thoughts on the role of science and technology in the basis of environment to support sustainable resource development. In addition to publication in the form of proceedings, the best papers presented at this international seminar, to be published in the international journal. The total in the first ISREM is 200 participants consisting of speakers, participants and invited guests.

Finally, we would like to thank you to all the speakers, the invited guests, the parties and all the donors who have supported this event and hopefully the success of this international seminar provides many benefits for us all.

Thank you
Wassalamualaikum Wr Wb

Dr. Ir. Hary Sastrya Wanto, MS
Chair of the Organizing Committee

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Rector of Wijaya Kusuma Surabaya

To honorable Ministry of Marine Affairs and Fisheries Indonesia.
To honorable Governor of East Java
To honorable Coordinator of Kopertis
To honorable Kapolda
To honorable Invited Speakers
To honorable Rectors
Ladies and Gentlemen

Assalammualaikum Warrahmatullahi Wabarakatuh
Good Morning.

Praised be to Allah SWT for His love and compassion that today we all gather for the first International Seminar Resource, Environment and Marine (ISREM) held by Wijaya Kusuma Surabaya University.

I would like to thank you for coming to this scholarly forum especially I would like to express my deepest gratitude to the Keynote speaker Ibu Susi Puji Astuti, Ministry of Marine Affairs and Fisheries who has spent time to attend and support this event. I wish to extend sincere gratitude to all respected delegates, invited speakers, presenters and participants for attending this seminar and for becoming our esteemed guests on this occasion. It is indeed a great honor for us to have you all at the seminar.

As we know, the theme "The Role of Science and Technology in the Basis of Environment to Support Sustainable Resource Development" is timely in order to address the issues and concerns about Resource, Environment and Marine in the Global Challenge. Indonesia includes one of the countries which own the biggest natural wealth in the world. If natural resource of Indonesia in mainland is combined with in the sea, so it is only Indonesia which has the biggest natural resources in the world. The utilization of the natural resources in Indonesia tend to economical aspect, while the aspects of ecology, biology, technology, and humanity is still limited. Whereas they have the very high economical value. For that reason, the International Seminar is the event of discussion on ideas, problems and solutions about resources, environment and marine as well as the information result of current research for scientists, observers, entrepreneurs, industrialists and policy makers. Thus, it will create the harmony the research activities with the problems and the real needs. This International Seminar is the 1st ISREM and it is hoped that the next year will be held again the 2 nd ISREM and so forth with the specific target.

Ladies and gentlemen
In the same time of this event, it is also held directly MoU among all Higher Education supporting the First ISREM 2015 and it will be established ISREM network. We will cooperate about seminar/ conference, student and lecturer exchange, research together.
Finally, on behalf of Wijaya Kusuma Surabaya University, I would like to take the opportunity to extend my appreciation to the committee, all participants and all sponsors, that have generously assisted us to host this seminar. I hope that we all could gain benefits and insights through this seminar.

Thank you,
Have a wonderful and insightful seminar
Wassalamualaikum Warrahmatullahi Wabarakatuh.

Prof. H. Sri Harmadji., dr., Sp.THT-KL (K)

Rector of Wijaya Kusuma Surabaya University

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SCHEDULE OF AGENDA

TIME	ACTIVITY	PIC
07.30-08.00	Registration	Sections of Secretariat and Registration
08.00-08.20	- Opening Ceremony - The National Anthem of Republic of Indonesia	Sections of Receptionist and Protocol
08.20-08.30	Speech By Chair of The Organizing Committee	Sections of Receptionist and Protocol
08.30-08.45	Speech and Official Opening by Rector of Wijaya Kusuma Surabaya University, Indonesia	Sections of Receptionist and Protocol
08.45-09.45	KEYNOTE SPEAKER The Fishery and Marine Ministry of Indonesia: SUSI PUDJI ASTUTI	Sections of programs, formulator, and taking minute Coordinator
09.45-10.00	MOU (All Higher Education supporting the 1st ISREM 2015)	Sections of Receptionist and Protocol
10.00-10.15	COFFEE BREAK	Section of Beverages and Meals
10.15-12.30	Invited Speaker	Sections of programs, formulator, and taking minute Coordinator
	Professor Dr. M. Dileep Kumar	
	Rexton F. Chakas, PhD	
	Professor Dr. Basri Rashid	
	Prof. Dr Ruswiati Surya Saputra, SE, MS	
	Prof. Dr. Ir. Achmadi Susilo, MS	
12.30-13.00	LUNCH	Section of Beverages and Meals
13.00-16.00	PARALLEL SESSION	Sections of programs, formulator, and taking minute Coordinator
16.00-Finished	COFFEE BREAK	Section of Beverages and Meals

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THE PHYSICAL AND MECHANICAL PROPERTIES OF CONCRETE USING CEMENTITIOUS VOLCANIC ASH OF MOUNT BROMO

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Abstract : This study uses volcanic ash waste from the eruption of Mount Bromo as a substitution of cement (cementitious) for mixture material of concrete, and observing its effect on physics and mechanic properties of concrete. The mix design analysis of concrete material uses DOE method with the characteristic strength is 300 kg/cm^2, and w/c factor 0.5. The volcanic ash that is used are 0%, 5%, 10%, 15%, and 20% from the weight of the cement, and have granular size grain number 200. The test that is conducted are compressive strength test, porosity test, and modulus of elasticity test.
The test result shows that compressive strength from concrete of volcanic ash waste is 5% and 10% reached the charactersitic strength, even though its under normal concrete for about 2% - 3%. The significant distinction occurs on porosity concrete value with mixed volcanic ash is over 10%, compare to 5% and 10%. The modulus of elasticity test result shows that volcanic ash concrete 10% and 15% shows the better elaticity, compared to normal concrete.

Keywords: Concrete, cement, cementitious, volcanic ash

1. Introduction

Concrete remains as the main material for building material, made from a mixture of portland cement or hydraulic cement, fine aggregate, coarse aggregate, and water, with or without additives, which form a solid mass. The function of cement as aggregate binder during the process of forming concrete. The portland cement is a hydraulic cement produced by grinding clinker which consists of hydraulic calcium silicates, that generally contains of one or more forms of calcium sulfate as an additional material is milled together with the main material. Raw material for producing the cement are materials that contain lime, silica, alumina, iron oxide, and other oxides (Table 1). The most elements that is contained in the cement is CaO or lime which is the type of rock classified as natural resources that is not able to be updated. Exploration of the limestone have been done continuously and excessive would disrupt the balance of the environment, such as reduced availability of groundwater. Furthermore, the impact of dust pollution arising from mining limestone is able to pollute the air around the mine (Samekto 2001). Therefore, some researches was conducted in order to obtain the alternative material substitution of cement.

The price of cement continuously increasing is also the reason of why researches are also conducted in order obtain the alternative material substitution of cement. The price of cement also affects the price of building materials. It is expected by using alternative materials substitution will be able to reduce the use of cement to the mixture of building materials, and affects the reduction of cement production. This study used the volcanic ash as a partial substitution of cement (cementitious).

The volcanic ash of this research is the result of Mount Bromo eruption that occurred on November 2010. The volume of volcanic ash was very large and has no economic value for the public. According to Amin (2010), the volcanic ash contains of chemical compounds that have the potential and allow it to be used as the ceramic material. While IGA Suradharmika (BPPT 2011), Chairman of the Technical Implementation Unit Development of Ceramics and Porcelain Art Technology (UPT-PSTKP) BPPT-Bali said they have been utilizing volcanic ash from Mount Merapi and Mount Bromo as ceramic glaze materials with high combustion temperatures 1250^{o}C. The statement indicates that the volcanic ash has the potential and more likely to be used as a building material, such as a mixture for the manufacture of paving blocks, bricks, rosters, tiles and concrete.

The problem that is observed in this study is how the influence of volcanic ash as cementitious material towards the physical and mechanical properties of concrete. Based on explanations above, this research attempts 1) determine the physical properties and chemical elements contained in the volcanic ash, 2) to determine the mechanical properties that the compressive strength of the concrete using a mixture of cementitious volcanic ash of Mount Bromo as substitution partial cement at age 3 , 7, 14, 21 and 28 days, 3) to determine the physical properties of concrete using volcanic ash of Mount Bromo are porosity and modulus of elasticity at age of 3, 7, 14, 21 and 28 days.

The aim of this research is volcanic ash of Mount Bromo can be used as a partial substitute of cement in the concrete mixture. Thus, the volcanic ash becomes useful materials and high value. The impact is expected to reduce the exploitation of limestone which is the main raw material for producing cement, which could lead to catastrophic landslide in the mountain area of limestone and damage to the natural balance.

2. Literature Review

a. Concrete

Concrete is made from mixture of cement, fine aggregate, coarse aggregate and water. Cement which is had already been given water will become a cement paste and aggregate becomes a binder. Due to its unique will require a fairly extensive knowledge about concrete technology, such as basic materials, how to make, how to evaluate, and variations of additives.

Based on volume density, there are two types of concrete, such as normal concrete and lightweight concrete. Normal concrete is concrete with a unit weight of 2200 kg/m^3 to 2500 kg/m^3 and made using a mixture of natural aggregate materials were crushed or without crushed. In order to change the properties of concrete, during the mixing step, admixture is added as necessary. For example, in order to improve the strength of concrete, previous studies found that using additives fly ash in concrete mix. However, nowadays, using fly ash will cost a lot due to its high value and easy to get.

b. Cement

Cement is an essential material in producing the concrete, due to its function as a binder to grain aggregate in order to be one entity. Raw material for making cement are materials that contain limestone, silica, alumina, iron oxide, and other oxides as in Table 1 (Samekto 2001). When cement is mixed with water and turn into a paste, then mixed with sand and water, it will be formed as a cement mortar. If aggregate was added, it will turn to concrete. If aggregate bound by a cement paste that serves as glue and can be harden, the quality of the cement greatly affects the quality of concrete. Thicker the cement paste, thus more powerful the bond. However, if it is too thick, it will not guarantee a good attachment (Samekto 2001).

Table 1. Cement elements

Chemical Elements	Percent
Lime, CaO	60 - 65
Silica, SiO_2	17 - 25
Alumina, Al_2O_3	3 - 8
Ferro, Fe_2O_3	0.5 - 6
Magnesia, MgO	0.5 - 4
Sulfur, SO_3	1 - 2
Soda/potash $Na_2O + K_2O$	0.5 - 1

Source : Samekto (2001)

However, the availability of raw materials for cement in the field that is started to decrease and its complicated process makes cement becomes expensive. Therefore, a lot of researches has been done to obtain alternative materials of cement with similar function nonetheless with affordable price. The important point in order to get the best quality cement: basic materials must be in a good quality and the mixture should be really homogeneous. The basic materials are clay and limestone mixed with a certain ratio.

Portland cement in Indonesia, which appropriate to SII 0013-81, is divided into five types, such as: (1) type I is a Portland cement for general purposes. For example, used for the manufacture of pavement, masonry, etc., (2) type II is a modified portland cement, a type that consists of half of type IV and half of type V (moderate). Nowadays, a number of type IV produced cement substitute. This type can also be used for drainage of buildings in places that have a slightly high concentration of sulfate, (3) the type III is portland cement with early rigidity which is required when concrete with the mold must be dismantled as soon as possible or when the structure must be immediately used, thus would be able to use for repairing concrete buildings that is soon to be operated, (4) type IV is a portland cement with a low heat of hydration. This type of cement is required when the speed and the amount of heat that arises must be minimum. For example, for a massive building such as large gravity dams. Growth from this type is much slower than type I, (5) type V is a sulfate-resistant Portland cement, which is used for concrete in order to face ferocious sulfate action, such as in soil or ground water containing high sulfate.

a. Cementitious

The studies that utilizing alternative materials in order to use as cementitious has been carried by the experts with the

aim to obtain a cement substitution materials within the mixture of building materials, thus reducing the cost of concrete-producing that started to increase (Sunyoto, 2006). Furthermore, it is expected to improve the quality of the concrete higher, or to increase robustness and durability of concrete.

Norman et al. (2008) using the pulp waste material as cementitious to produce concrete, and the result shows that there is an increase in the compressive strength and modulus of elasticity of concrete for the waste mixture is less than 5% of the weight of the cement.

Research with utilizing fly ash, which is the coal waste as a partial substitution of cement produces strong concrete higher than concrete without fly ash (Subakti, et al., 2012). The use of fly ash has been applied to the manufacture of concrete works in the field, mainly by batching plan that produces ready mix concrete.

A research result that has been conducted by Saputra (2011) using volcanic ash as additional material substitute for cement in the mixture of *Self Compacting Concrete* (SSC), and obtained an increase in the strength of concrete with mixture of volcanic ash, and optimal result is achieved by the concrete with a mixture of volcanic ash by 15% of the weight cement.

b. Volcanic Ash

The volcanic ash or pyroclastic fallout is the materials that is ejected into the air during volcanic eruption, consisting of large rocks to fine-sized, large (gravel boulders) usually falls around the crater to a radius of 5-7 km from the crater and the smooth ones could reach within hundreds of kilometers or even thousands of kilometers from the crater because it can be carried away by the wind. For example, the eruption of Mount Krakatau in 1883 can orbit the earth for days, also the eruption of Mount Galunggung in 1982 could reach Australia (Wibowo 2005).

The composition of the volcanic ash consists of three substances, such as the gas that comes from the hot magma which formed by magma and ground or water in its stream, rock, and silica. Heat and toxic clouds comes from mixing sulfur dioxide, carbon dioxide and hydrogen fluoride. When exposed to humans, it can lead to blindness, skin burn and chronic lung disorder, also may cause the machines damaged and not functioning, and contaminating the environment. Volcanic ash can be aired until the troposphere (8-12 kilometers above sea level), and can settle for a few weeks and change the weather locally. However, the occurrence of volcanic ash and the heat can not be predicted when it would happen. From observation by microscope with magnification of 400 times, volcanic ash from the eruption of Mount Bromo (2010) have forms, ranging spiky, angular, rounded up. Volcanic glass that has a tapered forms known as glass shard (Jeffry 2010).

The characteristics of volcanic ash relatively different from the dry dust as there are in general, especially in the dry season. Volcanic ash is formed from frozen magma that erupted explosively. Most of the details of this ash has a tapered shape, and because of the large silica content, this ash has a high absorption properties.

Table 2 Chemical Compound of Volcanic Ash of Mount Bromo

Parameter	Analysis result (%)	Cement (%)
Silicon dioxide (SiO2)	20.45	20 - 25%
Aluminium dioxide (Al2O3)	34.23	3 - 8%
Ferric Oxide (Fe2O3)	3.07	0.5 - 6 %
Kalsium Oxide (CaO)	1.55	60 - 65%
Magnesium Oxide (MgO)	5.43	0.5 - 4%
Titanium dioxide (TiO2)	0.18	
Alkali (Na2O)	0.87	

Source : Result of Laboratorium Test in TAKI ITS 2012

The volcanic ash particle size smaller than 2.38 mm. Volcanic ash is derived from the liquid magma which has a temperature about 600°-1200°C upon cooling will form a solid, such as minerals (solids having a crystal form) such as mineral plagioclase, pyroxene, hornblende, quartz and volcanic glass (solids that do not have a crystal form). When the mineral and glass clump together into a single entity called igneous rocks. Magma may freeze inside and outside the earth's surface. Magma out to the surface by effusive will form the lava (igneous), while the magma coming out explosively to form fractions (granules) solids which may be the cores of rock, granular crystals, or grains of volcanic glass, which has a size ranging from gravel to fine ash, which has a circular shape to a pointed.

Because of the tapered shape, so if it gets into the eyes will quickly feel sore, and if entry into the respiratory tract is likely to be harmful.

The chemistry in Bromo volcanic ash, namely are lapili and silica. Lapili is kind of volcanic eruptions, shaped rigid hollow or round. In Latin, *lapillus* is the name for the result of explosive volcanic eruptions measuring 2 mm to 64 mm. Silica is an element contained in cement, with the silica content in the volcanic ash of Mount Bromo, the ash can be used as a cement substitute material. The content of chemical elements in the volcanic ash of Mount Bromo is shown in Table 2.

Until now, the volcanic ash has not been used optimally by the local peoples. Therefore, research of volcanic ash as an alternative material for the manufacture of concrete mix is done to improve its economic value. The volcanic ash has the potential to be developed as a fine aggregate in concrete. If Bromo volcanic ash can be used as a fine aggregate in the concrete mix, so the glut of volcanic ash that can overcome the shortage of natural materials, especially in the supply of materials as materials for concrete.

3. Research Method

This research was conducted in the laboratory. Materials for concrete mixes, namely cement, fine aggregate and coarse aggregate were tested in the laboratory to determine the feasibility of material requirements, such as sieve analysis test (ASTM C136-2001), specific gravity (ASTM C128-93), weight of volume (ASTM C29-2003), the humidity test (ASTM C556-2001), water absorption test (ASTM C128-2001), and the cleanliness of the sludge test (ASTM C117-1995), and the wore-test for crushed stone (ASTM C131-2003). Volcanic ash testing contains of density test, weight of volume test, and chemical analysis to determine the chemical elements contained. Cement was used portland cement type 1, production of Semen Gresik. Coarse aggregate was used crushed stone comes from Gempol, Pasuruan, and fine aggregate was sand from Lumajang. Volcanic ash was used is waste from the eruption of Mount Bromo with a grain size sieve No.200.

Analysis of the composition of the material was needed for concrete mix using DoE method, water cement factor is 0.5, and slump is 70-100 mm. Compressive strength characteristics was 30 MPa, and the material composition shown in Table 3. The volcanic ash was used to mix with percentage of variation of 0%, 5%, 10%, 15% dan 20% of the total weight of cement.

Table 3 The Mix Concrete Requirements for 1m^3

	Volume (m3)	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Water (liter)
1m3 (SSD condition)		308	693.70	1288.30	185.00
1m3 (original condition)		308	742.95	1296.80	142.20
1 mixed	0.00157	0.48	1.17	2.04	0.22

The experiment that was conducted is the compressive strength test (ASTM C39M-2001), porosity test (ASTM C642-1997) on concrete specimen age of 28 days to determine the percentage of pores in the concrete. The specimens were cylinder diameter of 100 mm, and height of 200 mm. Modulus of elasticity test (ASTM C469-2002) was used the specimen cylinder diameter of 150 mm, height 300 mm age of 28 days.

4. Discussion

The test result of sand and crushed stone were obtained that materials have been fulfilled the requirements of standard for use as concrete mix. The test result of sand obtained that gradation of granular was in zone 2 with fineness modulus is 3.69%, moisture is 0.8%, water absorption is 1.42%, weight of volume is 1.42 kg/l and specific gravity 2.63 kg/cm^3. The test results obtained gradation of crushed stone granules are in zone 2, grain fineness modulus of 7.8%, 2% moisture crushed stone, water absorption of 1.7%, a specific gravity of 2.75 kg / cm^3, volume weight of 1.26 kg / l and resistance to wear of 19.7%. Testing result of volcanic ash density of 2,67 kg / cm^3, and the heavy volume of 1,126 kg / lt. Chemical elements contained in volcanic ash are shown in Table 2. It is known that the percentage content of SiO2 resembles cement, Al2O3 content is very large compared to cement and CaO content is very small compared to the cement.

4.1 Result of Cement Paste Test

Cement paste was made from mixture of cement, water and volcanic ash with variation of 0%, 5%, 10%, 15% and 20% of total weight of cement was needed. Normal consistency of test result obtained that paste with cementitious of volcanic ash 0%, 5%, 10%, 15% and 20% respectively by 30%, 31.55%, 31.90%, 32.60%, and 33, show that the greater the content of volcanic ash in the mix of pasta, the greater the moisture content is needed. Setting and hardened time test of cement paste with cementitious of volcanic ash 0%, 5%, 10%, 15% and 20% obtained setting time 120 minutes, and hardened 210 minutes, indicating that the setting and harden time of paste of volcanic ash cementitious there is no difference with a paste without cementitious of volcanic ash.

4.2 Result of Compressive Strength Test

Compressive strength test of concrete specimens aims to determine the ability of concrete with cementitious of Mount Bromo volcanic ash to withstand compressive loads, thus knowing the value of the optimal percentage of volcanic ash for mixes and able to withstand high compressive loads. Figure 1 shows the test results of the compressive strength of concrete ages 3 to 28 days, obtained that the concrete of volcanic ash cementitious 10% reach the highest strength value than the other volcanic ash concretes and below that value are concrete with cementitious of volcanic ash is 5%. The strength increased of concretes with volcanic ash cementitious from age 3 to 28 days is not very significant as in concrete without volcanic ash, and its strength achieved is lower than concrete without volcanic ash. The low value of the compressive strength of concrete with volcanic ash cementitious can be caused by CaO in the volcanic ash required will react when mixing, after being given water, the percentage of CaO is insufficient, so it is up first dissolved in water before the reaction mixture is finished.

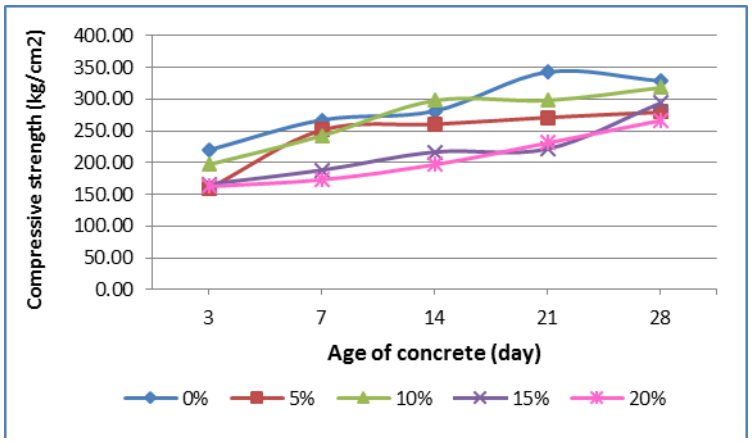

Figure 1 Relationship between compressive strength and age of concrete specimens