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# The Utilization of Sand Merapi Volcano Eruption for High Quality Concrete Material with Additive Substance Using Coir-Dust Particles

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***ABSTRACT:*** *The powder of coir-dust fiber can be utilized for the preparation of a compound named by Sodium Lignosulfonate. Sand from Merapi volcano eruption and Sodium Lignosulfonate are well known materials which can be utilized to produce high quality concrete for construction. The compound was prepared by filtrating coir-dust powder using a 40 mesh-sieve then boiled into a set of reflux equipment using sodium bisulfite (1:15). The results showed that the compound are formed which can be seen from the physical properties of the products. Qualitative tests of products were conducted through FTIR (Fourier Transform Infra-Red) analysis. Some concretes were made to determine the effects of the compound on a concrete compressive strength. The concrete was made by its comparative study of the composition of the cement and sand in 1:6. SLS powder was dissolved in water and from its various concentrations ranged 5% to 20% of the weight of cement used. Test result shows that maximum compressive strength of concrete at a concentration of 10% SLS. From these results, the compounds can be used as an additive substance to produce a concrete with higher quality by the utilization of Sand from Merapi volcano eruption.*

***Keywords****: Coir-Dust, Concrete, Compressive Strength, Sodium Lignosulfonate*.

## I. INTRODUCTION

The amount of volcanic material in some rivers around Mount Merapi as much as 5-10 million cubic meters. Total of volcanic material released during the phase of eruption of Mount Merapi in 2010 reached 140 million cubic meters [1] which the material contains 52-54% silica. In addition, it is also contains up to 15.47 meq/100 g calcium [2]. So that the material can be used as ingredients in the manufacture of high-grade concrete. In fact, the use of silica as an additive compound has been developed and applied in the cement industry [3]. But the silica's price is very expensive up to 10 times from the price of cement in Indonesia, so that Indonesia needs to fill up the demand by importing the silica [4]. Meanwhile, Indonesia has an abundant supply of sand, and one of the source is come from Merapi's eruption and it is expected to replace silica as good as a synthesized silica. For that case, we need to use substitute materials which has the properties similar to silica and more reasonable price to be sold, one of the methods is the usage of surfactants made from coir-dust.

Indonesia is currently producing a large number of coir-dust. Coir-dust production in 2002 reached 85 million tons of dry coir-dust. Coir-dust is generated about 35% by weight of the whole coir-dust. However, not all coir-dust utilized optimally [5]. Therefore, coir-dust can be used as an additive compound to gain a high quality concrete using Merapi-sand eruption. Coir-dust fibers are relatively short, which is 1 mm long and for the diameter is about 15 microns, it has a high buoyancy, the ability to resist for some bacterias and salt water, and it's relatively cheap. Coir-dust is composed from organic matter and minerals, namely pectin, hemicellulose, lignin, cellulose, potassium, calcium, magnesium, nitrogen and protein.

Coir-dust contains 40 to 50 % of lignin [6]. High enough levels are expected to be a source of raw material in the manufacture of Sodium Lignosulfonate (SLS). These compounds can be used as an additive binder (binder agent) and an amplifier on the concrete mix [7]. These compounds will be absorbed on the surface of the particles when added to the concrete mix and perform a strong bond between the particles due to the adhesion properties and dispersion. Furthermore, SLS can inhibit the diffusion of water in the material due to the nature of hydrophobic ability. Thus, the use of SLS is expected to produce stronger concrete and relatively impermeable to the water [8].

The addition of coir-dust fiber into the concrete will generate a lot of benefits such as increasing the compressive strength of concrete which is commonly very low so that it will obtain a high-quality concrete, and concrete resistance against crack formation also increases, as well as slow flaking and cracking in concrete cover. Furthermore, the addition of coco-dust also increase the strain which can withstand some loads from various directions, because the fiber is randomly distributed in a concrete in close distance to one and another. Another good point is, it can improve the resistance to deformation of the concrete such as impact, greater ductility, flexural strength and a better torque capacity [6].

Lignosulfonate as a natural surfactant is widely used in the industry. The usage of lignosulfonate is very diverse, which can be used as a stabilizer in the oil drilling industry, solvent in a textile industry, an emulsifier in the lubricant manufacture, adhesives and a dispersant agent for gypsum board, an additive to the culture medium, as a plasticizer in the concrete mixture. As a water reducing admixture agent and also as a retarder [9]. Lignosulfonate is a water-soluble surfactant which is widely use also as a material admixture agent which is help the mixing process in the cement mill and make more solid construction as lignosulfonate and also a good binding agent.

SLS is a lignin derivative compounds obtained by sulfonation of these compounds. We need a lot of natural materials with a high content of lignin to get SLS in a sufficient quantities. A high content of lignin in coir-dust is expected to be a source of raw material in the SLS production. On its general term there are two methods to synthesize this compound, namely two-stage process and the one-stage process. The first method is referred to the indirect method by isolating compounds from coir-dust lignin first and then do the process to get a compound sulfonation to form SLS. The second method is called direct method for the preparation of compounds SLS process performed directly on coir-dust without prior isolation. From this study was obtained the result for the precursor of SLS and we found a suitable method so we can obtain a high level of SLS yield.

SLS which added to the concrete mix will enlarge and improve the compressive strength of concrete. We were used an SLS with different concentrations into the concrete mixture with the same composition to obtain the compressive strength of concrete in order to achieve optimum criteria of high quality concrete. The general objective of this research is to make high quality concrete by using a modified sodium lignosulfonate which formed from coir-dust as a raw material to be utilize as an additive solution in the earthquake-resistant building. The utilization of Merapi-sand eruption is expected as a source of materials for concrete to build a permanent shelter for the victims of Merapi's disaster.

## II. EXPERIMENTAL

### 1. First method of SLS synthesize

1.1. Purification of coir-dust

Coir-dust was shredded and pulverized using a collision to indicate a fairly fine powder. The powder was sieved using a 40 mesh sieve to obtain a homogenous powder coir-dust size. Fifteen grams of coir-dust added into 100 ml of 96% ethanol and 200 ml of benzene in a round bottom flask. Then reflux was carried out for 6 hours at a temperature of 80 oC. A mixture of the solvent and coir-dust was cooled into the room temperature. The mixture was then filtered using a Buchner filter and washed with 96% ethanol solution. The powder was added into 300 ml solution of 96% ethanol and put into a round-bottom flask. Then it is reflux method was carried out again for 4 hours at a temperature of 80 oC. The results from the reflux was filtered by Buchner filter and washed with distilled water. Powder screening results are put back in the round-bottom flask, and mixed with 500 ml of hot distilled water. After that, simmer for 1 hour in a water bath in a temperature of 100 oC. Then filtered with a Buchner filter and washed again with hot distilled water. Then the product powder was dried at a room temperature.

1.2. Isolation of lignin from coir-dust powder

One gram of purified coir-dust powder added to 15 ml of 72% H2SO4 solution at a temperature of 15 °C. The expansion was dropped into 100 ml of beaker glass. Stirred with stirrer glass until dispersed, and stirred for 2 hours while covered with a watch-glass. Put the powder in a 1 L round-bottom flask and distilled water were added as much as 300 ml. Once that was done, reflux for 4 hours using an oil bath. Reflux temperatures set to remain at 100 °C. The powder is then filtered with a Buchner filter and washed with distilled water. The powder formed of lignin powder was 0.67 grams. The powder was then analyzed with an infrared spectroscopy.

1.3. Sulfonation compound reaction of SLS

Some lignin compounds reacted with an aqueous sodium bisulfite solution (2%) with a ratio of 1:10. Furthermore the mixture was refluxed for 4 hours at a temperature of 100 °C and then filtered using a Buchner filter. The solid formation then washed with a solution of and Sodium Lignosulfonate was obtained. The characterization of compounds was carried out using FTIR instrument.

## 2. Second method of SLS synthesize

For the very first beginning of this step, coir-dust was dried into the sunlight then crushed until the coir-dust was formed. The powder then crushed into 40 mesh of its size. A total of 10 grams of coir-dust was treated with 100 ml of concentrated solution of sodium bisulfite (39%) then refluxed for 5 hours. The result was a mixture of solid with a blackish brown solution. The mixture was filtered with a Buchner filter and the filtrate taken. For further purification step, the compound of SLS evaporated by the distillation method.

## 3. Determination of the optimum concentration of SLS

Concrete molding has done by using a mixture of cement, sand and water. Molding has done by the usage of a cube mold with a comparison between the cement and sand composition is 1: 6. SLS powder was dissolved in water and then varied the concentration from 0%, 5%, 10%, 15%, 20% of the weight of the cement used, each variation was marked with A, B, C, D and E respectively. Then the solution of SLS was mixed into the concrete mixture. All variation of the SLS concentration printed as 6 pieces of concrete. Cast concrete was dried for three days, tested by the hardness tester "Universal Testing Machine" type TN20 MO in a material studies laboratory, Faculty of Engineering, University of Gadjah Mada.

# III. RESULTS AND DISCUSSION

The preparation of SLS in this study has been done by two methods, namely one-step synthesized and two-step synthesized. The first method is referred to the indirect method by the isolation of the compounds from coir-dust lignin at its first step and the process to get a compound sulfonation SLS conducted right after the isolation process. The second method is called direct method for the preparation of SLS compound; it was performed directly on coir-dust without any prior isolation.

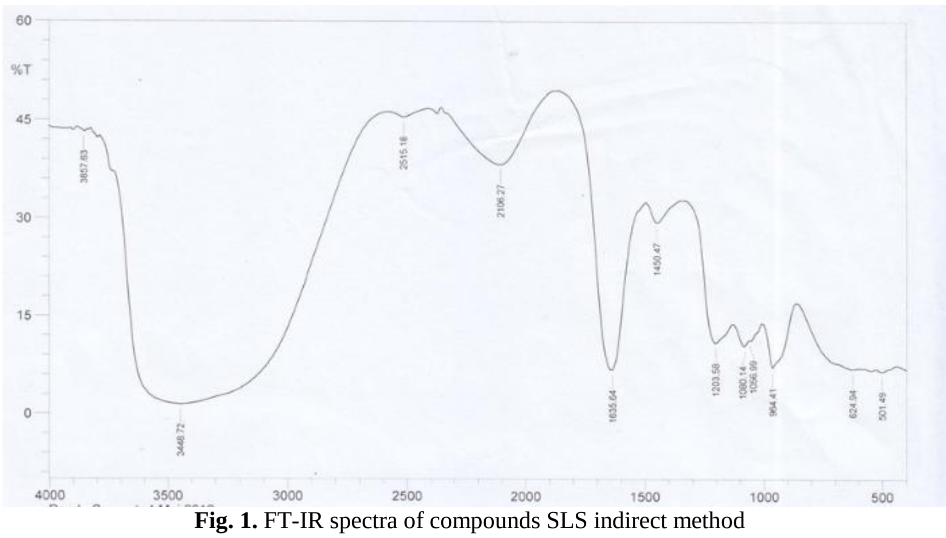


**Fig. 1.** FT-IR spectra of compounds SLS indirect method

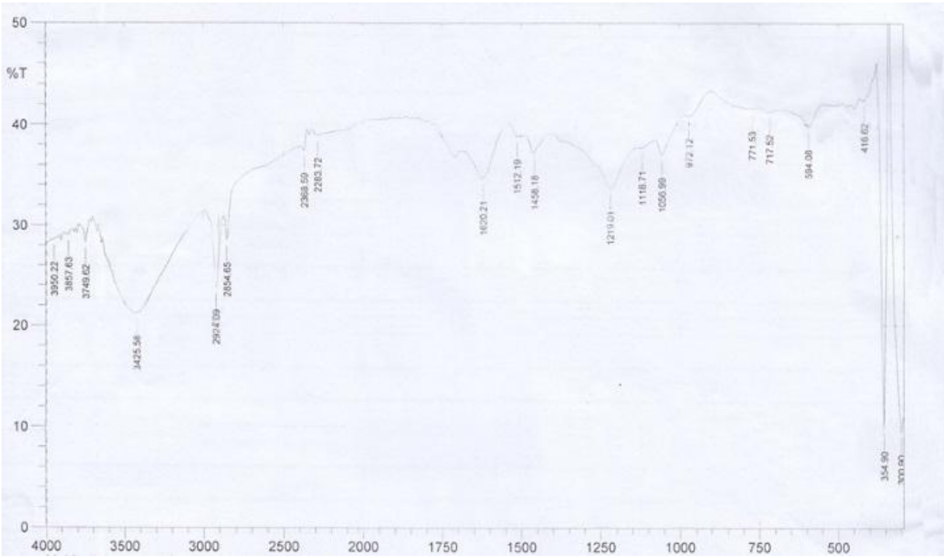


**Fig. 2.** FT-IR spectra of compounds SLS direct method

Based on its physical appearance of the SLS compound obtained from both methods shows that the direct method is better than the indirect method. This was appeared on the characteristics of the two products which were obtained. SLS compounds derived from indirect methods, appearing a yellow translucent brown straight color, we determined that this is not an SLS because SLS which currently appearing on our environment is in a chocolate color. It is also determined by the FT-IR spectra which shows that there is no absorption of S-O and S=O binding on its spectra's product (Fig. 1). Therefore, indirect methods can be categorized as unsuccessful method for the SLS synthesize. This is because the sodium bisulfite solution which used in the sulfonation has a high impurity. For its further prove to show that the compound is not an SLS, the small part of SLS was used with methanol, from this reaction, it will produce a sulfur precipitation.

The product of SLS obtained in the direct method was accordance with the characteristics of the standard compound. FT-IR spectra shows that there is absorption of S-O and S=O binding on its spectra's product (Fig. 2). So the compound is confirmed as SLS based on the standard. In order to obtain more products then this method is repeated 2 times so it can be used as an added ingredient in the manufacture of concrete. Once the substance of SLS obtained on the previous process, the process continued by processing the concrete. The process continued to determine the effect of the compound on a concrete compressive strength. The test results of some of the concrete compressive strength have varied on its concentration. It can be obtained the maximum concentration of the compound in order to get the highest compressive strength of the concrete.

From the Fig. 3, based on the test results, the maximum concrete compressive strength obtained at 10% of the SLS concentration However, the test of compressive strength of concrete shows that the concentration of SLS at 5% is lower than its standard. It provides the information that, in the 5% concentration of SLS makes the compressive strength of concrete decreased.

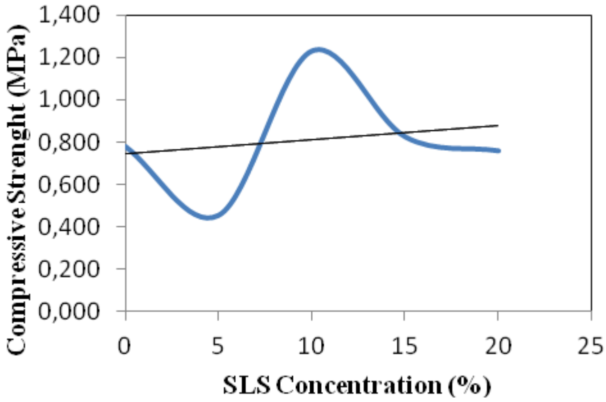


**Fig. 3.** The influence of SLS Concentration to the compressive strength of concrete

## IV. CONCLUSION

The results showed that the direct method a better product than the indirect method. It can be seen from the physico-chemical properties of the products of the two methods. The results also proved by analysis using Fourier Transform Infra-Red spectroscopy which showed the presence of characteristic functional group of compounds of SLS. The result from Universal Testing Machine testing indicates that the maximum concrete compressive strength was obtained on addition of 10% SLS compound with a compressive strength of 1,233 MPa. It is proved that the Sodium Lignosulfonate can increase the compressive strength of concrete.

## V. ACKNOWLEDGMENT

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## REFERENCES

[1] A. A. Idjudin, M. D. Erfandi and S. Sutono, *Teknologi peningkatan produktivitas lahan endapan volkanik pasca erupsi gunung merapi, DPPM & MTS UII*, 2011, Yogyakarta.

[2] D.A. Suriadikarta, A. Abbas, Sutono, D. Erfandi, E. Santoso and A. Kasno, *Identifikasi sifat kimia abu volkan, tanah dan air di lokasi dampak letusan gunung merapi*, Balai Penelitian Tanah, 2010, Bogor.

[3] Majhotta, *Fly Ash, Silica Fume Slag and Noturol PozoIons in Ctmc1ete,* American Concrete Institute, 1989, Detroit.

[4] B. Widhia, Suryadi, W. Firmansyah, B.W. Wahyu, N. Alfian, M.I. Amal, S.W. Agus and T.R. Nurul, Studi dasar posibilitas pemanfaatan bubuk silika dari batuan alam lokal dan lumpur lapindo sebagai bahan tambaban semen, *Jurnal Fisika dan Aplikasinya Volume 3*, 2000.

[5] A. Khuriati, E. Komaruddin and M. Nur, Disain peredam suara berbahan dasar sabut kelapa dan pengukuran koefisien penyerapan bunyinya, *Berkala Fisika Vol.9*, 2006, 1410 – 9662.

[6] Sunariyo, Karakteristik komposit teroplastik polipropilena dengan serat sabut kelapa sebagai pengganti bahan palet kayu, *Tesis Sekolah Pasca-Sarjana Universitas Sumatera Utara,* 2008, Medan.

[7] A. Amri, P.S. Utama, Padil dan M. Nasir, Sintesis of Sodium Ligno-sulfonate from empty fruit bunch using $NaHSO_3$: influence of concentration, liquid-solid ratio and pH, *Proceeding of 18th National Seminar,* 2007.

[8] J.D. Gargulak, L.L. Bushar and A.K. Sengupta, Ammoxidized lignosulfonate cement dispersant, *US Patent US 6,238,475 B1,* 2001.

[9] A. Suryani, J. Mangunwidjaja, E. Hambali and K. Anwar, Proses optimasi suhu dan konsentrasi sodium bisulfit ($NaHSO_3$) pada pembuatan sodium lignosulfonat berbasis tandan kosong kelapa sawit (TKKS), *J. Tek. Ind. Pert. Vol. 18*), 127-137, Departernen Teknologi lndustri Pertanian -PATETA IPB, 2008, Bogor.