Internasional Journal of Integrative Sciences (IJIS)
Vol.2, No.3, 2023: 379-386

Experimental Study of the Quality of Geopolymer Concrete with Wood Powder

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A R T I C L E I N F O

Keywords: Geopolymer Concrete, Sawdust, Setting Time

Received : 5 February
Revised : 18 February
Accepted: 20 March

A B S T R A C T

With the development of technology in the field of materials engineering, experts are working on existing problems in the field of construction. One of them uses eco-friendly waste as another alternative material and can be used as a substitute for cement in concrete mixes. The concrete mix produced is environmentally friendly as it uses industrial waste to completely replace cement. Concrete mixtures are known as geopolymers. This geopolymer concrete can be formed from raw materials containing many silica and aluminum elements. These elements are found in many industrial wastes, including fly ash. And many other wastes in use today are not used as substitutes for fly ash, but as additives. One such waste is sawdust. Waste from mechanical or manual cutting of wood. The lumber industry inevitably produces wood waste in the form of sawdust and chips. One solution is to turn this waste into value-added products using simple technology. One of them is the mixture used to make geopolymer design

DOI: https://doi.org/10.55927/ijis.v1i4.3421
ISSN-E: 2985-9050
https://journal.formosapublisher.org/index.php/ijis

INTRODUCTION

Concrete as the most popular building material consisting of a basic composition of coarse aggregate, fine aggregate, water and portland cement is a very important material and is widely used in the construction of various infrastructures. Infrastructure development, which is increasing day by day, also has an impact on increasing cement production. The uncontrolled use of construction materials also damages the environment and contributes to global warming. As material technology develops, experts solve problems that exist in the construction industry. One of them is environmentally friendly waste disposal as another alternative material that can be used as a substitute for cement in concrete mixtures. It can be said to be environmentally friendly because the resulting concrete mixture actually replaces cement by using industrial waste materials. The concrete mixture is known as geopolymer (Cahyadi et al., 2012).

As material technology develops, experts solve problems that exist in the construction industry. One of them is environmentally friendly waste disposal as another alternative material that can be used as a substitute for cement in concrete mixtures. It can be said to be environmentally friendly because the resulting concrete mixture actually replaces cement by using industrial waste materials. . Concrete mixes are known as geopolymers. Geopolymer concrete can be formed from raw materials containing high amounts of silica and aluminum elements. These elements are found in many industrial wastes, one of which is fly ash.

Based on PP No. 85 of 1999 concerning the management of hazardous and toxic waste, fly ash is categorized as a hazardous and toxic waste because it contains heavy metal oxides which will naturally leach and pollute the environment. Utilization of coal fly ash waste can overcome the waste produced. Besides being usable. Fly ash fly ash can be used as a raw material for construction. It is not only fly ash waste that is used as a material for making geopolymer concrete. Now many are using other wastes that are used, not as a substitute for fly ash but as an additional material. One of these wastes is sawdust (Boni et al., 2019). This substance cannot react alone for the binding process, but also requires an alkaline compound as an activator (NaOH) and a catalyst (Na2SiO3). It is not only fly ash waste that is used as a material for making geopolymer concrete. Now many are using other wastes that are used, not as a substitute for fly ash but as an additional material. One such waste is sawdust.

The waste generated from the sawmill industry is still not utilized optimally. According to Miniati (2014), if solid waste is stockpiled and decomposes due to the presence of microorganisms in the dry and rainy seasons, a process of breaking down organic matter by degrading bacteria occurs in an aerobic/anaerobic atmosphere which has an impact on health, including asthma, bronchitis and the respiratory tract. Meanwhile, the handling of sawdust waste is only left to rot, stacked and burned, all of which have a negative impact on the environment. One solution is to utilize this waste into a value-added product using simple technology. One of them is as a mixture for making geopolymer concrete (Muhammad Ikhwan et al., 2013), (Prasetya et al., 2019).

In the 2007 study by Siswadi, Rapa and Puspitasari using variations in the addition of sawdust of 0 kg/m3, 0.5 kg/m3, and 1 kg/m3 . 2014 research added sawdust 5gr/cube (Ariyani et al, 2014). The greatest compressive strength was obtained in geopolymer mortar with sawdust content of 10% cement substitute, namely 8.1 MPa at 7 days and 9.6 MPa at 28 days. While the smallest compressive strength was obtained in geopolymer mortar with sawdust content of 40%, namely 0.96 MPa at 7 days of age and 0.99 MPa at 28 days of age (Karyawan Salain et al., 2021), (Ginanjar et al., 2019), (Sulianti et al., 2021).

The addition of NaOH and Na2SiO3 as alkali activators with different ratios of alkaline activators, namely 1.5, 2.0, 2.5, with 8M NaOH, as well as composition of wood powder with variations, namely 0%, 5%, 10%, and 15% by weight of fly ash. Based on this description, the researcher will conduct a study entitled "Experimental Study of the Quality of Geopolymer Concrete With Wood Powder" with a ratio of sawdust and fly ash of 1:3. The purpose of this study was to determine the quality of geopolymer concrete mixed with sawdust.

METHODS

The research method is the method used in preparation to ensure that the implementation and results of the research can be accounted for. In this study using the experimental method. Tests on concrete compared the results of tests between concrete without using wood sawdust as a control sample with concrete mixed with wood sawdust as an experimental sample (Riger et al, 2016), (Julianto dkk et al., 2019), (Faradila syahrin fatiha et al., 2012), (Efendi et al, 2018).

This research was started by collecting party reviews from several journals and e-books to be used as a reference for making geopolymer concrete with sawdust and making sawdust waste as an added ingredient in a trial mix design. Preparation of sample mortar with a mix design of 5% and 10% fine powder and 5% and 10% coarse powder. The number of samples to be tested is 20 samples with an age of 14 days and with a print size of 5cm x 5 cm x5cm (Sulianti et al., 2021), (Sintya lestari et al, 2022), (Qomaruddin et al., 2019). The research method is a method used in preparation to ensure the implementation and consideration of research results, and this study uses an experimental method. In concrete testing, the results of testing concrete without sawdust as a control sample were compared to a mixture of concrete with sawdust as a test sample (Sengkey, S.L; Irmawaty, R; Hustim, 2020), (Januarti Ekaputri et al, 2013), (Edowinsyah et al, 2019).

This research began by collecting reviews from several journals and e-books to be used as reference material for the manufacture of sawdust geopolymer concrete and for the manufacture of sawdust waste as an additional material for a trial mix design. Sampling of sawdust waste material originating from one of the furniture in Jepara, precisely in Mulyoharjo Village RT 05/03, Jepara District, Jepara Regency. The research was conducted at the Construction Materials Technology Laboratory, Faculty of Science and Technology, UNISNU Jepara.

RESULTS AND DISCUSSION

1. Analysis of Mud Content in Fine Aggregate with Washing

The experiment was carried out with a washing system. From the experimental results obtained data:

Table 1. Mud Content in Fine Aggregate

Information	Experiment I	Experiment II
Initial weight of sand	100 gr	100 gr
Heavy after washing	97,4gr	98,1gr
Heavy after washing	2,6 gr	1,9 gr

The fine aggregate used contains 2.25% mud, so the fine aggregate can be used according to PBI 1971, that fine aggregate may not contain more than 5% mud (determined by dry weight) because the mud will form a thin layer on the surface of the fine aggregate which will can affect the bond between the paste and the fine aggregate. What is meant by mud is the part that can pass through a 0.063 mm sieve. If the silt content exceeds 5%, the fine aggregate must be washed.

2. Analysis of Organic Substances in Fine Aggregates

In the experiment of organic matter content, the color of NaOH obtained was blackish brown. These results do not meet the requirements of PBI 1971 N.I-

Figure 1. Organic Substances in Fine Aggregates

3. Sieve Analysis

From the results of the fine aggregate sieve analysis:

Table 2. Sieve Analysis of Fine Aggregates

Sieve Diameter (mm)	Remains on the Sieve				Cumulative Remaining Amount (%)	Passed Amount (%)
	Filter 1 (gram)	Filter 2 (gram)	Average gram)	%		
					0	100
9,52 mm	118	128	123	12,3 %	12,3	87,7
4,76 mm	99	88	93,5	9,35 %	21,65	78,35
2,36 mm	130	124	127	12,7 %	34,35	65,65
1,18 mm	139	118	128,5	12,85 %	47,2	52,8
0,6 mm	154	166	160	16 %	63,2	36,8
0,25 mm	137	175	156	15,6 %	78,8	21,2
0,15 mm	94	89	91,5	9,15 %	87,95	12,4
0,07 mm	102	91	96,5	9.65 %	97,6	2,4
0,0 mm	26	19	22,5	2,25 %	99,85	0,15
Amount	999	998	998,5	99,85		

Based on the results of the fine aggregate sieve analysis that has been carried out, the FM value obtained is 3.45. So that the value of Fine Grain Modulus (MHB) is classified as a rough category because it ranges from 2.5 to 3.5.

Figure 2. Sieve Analysis of Fine Aggregates

4. Water Cement Factor (FAS)

The water-cement factor (FAS) or water-cement ratio (wcr) is an important indicator in the design of concrete mixes because FAS is the ratio of the amount of water to the amount of cement in a concrete mix.

Calculation of the results of the water mixture:

Water: FAS x Fly Ash: 0.5 x 1200 grams: 600 grams

The activator mixture needed in 5 sample mortars is 600 grams. Then the FAS value of 0.5 is the type of concrete in the building space with a non-corrosive circumferential condition, referring to PBI 1971.

5. Initial Setting Time

The initial cement setting time is the time required from the start of measuring the paste to lose some of its plastic properties (become frozen). The initial setting must be slow, this is so that there is a pause between the stirring process and the construction process so that the work process is not difficult. According to SNI, the initial binding time is a minimum of 45 minutes and a maximum of 8 hours or 480 minutes. Initial setting time in this study, after 12 hours the geopolymer sample with 10% coarse powder mixture did not decrease while the geopolymer with 10% fine powder mixture experienced a 3 mm decrease. With this the initial cement setting time in this study did not meet the SNI.

CONCLUSIONS AND RECOMMENDATIONS

Geopolymer concrete using sawdust as an activator between NaOH and NaSiO3 cannot occur optimally. This is evidenced by the results of the setting time which exceeds the duration according to the standard, which is more than 12 hours. The longer the binding time, the longer the activator binds the filler material in the form of sand. So it can be concluded that the use of sawdust as geopolymer concrete cannot be done well for the laboratory scale even for the industrial scale.

FURTHER STUDY

It is necessary to examine the chemical content in the sawdust to obtain the cause of the sawdust not reacting to NaOH and NaSiO3 to form geopolymer concrete. This is because the chemical composition produced by sawdust cannot be equated with fly ash and bottom ash.

ACKNOWLEDGMENT

Thank you to LPPM UNISNU Jepara for funding this collaborative student research with lecturers. Thank you also to all parties who have assisted in the implementation of research and data processing of the results of this study.

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