Study Of The Utilization Of Carbide Waste And Fly Ash On Geopolymer Paste

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Abstract. Portland cement is made of the main ingredients are limestone / lime are included in natural resource that is not renewable. So that needs holding replacement with environmentally friendly materials one of which is of geopolymer concrete. Fly Ash is the waste coal combustion products also include natural resources that can not be refurbished. Based on data obtained from PT. Z, carbide waste generated in a year on average around 1978.72 m³, it can be put to good use for waste carbide itself has a high CaO content. The composition of the material used in this study was 100% waste carbide, carbide waste 50%: 50% fly ash, as well as 100% fly ash and the activator used as NaOH and Na₂SiO₃. This study aims to determine how much influence the utilization of waste carbide and fly ash in geopolymer paste in the testing setting time, compressive strength, porosity, UPV, and permeability. The highest compressive strength besides there on the composition of a 100% fly ash is also present in 50% of waste carbide composition: 50% fly ash with activator ratio of 0.5 at the age of 56 days amounted to 39.59 Mpa. The use of fly ash in geopolymer still can not be eliminated 100%, due to the utilization of waste carbide can only be used as an additive or filler.

1. Introduction

Portland cement is an industrial product used for normal concrete building materials made of main ingredients are limestone / lime high levels of calcium and clay, or other similar materials with the composition, including into natural resources that cannot be renewed. Natural resource exploration excessive, would disrupt the environmental balance [1, 2], it is necessary to the holding of a replacement with environmentally friendly materials one of which is a popular geopolymer concrete with fly ash as the main material of geopolymer concrete manufacture [6-9]. Waste fly ash is the result of burning coal in a steam power plant furnaces are pozolanik [3, 4]. Coal itself is a natural resource that cannot be updated [2] and if in continuously being explored would disrupt the balance of nature. For that we need in less utilization of fly ash, one of which is waste carbide. Waste carbide is the remainder of the evaporation of calcium carbonate powder with water from the manufacture of acetylene gas. Based on data obtained from PT. Z, carbide waste generated in a year on average around 1978.72 m³, it can be put to good use for waste carbide itself has a high CaO content [5]. Thus, in this study utilizes carbide waste and fly ash as the main material of geopolymer paste. The main objective of this research is to prove whether the waste fly ash can replace carbide or simply to minimize the use of fly ash as filler.
2. Methodology
The method used to answer this research is the experimental laboratory. Fly ash used in this study as the basic material for the manufacture of geopolymer from PLTU Paiton, Probolinggo. And the carbide waste is from PT. Z. To determine the chemical composition contained in fly ash and waste carbide, tests will be conducted SEM-EDX and XRF (X-Ray Fluorescence).

This study includes three series of studies, which is the study of literature, preliminary experiments and the main experiment. Activators for alkaline solution used is sodium silicate (Na₂SiO₃) and sodium hydroxide (NaOH) with molarity 8 M. For the manufacture of test specimens using a cylinder with a diameter of 2.5 cm x 5 cm and a cube of 15 cm x 15 cm x 5 cm. Tests include UPV and permeability with cube specimen conducted at the Laboratorium Beton Diploma Sipil, ITS Surabaya, compressive strength test using cylindrical performed in Laboratorium Struktur Teknik Sipil, ITS Surabaya and porosity test using cylinder conducted at the Laboratorium Jalan Diploma Sipil, ITS Surabaya.

3. Result and discussion
Some results from fly ash and waste carbide test are presented in the figure and the table below:

SEM fly ash test result has a relatively round grain shape so it is more easily oxidized than the carbide waste that is shaped like clod. So, the faster the oxidation process, the faster the binding occurs[10].

Figure 1. Fly Ash in magnification of 500x.
Figure 2. Fly Ash in magnification of 1000x.
Figure 3. Waste Carbide in magnification of 500.
Figure 4. Waste Carbide in magnification of 1000x.
**Table 1.** The XRF Test Result of Waste Carbide.

| Type Compounds | Content (%) |
|----------------|-------------|
| SiO₂           | 3.91        |
| Fe₂O₃          | 0.87        |
| Al₂O₃          | 2.01        |
| CaO            | 91.48       |
| MgO            | 0.23        |
| Na₂O           | 0.72        |
| K₂O            | 0.07        |
| MnO            | 0.02        |
| ZnO            | 0.01        |
| TiO₂           | 0.14        |
| SO₃            | 0.27        |
| P₂O₅           | 0.01        |

**Table 2.** The XRF Test Result of Fly Ash.

| Fly Ash Type F (Paiton) | Type Compounds | Content (%) |
|-------------------------|----------------|-------------|
| SiO₂                    | 47.1           |
| Fe₂O₃                   | 16.07          |
| Al₂O₃                   | 24.25          |
| CaO                     | 5.83           |
| MgO                     | 2.62           |
| Na₂O                    | 0.65           |
| K₂O                     | 1.64           |
| MnO                     | 0.1            |
| ZnO                     | 0.29           |
| TiO₂                    | 1.16           |
| SO₃                     | 0.21           |
| P₂O₅                    | 0.18           |

From the XRF test results known that the fly ash used in this study contains a compound of Si + Al + Fe > 70%. CaO <10%. So that the fly ash used is type F. CaO content of fly ash used in this study is 5.83%, according to ASTM C 618-84 fly ash which has a CaO content of less than 10% is classified in type F.

Here are the test results setting time, compressive strength, porosity, and permeability UPV presented in Graph 1 - Graph 6. From Figure 1, note that setting the fastest time of 50% occurred in the composition of waste carbide: 50% fly ash with a time of 30 minutes 0mm in comparison with a decrease of 0.5 activator. In Figure 2 the compressive strength test, the highest yields are on a 100% fly ash composition age of 56 days with a ratio of 1.5 activator of 39.72 Mpa and 50% of waste carbide: 50% fly ash age of 56 days with a ratio of 0.5 activator 39.59 Mpa. While Graph 3 test porosity, low porosity values occurred in the composition of a 100% fly ash age of 56 days with 1.5 activator ratio of 12.64%. Graph 4 UPV test, the highest yields are on a 100% fly ash composition age...
of 56 days with a ratio of 1.5 activator of 3556.67 m/s. Graph 5 permeability test, the result was lowest for the composition of a 100% fly ash age of 56 days with a ratio of 1.5 activator of 0.002 E-16 m2 and 50% of waste carbide: 50% fly ash age of 56 days with 0.5 activator ratio of 0.001 E-16 m2. And in Chart 6, the compressive strength of the age of 3 days with a special activator ratio of 0.5 and 1.5, the main composition of 100% Waste Carbide, 50% Waste Carbide: 50% Fly Ash and Fly Ash 100% as well as an additional 75% Waste composition carbide: 25% fly ash and 25% waste carbide: 75% Fly Ash can be seen that the percentage of waste carbide may slightly increase the compressive strength of 100%, while the percentage of waste carbide compressive strength is very weak compared with the composition of the mixture.

Graph 1. The Setting Time Test Result.

Graph 2. The Compressive Strength Test Result.
Graph 3. The Porosity Test Result.

Graph 4. The Ultrasonic Pulse Velocity (UPV) Test Result.

Graph 5. The Permeability Test result.
4. Conclusion

The highest compressive strength besides there on the composition of a 100% fly ash is also present in 50% of waste carbide composition: 50% fly ash with activator ratio of 0.5 at the age of 56 days amounted to 39.59 Mpa, 0.13 Mpa only difference from the composition of 100% fly ash with a ratio of 1.5 activator at the age of 56 days of 3.72 Mpa. The use of fly ash in geopolymer still cannot be eliminated 100%, due to the compressive strength all age composition 3 days, it was found that the lower the percentage of waste carbide used the higher the compressive strength obtained. It can be concluded that the waste carbide can only be used as a filler can only minimize the use of fly ash with a maximum percentage levels of 50%.

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