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A WASTE PAPER MILL SLUDGE ASH BASED GROPOLYMER CONCRETE

Kale Satish[*1], Pawar Dayanand[2], Mungase Sagar[3], Pachpute Abhishek[4]

[*1, 2, 3, 4] Lecturer in Civil Engineering Department, Jaihind Polytechnic, Kuran (Pune, Maharashtra) India

ABSTRACT

India is one of the most developing countries that need to face major environmental pollution. Have many ways to minimize environmental pollution that causes by production of Portland cement and cause by the increasing of wastage material. Geopolymer concrete incorporate with recycle concrete aggregate (RCA) is one of the best methods. Waste Paper Mill Sludge Ash (WPMSA) and alkaline liquid fluid as a binder are being used to replace the Portland cement to produce geopolymer concrete. The alkaline liquid that has been used in geopolymerisation is the combination of sodium hydroxide (NaOH) & sodium silicate (Na_2SiO_3). At the present study, two (2) series of geopolymer concrete specimens composing of two different molar of the sodium hydroxide (NaOH) which are 8M (Molarity) and 14M (Molarity) were adopted. There are 30 cube specimens at size 100mm x 100mm x 100mm are prepared which is 15 cubes for 8M (Molarity) and another 15 cubes for 14M (Molarity). The compressive strength of the geopolymer concrete specimens is tested at the age of 3, 7, 14, 21 days and 28 days after cured in local laboratory ambient condition. The result shows that the strength of geopolymer concrete based Waste Paper Mill Sludge Ash (WPMSA) incorporating with recycle concrete aggregate (RCA) increase by increasing the molarities of sodium hydroxide (NaOH).

Keyword- *Geopolymer concrete, Waste Paper Mill Sludge Ash (WPMSA), Water, NaOH & Na_2SiO_3 Recycle Concrete Aggregate (RCA), and Concrete strength.*

I. INTRODUCTION

At the present time, Portland cement (PC) concrete is the most popular and widely used building materials, due to its availability of the raw materials over the world, its easiness for preparing and fabricating in all sorts of conceivable shapes. The applications of concrete in the area of infrastructure, habitation, and transportation have greatly prompted the development of civilization, economic progress, and stability and of the quality of life. However, due to the restriction of the manufacturing process, the raw materials, & some inherent disadvantages of Portland cement are still difficult to overcome. There are two major drawbacks with respect to sustainability. About 1.5 tonnes of raw materials is needed in the production of every tonnes of Portland cement, at the same time about one tonnes of carbon dioxide (CO^2) is released into the environment during the production [1]. Therefore, the production of PC is very resource and energy intensive process. On the other hand, the global warming also can take place because of the greenhouse gases such as carbon dioxide (CO_2) to the atmosphere.

a number of studies have been carried out to reduce the use of Portland cement in concrete to address the global warming issues. These include the utilization of supplementary cementing materials such as fly ash, silica fume, granulated blast furnace slag, rice-husk ash & metakaolin, and the development of a alternative binders to Portland cement [2]. Other type of ash is Waste Paper Mill Sludge Ash (WPMSA) which is a by-product from the paper mill sludge where it is a de-inking and re-pulping of paper. WPMSA compose of some oxide materials derived from inorganic compounds that remain present after burning. WPMSA have similar characteristic like fly ash that contains a large quantity of silica and alumina, it is suitable source to making the geopolymers [3].

Recycle Concrete Aggregate (RCA) is the main components of old concrete and for many reasons there is a need to re-use them. It is better to the reuse of waste aggregates as recycled aggregates in structural concrete, instead of throwing out as a total waste material. Thus in current years, the use of recycled concrete aggregate has gained remarkable momentum in constructional engineering. Utilization recycling of the waste concrete would benefit into two folds. First, reduce the environmental problems and second reduce the utilization of the natural resources. By the production and use of RCA, these advantages include that lower environmental pollution, reduction in valuable landfill space, and savings in natural aggregate resources, [4].

II. PROCEDURE OF EXPERIMENT

In this experiment studies the strength characteristic of geopolymer concrete that containing Recycled Concrete Aggregate (RCA). To produce geopolymer concrete in this study, materials which are Waste Paper Mill Sludge Ash (WPMSA), sodium hydroxide solution (NaOH) and sodium silicate solution (Na_2SiO_3), water, recycled concrete aggregate (RCA) and super-plasticizers will used in this study. The Aggregate Impact Value (AIV) and Aggregate Crushing Value (ACV) for the aggregate were tested. The

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AIV and ACV testing are tested as accordance to Indian Standard. Two (2) series of mix proportion with different concentration at 8 Molar and 14 Molar of sodium hydroxide solution (NaOH) mixing with sodium silicate solution (Na_2SiO_3) were adopted. For each series, fifteen (15) concrete specimens are being casted. The total numbers of specimens is 30. The dimension of concrete specimen is 100 mm x 100 mm x 100 mm & the detail of concrete specimens as shown in Table 1. After casting for 24 hours, the moulded concrete was de-moulded. The de-moulded concrete specimens were cured at ambient condition. The curing time difference from 4 hours to 96 hours (4 days). After curing process, the concrete specimens were the compressive strength of the geopolymer concrete at the age of 3, 7, 14, 21 and 28 days. The compressive strength will be tested as accordance with BS 1881: Part 2. Also, the compressive strength for the two (2) series concrete specimen was recorded. The effect of using different NaOH concentration was assessed.

Production of RCA:-

The RCA is a from tested concrete cube specimens in lab concrete or in site construction. The tested concrete cubes are getting from Easy Mix mixture plant. The concrete cube was crushed using Jaw crusher machine at lab concrete. After the crushing process, the RCA were graded to the particular size. Then the RCA are sieved using sieves to separate the fine and coarse RCA. Fig. 1 shows the flow of the RCA production.

Fig. 1. Production of RCA

Production of WPMSA:-

Waste Paper Mill Sludge Ash (WPMSA) will be used as a binder to replace cement. Cement is not used in this present study. The mineral phases contained in WPMSA are CaO, gehlenite (calsium aluminate silicate) and quartz. The source of WPMSA is getting from Malaysian Newsprint Industry (MNI) Mentakab, Pahang. The fig- 2 shows the production procedures of WPMSA that were used in this study and table 1 show the chemical and physical properties of WPMSA [5] and the comparison chemical composition of high calcium Fly ash [21]. Based on the Table 2, the chemical composition of a high calcium fly ash is different for particular grain size fractions.In finest fractions a higher content of calcium compounds was found, while in coarser particle fractions (40–60 m, >60 m) SiO2 is a main component [21].

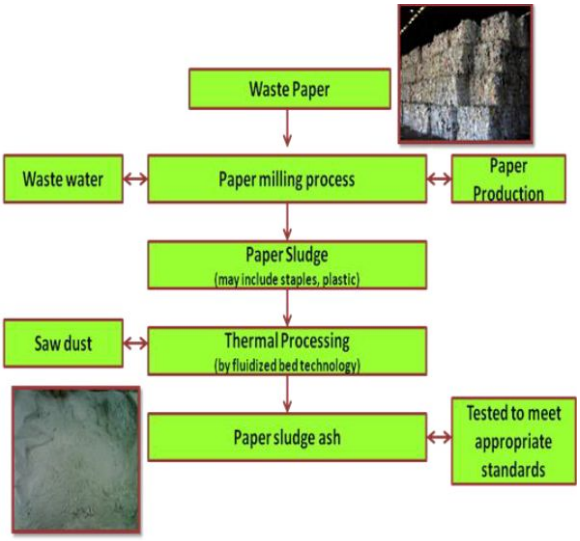

Fig. 2. Production process of WPMSA

Table 1- Chemical composition for concrete

Chemical Composition		
Oxide	**WPMSA (%)**	**FLY ASH (%)**
SiO_2	26.25	42.8
CaO	66.39	23.4
Al_2O_3	14.26	17.5
Fe_2O_3	0.77	4.4
MgO	5.46	0.9
Na_2O	0.42	0.1
K_2O	0.35	0.2
SO_3	0.58	4.3
LOI	14.83	2.1

Table 2- Physical composition for concrete

Physical Properties (WPMSA)	
Specific Gravity	1.9
Colour	White
Passing 75 µm sieve (%)	80

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III. RESULT AND DISCUSSIONS

If using higher concentration of sodium hydroxide it gives the higher compressive strength of the concrete because the higher concentration of NaOH will make the good bonding among aggregate and paste of the concrete. Naturally, for the normal concrete, the strength at 3 days will shows the result of the strength at 28 days which is strength at 3 days is 2/3 of the strength at 28 days but it is different with geopolymer concrete. The figures below which are Figured 3 and Figure 4 show the different molarities give the different result of strength at 7 and 28 days respectively. Base on the graph, the age factor between 8 molar and 14 molar NaOH is quiet similar from age at 3 days until 28 days. The graph also shows the strength development in the geopolymer concrete which is at 7 days the strength increase almost 90 percent of the strength geopolymer concrete at the 28 days. Besides that, the records from the Aggregate Impact Value (AIV) and Aggregate Crushing Value (ACV) of the Recycled Concrete Aggregate (RCA) are 23.95% and 19.33% respectively. These percentages show that the RCA was not been treated with caution.

Moreover, from Valeria Corinalde is concluded that the WPMSA, particularly if it replaces less than 10% of cement, show a positive effect on time development of concrete mechanical performance. Probably, WPMSA can give an active contribution to cement paste hardening (positive value of the cement activity index). On the other hand, due to its high fineness, and consequently high water absorption, the dosage of WPMSA should not be too high (the upper limit appears to be 10% by weight of cement). [22]

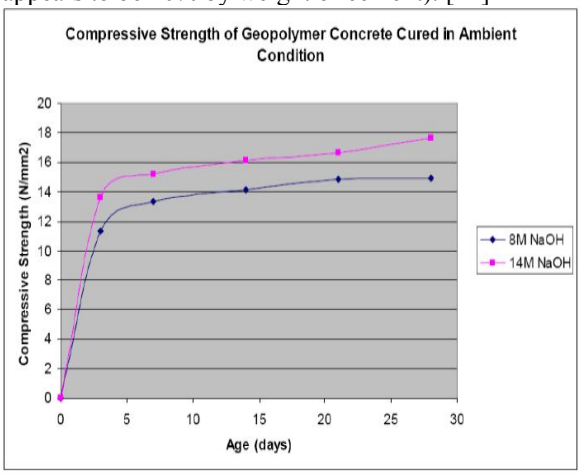

Fig.3. Compressive Strength of GPC with different molarities of sodium hydroxide (NaOH)

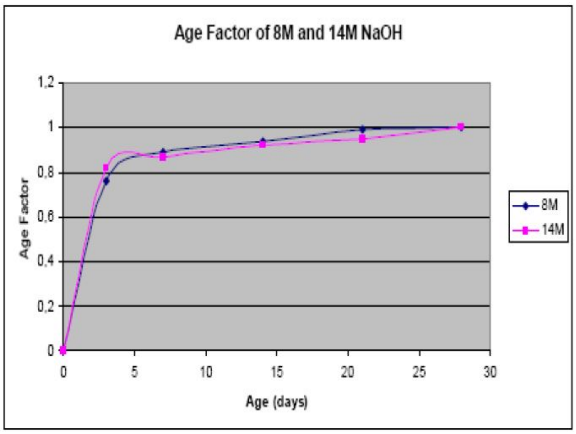

Fig.4. Age factor of 8M and 14M NaOH based on the strength of Geopolymer concrete

IV. CONCLUSION

This paper we can be concluded that:-

- The concentration (in term of molarity) of NaOH influenced the strength characteristic of geopolymer concrete. The higher concentration of sodium hydroxide (NaOH) solution, higher compressive strength of the geopolymer concrete will produced because the higher concentration of NaOH will make the good bonding involving between aggregate and paste of the concrete.
- Geopolymer concrete containing Waste Paper Mill Sludge Ash (WPMSA) will set more rapidly and rapidly hardened compare to geoplymer concrete containing Fly Ash. It happens because of Waste Paper Mill Sludge Ash (WPMSA) containing higher number of calcium in chemical composition compare to the fly ash [15].
- From the end result justification, this new green material we can be use in infrastructure work and further experiment are needed to get the effect of using different % of RCA and WPMSA.

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future research.

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