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RHA_SSA: PARTIAL CEMENT REPLACEMENT IN GREEN CONCRETE

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ABSTRACT

Sludge is an unavoidable product of wastewater treatment and creates problems of disposal. For highly urbanized cities, sludge disposal by land filling might not be appropriate due to limitation of land. Using RHA_SSA for this study will encourage Malaysia to build more low carbon and sustainable building construction. Finding more alternative materials in enrich concrete structure and at the same time promoting the environmental sustainability is a must for Malaysia as developing country with increasing number of infrastructures built throughout the year. This research had been studied the effect of partial replacement of cement by Sewage Sludge Ash (SSA) and Rice Husk Ash (RHA). The effects on the nature of concrete exhibited mechanical properties of concrete such as compressive strength, water absorption, from a combination of sewage sludge ash and rice husk ash at different proportions. There were 108 samples had been prepared at different percentages of replacement of cement by using sewage sludge ash and rice husk ash. RHA_SSA are used as partial replacement of cement for 10%, 20%, 30%, 40% and 50% in the concrete. The samples had been tested with compressive test. From the results, initially, there was an increment compressive strength of concrete at 10% amount replacement SSA and RHA, but the compressive strength declined when the amount replacement SSA and RHA are developing more than 10%. In addition, the concrete also showed increasing of compressive strength within the additional curing period, which was 7 days, 14 days and 28 days. Therefore, there is potential to reuse this waste material as part of construction materials and for future researches in minimization of waste.

Keywords: rice husk ash, sewage sludge ash, compressive strength, concrete, green

1. INTRODUCTION

Malaysia have been handling over 4.5 million cubic meters of residential sludge since 2005 according to Indah Water Konsortium (IWK) and the quantity of the sludge has been increased from year by year. [1] The treatment of wastewater sludge is quite expensive and cause the environmental problems as an overwhelming huge quantity of wastewater sludge produced every year. [2] Thus, the wastewater sludge will be disposed to landfill and spreading on reclaimed land. Sludge contains heavy metals such as nitrogen, phosphorus and potassium that can harm the environment. The used of cement contributes to the emissions of carbon dioxide which can cause the global warming. [3] The high usage of concrete in construction will lead to environmental problem because cement is one of major contributor of carbon dioxide emission. [4,5] Replacing wastewater sludge as a partial replacement of cement is necessary to reduce the cement production and thereby reduce the disposal problem of wastewater sludge. The additive of wastewater sludge in concrete tends to slow the curing process and decreases the properties of concrete. [6] The compressive strength of the concrete cubes is decreased, and water absorption of wastewater sludge increased as the percentage of the replacement increases.Pozzolanic properties which influence the strength development abilities is a necessary condition for any material to be considered for structural applications. This property is of utmost importance for it is an indication of its ability to participate in the reaction that

lead to the formation of strength in concrete. Study on pozzolanic properties in RHA done by [7,8] showed that the presence of amorphous silica in RHA, its fineness and high specific surface area contribute to high pozzolanic activities. [9] found out that the pozzolanic activities increased with increase in the degree of its amorphousness but decrease with the particles size of the RHA. The major elements of SSA, such as Si, Al, Ca, Fe and P are always have quartz (SiO_2), whitlockite (Ca_3 $(PO4)_2$) and hematite (Fe_2 O_3) to form crystalline. This is an important characteristic when considering SSA as a potential pozzolanic additive in blended cements [10]. Knowing the potential of this Sewage Sludge Ash (SSA) and Rice Husk Ash (RHA) as building material, a study was initiated to investigate the potential use of the locally available SSA and RHA as partial replacement for cement in Grade 30concrete in terms of its compressive strength. The use of wastes in construction can conserve non-renewable resources, make products more cost competitive and reduce the amount of waste disposed of to landfill.

2. MATERIAL AND METHOD

Materials Rice Husk Ash (RHA) was originated from the rice mill Padiberas Nasional Berhad (BERNAS) in Pinang Tunggal, Pulau Pinang while Sewage Sludge Ash (SSA) was generated from the sewerage treatment plant (STP) from UiTM Pulau Pinang. The design mix for a proportion of Portland cement (OPC), sewage sludge ash (SSA), rice husk ash (RHA), coarse and fine aggregate and water were prepared. The water cement ratio used in this study was 0.54.The samples have been subjected to five different percentages of RHA and SSA replacing cement, which is 10%, 20%, 30%, 40% and 50% These concrete specimens were casted in cube concrete cube with the dimension of 100x100x100 mm. Another batch of control conrete also prepared for this study without adding RHA and SSA ın the mıx propotıon. After 24 hours of castıng, concrte specımens were remolded and cured under the water curıng condıtıon. The entıre specımens were tested for compressıve strength at the age of 7,14,28 days. The purpose of compressive strength is to determine the ability of specimen to cater the load and estimate the characteristic of ductile and plastic material limitations by compressing specimens in a compression test machine. The test was conducted accordıng to BS 1881-108:1983.

3. FINDINGS

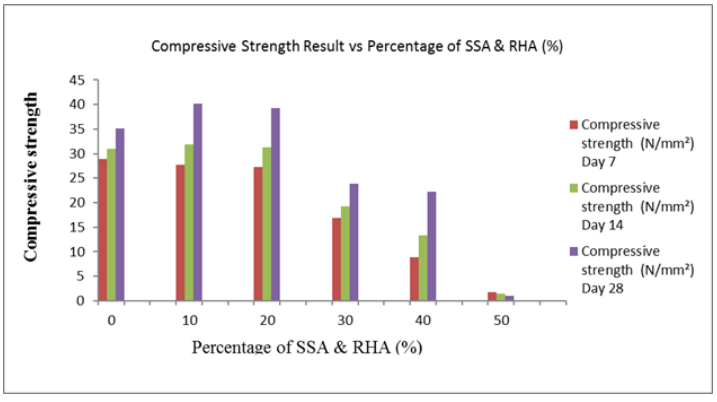

Figure 1. Compressive Strength Result of OPC and different percentages of SSA and RHA in concrete (%)

The highest value of compressive strength is 5%RHA+5%SSA which is 31.87 N/mm² at 14 days and 40.15 N/mm² at 28 days as shown in Figure 1. Meanwhile, the 25%RHA+25%SSA combination achieved the lowest value of compressive strength for all curing times, which is 1.72 N/mm², 1.49 N/mm² and 1.03

N/mm² respectively. There are several factors that affected the declination of strength in RHA and SSA concrete. One of the factors is the reduced amount of cement in the concrete. According to [11] and [12] stated that the reduction of the amount of cement concrete will lessen the hydration process. When the amount of cement reduced, the hydration and hardening process will become less. Hence, the components of mixed concrete will not effectively be combined.

4. CONCLUSION AND RECOMMENDATION

From discussion of the present study, the findings are outlined as follows:

i. Reusing RHA and SSA as cement replacement in concrete mix enhanced the compressive strength of RHA +SSA concrete.
ii. The optimum value of RHA and SSA concrete is at 10% replacement, which is high compressive strength, 40.15 N/mm² at 28 days. The pozzolan effect developed at optimum which makes the concrete become durable than OPC.

More exploration in many factors need to be conducted to verified and produce a better quality of RHA+SSA concrete. It is suggested that this local made RHA and SSA to be reused as partial cement replacement in making concrete or any reinforced concrete structure such as wall panel, slab, culvert drain etc. Nevertheless, deep researches regarding this matter need to be accomplish before it is being practically used.

REFERENCES

1. Guan, T, K. (2015). The use of sewage sludge ash (SSA) as partial replacement of cement in concrete (Bachelor Engineering). Universiti Malaysia Pahang. http://www.researchgate.net/publication/283007823
2. Amminudin, A, L., Ramadhansyah, P, J., Doh, S, I., Mangi, S, A., & Haziman, W, I, (2019). Effect of dried sewage sludge on compressive strength of concrete. Doi: 10.1088/1757-899X/712/1/012042
3. Ing, D, S., Chin, S, C., Guan, K, T., & Suil, A. (2016). The use of sewerage ash (SSA) as partial replacement of cement in concrete. Journal of Engineering and Applied Sciences.
4. Jamshidi, M., Jamshidi, A., & Mehrdadi, N. (2011). Application of sewage dry sludge in concrete mixtures. Asian Journal of Civil Engineering (Building and Housing).
5. Jamshidi, M., Jamshidi, A., Mehrdadi, N., & Pacheco-Torgal, F. (2011). Mechanical performance andcapillary water absorption of sewage sludge ash concrete. International Journal of Sustainable Engineering.Doi: 10.1080/19397038.2011.642020.
6. Mandlik, A, D., & Karale, S, A., (2018). Sludge use in concrete as a replacement of cement. International Journal for Research in Engineering Application & Management (IJREAM). Doi: 10.18231/2454- 9150.2017.0070
7. Antiohos S K, Papadakis V G and Tsimas S 2014 'Rice Husk Ash (RHA) Effectiveness In Cement and Concrete as A Function of Reactive Silica and Fineness' Cement and Concrete Research 61-62 (2014): 20-27
8. Kartini K 2011 Rice Husk Ash – Pozzolanic Material for Sustainability International Journal of Applied Science and Technology Vol. 1 No. 6 169-178
9. Mehta, P K 1992 Rice Husk Ash – A unique supplementary cement material Proceeding of International Conference on Advance in Concrete Technology – CANMET. Greece, pp. 407-431
10. Doh S I, Siew C C, Tan K G and Adilen S 2016 The Use of Sewage Sludge Ash (SSA) As Partial Replacement of Cement in Concrete ARPN Journal of Engineering and Applied Sciences, Vol. 11, No. 6, March 2016,3771- 3775

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Sekian, terima kasih.

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