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PHYSICAL PROPERTIES OF CONCRETE WITH RICE HUSK ASH (RHA) AS MINERAL ADMIXTURE AND CRUSHED CERAMIC TILES AS REPLACEMENT TO COARSE AGGREGATES

Siti Nur Aishah Mohd Noor[1], Rohasnita Roslan[2], Norrazaman Zaiha Zainol[2] and Shariffah Zatil Hidayah Syed Jamaludin[3]

[1]*Department of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, 32610 Perak, Malaysia*

[2] *Department of Civil Engineering Technology, Faculty of Engineering Technology, Universiti Malaysia Perlis, Padang Besar, 02100, Perlis, Malaysia*

[3] *Department of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA Shah Alam, 40450 Shah Alam, Selangor, Malaysia*

Abstract

Rice Husk Ash (RHA) is an agro-waste material that is highly produced in Malaysia over the year containing high amorphous silica which can improve the performance of the concrete. It is economical to be used in partial replacing or as mineral admixture in the Ordinary Portland Cement. Meanwhile, the waste from the ceramic tiles is beneficial to be used in concrete as coarse aggregates replacement due to its characteristic of ceramic tiles which are hard and durable. This research intended to study the effect of physical properties of RHA as mineral admixture for cement in concrete and also the effect with addition of crushed ceramic tiles (CCT). In this study, the RHA has been replaced at 10% by mass of cement as mineral admixture with various percentages of CCT as coarse aggregates starting from 0%, 5%, 10% and 15%. Workability, density and water absorption tests have been conducted to study the physical properties of the concrete. The results obtained show that 10% is the optimum percentage for CCT in concrete with 10% of RHA.

Keywords: *rice husk ash; crushed ceramic tiles; concrete; aggregates*

1.0 INTRODUCTION

Concrete is a composite substance that contains a few elements such as cement, water, coarse aggregates and fine aggregates. Cement is a powder that has cementitious properties and a binding agent to the aggregates and water. Recently, recycled material has been widely used in concrete to overcome the environmental problem. Besides that, the recycle material is also good to be used in concrete to provide a good management of waste disposal instead of being abandoned or just thrown away. Most of the waste material has their own value depending on how they are utilized. Rice Husk Ash (RHA) has been utilized in concrete as mineral admixture in cement due to pozzolanic material. Nithyambigai (2005) stated that RHA is a pozzolanic material that contains 85% of silica content. RHA also was added as a partial replacement in cement characteristic of cementitious and enhanced the strength of the concrete.

On the other hand, the waste disposal such as ceramic tile can be used as coarse aggregates replacement in concrete. The production of the solid waste is increasing due to its high demand in the construction industry. The replacement of CCT (Crushed Ceramic Tiles) potentially applied in aggregate replacement in a large amount. This idea can decrease the request on natural aggregate such as riverbed stone or pulverized stone that would be pulled from the earth and transported in some cases distant separations for utilization in concrete, Anderson, Smith, & Au (2016). Dhrolwala, Kanani, Patel, & Soni (2018), in their research, analyses the mix design of concrete using ceramic waste and rice husk ash where they have replaced the ceramic tile as coarse aggregates and fine aggregate at certain percentage. Besides, the research also produced a few mix designs for concrete with RHA and ceramic waste to study the mechanical properties on various mix designs.

Therefore, this research was done to study the physical and mechanical properties of concrete with rice husk ash (RHA) as mineral admixture and crushed ceramic tiles (CCT) as partial replacement to coarse aggregates. In this research, concrete grade 25 was designed and the RHA has been replaced at 10% by mass of cement as mineral admixture with various percentages of CCT as coarse aggregates which is 0%, 5%, 10% and 15%. There are 60 cubes samples and 30 beams size samples were prepared to study the physical and mechanical properties of the concrete. The sample was cured in water for 7 and 28 days. The physical properties were examined by conducting workability, water absorption and density tests.

2.0 METHODOLOGY

2.1 Materials

The materials used in this research are Ordinary Portland Cement (OPC), RHA, fine aggregates, coarse aggregates of CCT and tap water. The grade of OPC ARE 42.5 and the RHA was obtained from the rice mill. Then it was re-combustion using a furnace at 550 degree Celsius for 2 hours. RHA was used as admixture at 10% by mass of the cement. The coarse aggregates with relative density of aggregate (SSD) according to JKR standard has been used in this research and the aggregate size used was maximum at 20mm. The desired size of gravel was obtained by using the sieving machine in the laboratory. Same as CCT, it was crushed into a maximum size of 20mm. The broken and rejected ceramic tiles were collected from the store, Acfirst Ceramic Sdn. Bhd, located in Jitra, Kedah.

2.2 Methodology

All of the materials have been prepared and weighed carefully according to the mix proportion of that has been designed with 0.54 water cement ratio. The concrete was mixed with the concrete mixer. The mass of each material for different percentages of CCT was shown in Table 1. Slump test has been performed to fresh concrete once concrete mixing was ready to check the consistency and the workability of the fresh concrete before it will be set by using a tamping rod, slump cone, and plate concrete. The slump cone was put on the plate, the cone will be filled up with fresh concrete at three layers. Each layer was tamped with the standard 16mm diameter steel rod. The cone must be held firmly at the base during the tamping for 25 times. For the last layer at the top of the cone will be levelled using a trowel. Then the cone was lifted up carefully and placed beside the concrete to measure the slump that occurred. The free concrete that has no support was slump and reduction in height has been measured from the center of the slump concrete. The standard use for slump test is based on BS 1881-102, (1983). Then the concrete was placed in the mound followed by compacting using the concrete vibrator. After 24 hours, the concrete was hardened and continued the curing process for 7 and 28 days. The water absorption was carried out according to BS 1881-122, (1983) while the density test was carried out according to BS 1881-114, (1983).

Table 1: Mix proportion for each mix

Cement (kg)	RHA		Water(kg)	Fine aggregate (kg)	Coarse aggregate (kg)	CCT	
	%	Mass (kg)				%	Mass (kg)
4.56	0	0	2.46	10.08	11.82	0	0
4.10	10	0.46	2.46	10.08	11.82	0	0
4.10	10	0.46	2.46	10.08	11.17	5	0.59
4.10	10	0.46	2.46	10.08	10.58	10	1.18
4.10	10	0.46	2.46	10.08	8.26	15	1.76

3.0 RESULT

3.1 Workability

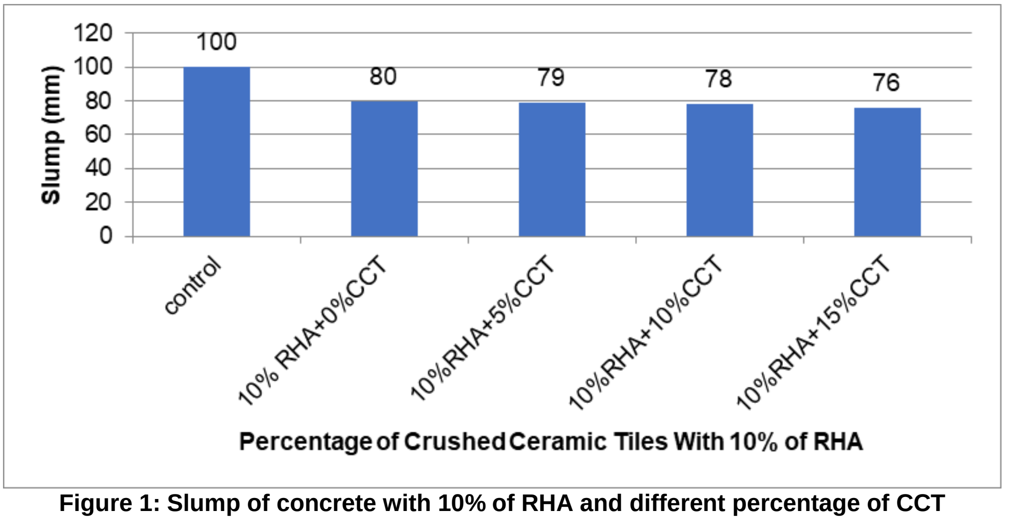

Figure 1: Slump of concrete with 10% of RHA and different percentage of CCT

Workability of the concrete was determined by a slump test and also as the first stage to indicate whether the concrete is acceptable or not. The acceptable slump for concrete with 0.54 water cement ratio is 60mm to 80mm of reduced height. Figure 1 shows the slump value for the concrete at different percentages of CCT. The slump value decreases as the percentage of the CCT increases. The highest slump can be seen on the control sample while the lowest slump obtained by the sample with 15% replacement of CCT.

Figure 1 shows that the slump of the fresh concrete decreases as the replacement of CCT increases. It is due to the RHA that absorbs more water and causes the fresh concrete to become dry. However, the difference was not obviously shown by each of the samples. This result was also supported by Pitarch, Reig, Tomás, & López, (2017) where he stated that the slump of concrete with CCT replacement tends to decrease as the percentage increases.

3.1.1 Density

Density test was performed on the cube by recording the weight of the cube at room temperature after a few minutes the sample was removed from the curing tank. The density test was carried out for an average of 3 samples. The dimension of the cube was fixed at 100mm x 100mm x 100mm according to the size of mould used. Figure 2 shows the result of the density for the concrete. The density drops after the replacement of the 10% of RHA with 0% of CCT aggregates. Then the density of the concrete decreases slowly as the percentage of CCT increases. This due to the density of natural coarse aggregates is greater than the density of CCT. Other than that, the replacement of RHA which is light also affects the reduction of the concrete weight. However, there is only a small difference of density between 0%, 5%, 10% and 15% replacement of CCT.

According to Wadie, Sadek, & Wahab, (2017) the density of the concrete with CCT without any replacement on other raw material was decreased as the percentage of CCT increases. Hence, there is a bit different in this research because the RHA as mineral admixture by 10% mass of cement has been replaced. It has led into the decreasing of the concrete weight because the RHA is lighter than Portland cement. This also because the distribution of CCT in the concrete for each cube was not exactly the same since the mix was done in a large portion. Pitarch et al. (2017) mentioned that the density of concrete with partial replacement with ceramic tile waste as coarse aggregates has decreased as the percentage replacement of CCT aggregates increases.

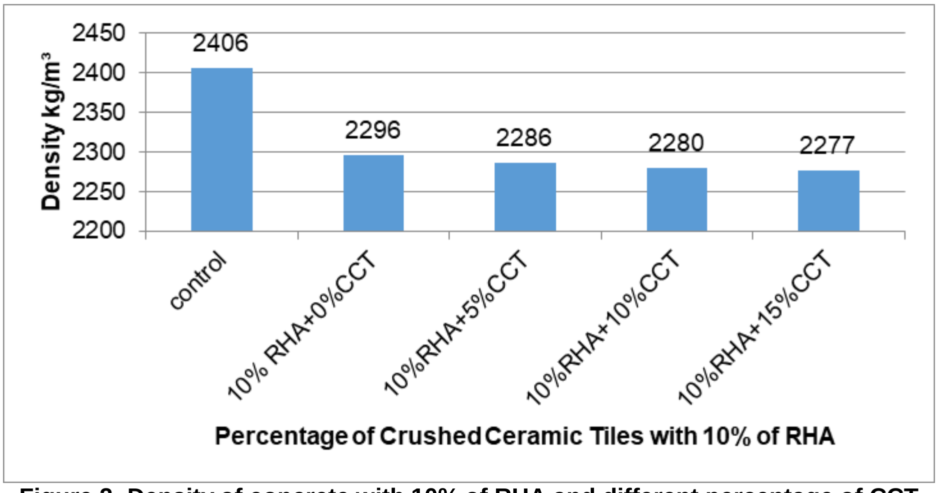

Figure 2: Density of concrete with 10% of RHA and different percentage of CCT

3.1.2 Water Absorption

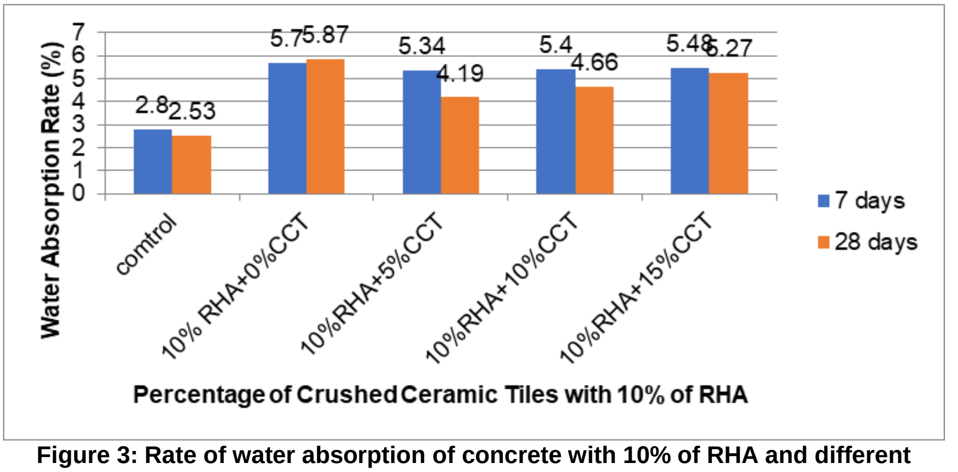

Figure 3: Rate of water absorption of concrete with 10% of RHA and different percentage of CCT

A total of 30, 100mm x 100mm x 100mm cubes have been tested for water absorption. The test was carried out after 7 and 28 days of curing. Figure 3 shows the result for the water absorption of concrete with 10% of RHA and different percentages of CCT. The percentage of water absorption increases at 10% of RHA with 0% of crushed ceramic tiles for 7 and 28 days of curing. This is correlated to Tutur & Noor (2018) which stated that as the percentage of RHA increases, the water absorption will increase. However, after 5% replacement of crushed ceramic tiles aggregates, the water absorption tends to decrease slowly for 7 and 28 days of curing. According to Prasad, Hanitha, & Anil, (2016) the water absorption decreases with the increases of CCT aggregates in the concrete.

But in this research, it shows that after the replacement of CCT increases, the water absorption increases. According to Prasad et al. (2016), their research of the water absorption test for CCT found that when coarse aggregate and ceramic tiles as fine aggregate replacement, the result shows that the percentage of replacement for both fine and coarse aggregates increases, the water absorption increases at 7 and 28 days. In this research also, a partial replacement of CCT in concrete with 10% of RHA has resulted in the decreasing of the water absorption compared to the concrete with 10% of RHA only as the percentage of crushed ceramic tiles aggregates increases. The water absorption at 7 days of curing for 15%

replacement of CCT is the highest. The reason behind it is due to the appearance of pores in the cube surfaces which effect from less vibration during placement of the concrete.

Overall for the water absorption, it can be seen that concrete absorb more water at curing age of 7 days compare to 28 days of curing because the chemical reaction between RHA and the cement started at 28 days and the particle of the pozzolanic material of RHA fill the spaces in the concrete.

4.0 CONCLUSION

Overall from this research is to determine the optimum percentage of CCT in concrete with RHA by conducting test on physical of the concrete as following:

- The slump of the concrete presented that 5% of CCT replacement is the highest among the samples that contained RHA with crushed ceramic tiles.

- The density of concrete with 10% of RHA as mineral admixture with CCT are the best at 5% of CCT replacement. However, the control sample has the highest density among all of the samples.

- The water absorption for concrete with 10% of RHA with 5% of CCT aggregates has the highest value which is 5.87% due to the porosity of the material replaced in the concrete and control sample has indicated the lowest water absorption at 2.53% at 28 days.

As the conclusion, the percentage replacement of CCT in concrete with 10% of RHA as mineral admixture has shown that 10% replacement is the best. Even though the control sample show the highest value, by replacing 10% of CCT and 10% of RHA, it can help to reduce the cost of the concrete.

5.0 ACKNOWLEDGEMENT

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