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The Implantation of Waste Concrete Ash as Partial Cement Replacement Materials in Concrete

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ABSTRACT

The main objective of this research is to investigate the possibility of recycling the waste concrete ash as cement replacement materials. This paper presents the influences of different percentage waste concrete ash use as cement replacement materials to form a new concrete. The experimental process will be evaluated based on mechanical capability of concrete. In improving the quality of cement replacement concrete, concrete admixture is used with at a mixture. The mix proportioning of waste concrete ash uses is between 5% to 40% of replacement cement materials and for concrete admixture is fixed in optimum amounts. All specimens are involved with water curing process. The specimens will be tested at the age of 7, 14, 28, 90 and 180 days. This study reveals that an increasing percentage of waste concrete ash will affected to physical properties, however the additional of concrete admixture will restore the strength concrete. Other than that, it shows that an increasing of waste concrete ash in percentage of cement replacement will affected to pore concrete structure.

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INTRODUCTION

The increasing rate of development and construction industry does not only boost demand on concrete but it also makes concrete one of the major contributors to construction waste. In the construction industry, it involves of build and rebuild a structure from demolishing an old building. At developed country, the estimates for waste concrete at United Kingdom are 30 million tonnes/year and it about 500kg/person/year (RILEM, 1984) and the construction waste obviously become a major concern among community. However in developing country like Malaysia, the waste product from construction industry is not being taken seriously and almost all construction in Malaysia is based on build concept.

Concrete is used widely in construction industry and almost all type projects are being produce by concrete as a structure. The important of concrete is based on it characteristic which has high ability to strength and has good durability performance. Through the large consumption of concrete in construction industry, the cement material as the main ingredients in making concrete was became one of the important raw materials needed. Cement is one of raw materials that used in concrete mix and it works as binder materials between sand and aggregate. Based on some researcher, a production a tonne of Portland cement generates about one tonne CO_2 to the atmosphere and it is 5% of global CO_2 emission (Nuruddin, M.F., 2010). In annually, global production of Portland cement was causes 1.35 billion tonnes of greenhouse emission (Malhotra, V.M., 2002; Hardjito, D., 2004). The reduction in cement on concrete mix can certainly help to reduce the dependency on cement, which affected to global warming.

The construction waste problem is not something new and happens in all countries. By recycling and reused the waste concrete into new product is a methods that can overcome this problem. There is study about the use of recycled cement based on waste concrete, it revealed by using 40%-50% of waste concrete and others pozolanic material to replace cement can reach 20-40MPa strength of concrete. Recycled a waste concrete into a new concrete will affect substantially the concrete situation in terms of load capacity and durability.

There are few factors that been considered when using the waste concrete in replacing cement content in a new concrete. The concrete strength is one of the important benchmark to used in define the mechanical performance of concrete. There is a study about the use of waste concrete as main materials to directly produce replacement cement by grinding.

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The result shows that, compressive strength of recycled cement concrete can be achieved to 10MPa at 3 days age and at 28 days age it can reach 20-40Mpa (Zong Shou Lin And Yang Chong, 2012). Another impact of using the waste concrete is the ability of waste concrete in absorbing water. The water absorption increases linearly with the replacement ratio and this is to be expected since fine recycled concrete aggregates has a more porous structure (Evangelista and J. de Brito, 2010). Low strength of waste concrete is caused by porous, low density loose and weak layers of mortar present on the surface and affecting the bonding in the interfacial transition zone (ITZ) (Khaleel, H., 2013).

Methodology of research:

1.1. ***Experimental program:***

The experimental program was designed to investigate the used of waste concrete ash as partial cement replacement in concrete. On this study, the replacement level of cement by waste concrete ash are selected as 5%, 10%, 25% and 40%. The experiment was being conducted to produce new concrete with grade 50 (high strength concrete). All specimens are being cast in size cubes (100mm x 100mm x 100mm) and prism (100mm x 100mm x 500mm). Each specimen containing 15 cubes and 15 prism that being used for testing at ages of 7, 14, 28, 90 and 180 days which is 3 samples for each test. To define a mechanical performance of specimens, there are two tests is being conducted which is compressive strength and flexural strength

1.2. ***Materials and mix proportions:***

The waste concrete ash in this study is obtained from experimental waste concrete cube and it been involved with few procedures in the laboratory to form final product that used in replace cement materials. To produce the waste concrete ash, there are the various processes that being involved from the waste concrete cube at size 150mm into 0.3mm. This process involves the step of crushing and sieve a concrete waste that will eliminate the presence of coarse aggregate inside the concrete so the end product are mostly cement paste and fine aggregate. To improve the characteristic of new concrete, a concrete admixture is being added into all mix with include WCA as cement replacement. The type of concrete admixture use is a densified silica fume with percentages of 5% from total binder with 1% of superplasticizer. The mix proportioning in this study is based on the calculation from DoE method. The percentages of waste concrete ash were used to replace OPC cements at percentages of 5%, 10%, 25% and 40%.

RESULT AND DISCUSSION

Compressive strength is the element to identify the performance and quality of almost all types of concrete. The complete result of this test is summarized for better analysis in Figure 3.1 which presented the result for compressive strength that obtained from all specimens. The result shows an increasing percentage of WCA in mix was affect to decreasing compressive strength of concrete. From previous study, residual mortar has changed the absorption and density and can have adverse effects on the performance of concrete. As widely reported typical order of 10% reduction in compressive strength compare to the normal concrete.[9]. Through Figure 3.1, it shows that a specimen containing low percentages of WCA which is 5% and 10% is achieving a higher compressive strength compare to CTRL specimens. However, for specimens containing percentages WCA of 25% and 40% is achieving lower strength than the CTRL specimens. Based on the result, the optimum percentages of WCA can be used are below 10%. The higher percentage of WCA will cause to pores structure of concrete that reduce their strength and also to the durability of concrete.

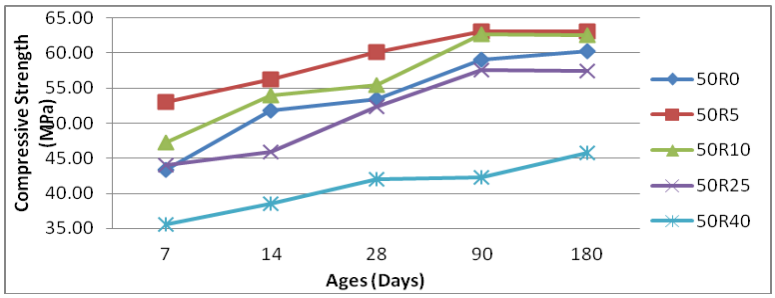

Fig. 3.1: Compressive Strength Of Specimen Concrete Grade 50 Versus Ages.

The flexural strength test is being conducted to define the ability of specimens on bending force. The flexural strength tests results are obtained from all specimens are being summarized in Figure 3.2. Based on Figure 3.2, it shows that a flexural strength of all specimens is increased when the ages of specimens increased. The directly proportional of flexural strength and specimens ages is due to improvement in the quality and capability of concrete in receiving bending force. Based on Figure 3.2, specimens 50R5 was achieved higher flexural strength compare to CTRL specimens at an early

stage between 7 days to 28 days ages with percentage 1.1% and 2.7%. However, at the ages of 90 days and 180 days the results for CTRL specimens are overpass the flexural strength of specimens 50R5. Based on these tests result, it shows an increasing of the WCA as a cement replacement in a mix will reduce the concrete capability in receive bending force. Even with the lowest percentages replacement, the use of WCA in concrete still give an effect to concrete.

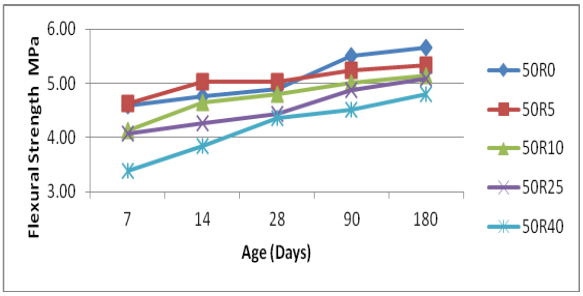

Fig. 3.2: Flexural Strength Of Specimens Grade 50.

Conclusion:

From this study, the physical properties of concrete use waste concrete ash as cement replacements is being determine. The compressive strength for new concrete that using WCA as replacement cement material is not being affected if the percentage of WCA is in low percentages. Based on the result, the WCA replacement up to 10% is produce a higher concrete strength compare to the CTRL specimens and it means that, the optimum percentages of the WCA as cement replacement is up to 10%.For flexural strength, the results show that all specimens are increasing their strength when their age is increased. At early ages, a specimen with containing 5% of WCA is achieving highest flexural strength result compares to others. However at ages of 90 days, it being overpass by CTRL specimens with differences of -4.7%. The use of WCA as cement replacement in concrete give bigger impact to flexural strength even it used in the lowest percentages of replacement.Through this study, all results show that it is possible to use WCA as cement replacement materials, but it need to be in right percentages so that the concrete produce has a same characteristic to conventional concrete. From this study, the optimum percentages of WCA use as cement replacement is 10% and lower to achieve a batter physical properties.

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