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EFFECT OF RHA AND GRADING COARSE AGGREGATE ON THE CONCRETE STRENGTH.

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ملخص البحث:

رماد قش الارز (RHA) من مخلفات الزراعة حيث أنه يتم حرقه مما يسبب مشكلة و تلوث للبيئة و قد بدأت منذ فترة ليست بالقريبة الأبحاث على هذا الرماد حيث أنه يتسبب بمشكلة بيئية في التخلص منه لذلك كانت من ضمن الأفكار التي طرحت و هي استغلال هذا الرماد كبديل جزئي للاسمنت و بمرور السنوات و توالي التجارب أثبت هذا الرماد جودته و كفائته في تحسين خواص الخرسانة و تقليل كميات الاسمنت المستخدمه مما يعطي من ناحية توفير في التكلفة و من ناحية أخرى التخلص من مخلفات صناعية ضارة بالبيئة و من ناحية ثالثة تحسين خواص الخرسانة. في هذا البحث تم استخدام خلطات خرسانية بركام (السن) المقاس الاعتباري الأكبر له ١٠ مم و وأخري بركام المقاس الاعتباري الأكبر له ٤٠ مم و قد تم إضافة نسبة من (RHA) ٠,٥% و ١% و ١,٥ % و ٢% و ٢,٥% و ٣% و ذلك للوصول الى النقطة العظمى او النسبة الافضل من هذه المادة لتحسين خواص الخرسانة من حيث : اجهاد الضغط. تأثير الحرارة على مقاومة الانضغاط. اختبار الشد الغير مباشر. نسبة بواسون مع تغير المقاس الاعتباري الأكبر للركام.

Abstract:

Rice Husk Ash (RHA) is an industrial waste produced from burning baddy which causes pollution problems. RHA could be used as a low-cost partial replacement for ordinary cement in civil engineering and building works. Research on ash from burning of rice husks has already demonstrated that it is one of the most promising supplementary cementing materials. The objective of this study is to investigate the effect of using rice husk ash (RHA) as a partial substitute of ordinary Portland cement for different grades of coarse aggregate on the concrete properties.

In this paper, concrete mixes using two different coarse aggregate of 10 &40 mm maximum size were used with RHA ratios of 0.5%, 1%, 1.5%, 2%, 2.5%, and 3%. The following tests were carried out on specimens of these mixes: compressive strength, Effect of heat on compressive strength, indirect tensile strength, and Poisson's ratio. The obtained results were analyzed and discussed.

Introduction:

Supplementary cementing materials have been proven to be effective in meeting most of the requirements of durable concrete and blended cements are now used in many parts of the world. Rice Husk Ash (RHA) is a silicon-rich agricultural waste originated from the combustion of the rice husk intended to produce energy for rice drying ovens. Each ton of rice produces approximately 200 kg of husk, which when burned gives way to 40 kg of RHA.

About 662 million tons of rice are produced globally every year (FAO, 2008). The husks represent 20% of this weight, which means that 132.4 million tons of waste is generated annually. If totally was burned, an annual environmental impact of 26.48 million tons results. As there are few industrial scale applications directed towards managing RHA, a large part is used as agricultural compost or simply disposed on riverbanks, causing organic pollution.

Utilization of rice husk ash (RHA) as supplementary cementing material, has become one of the leading research interests in the area of cement and building materials in recent decades. It was found that the optimum degree to produce ash is between 500 to 900 degrees. Burning method and the fineness of the particles are two major factors that primal affect the reactivity of RHA.

The amorphous silica powders with high surface area are more reactive than the crystalline form of the silica. White variety of RHA contain up to 90 to 99% silica. As much as 95% of the silica powder can be produced after burning rice husk at 700 °C for six hours. Silica reacts with C3S and C2S in the cement and produces CSH3, which forms a strong, solid bond of gel. Silica gel has been proven to improve physical and mechanical properties of concrete.

Many researches were investigated to prove the efficiency of using RHA as a partial replacement to cement in concrete.

According to K. Kartini, H. et. al (2010), replacing cement with RHA lowers initial surface absorption, the permeability, and absorption characteristics. It was also found that it improves the absorption and permeability characteristics of concrete during long age (360 days) and also it was found that adding RHA increases the chloride ion resistance. In their research, **K. Ganesan, . et. al (2007)** noted that adding RHA and bagasse ash to concrete improve the properties of concrete especially in permeability , chloride resistance and compressive strength increased by 18% and 15% for 20% RHA and 15%BA (Bagasse ash) compared to control after 90 days of curing.

A. Salas, et. al (2009) treated rice husk ash with the thermal and chemical methods. The results showed that chemical treatment gives better properties than thermal treatment and Compressive and flexural strengths of Chemical RHA concrete are comparable to a SF (silica fume) concrete made with the same replacement level therefore these strengths are higher than the control and temperature RHA mixtures.

M. Nuruddin and M. Darmawan (2010) found that the external treatment of fly ash and rice husk ash was the best way and higher curing temperature promotes better strength development of polymeric concrete and External exposure curing method is the best among all curing regimes. **P. Gisele, et . al (2009)** concluded that burning rice husk ash at low temperatures resulted in lower compressive strength and bigger water absorption values, which can be avoided by increasing the burning period and the rice husk ashes burned at 250ºC for 7 hours contained glassy silica. **A. Givi, et. al (2010)** provided detailed reviews for many significant works that have been done in on RHA in the USA and Incorporation of RHA as a partial cement replacement between 12% and 15% may be sufficient to control deleterious expansion due to alkali-silica reaction in concrete, depending on the nature of the aggregate. **M. A. A. Awady et. al (2016)** tested a mix of concrete which had 10 mm maximum size of coarse aggregate and RHA ratios equal to 0,0.5,1,1.5,2,2.5 and 3%. The peak point for compressive strength was 2.5%. The heat moved peak point of compressive strength from 2.5% to 0.5%.The best value in indirect tensile strength is 0.5% ratio.

Experimental Work:

In the present study, concrete mixes were designed to achieve the optimum properties of concrete using coarse aggregate with maximum size of 10 mm and 40 mm. RHA with percentages of 0%, 0.5%, 1.5%, 2%, 2.5%, and 3%.by weight of used cement were added to the designed mix. The following tests were conducted on the mixes: compressive strength, indirect tensile strength, stress strain relationship, effect of heat on compressive strength and Poisson's ratio.

Results of each test will be discussed in the following sections.

Compressive Strength:

In this test the concrete was mixed and cast in cubes(three cubes for each ratio) with dimensions of 15*15*15 cm using RHA ratios equal to 0%, 0.5%, 1.5%, 2%, 2.5%, and 3%. The cubes were tested after 28 days. Figure 1 shows the results of these tests.

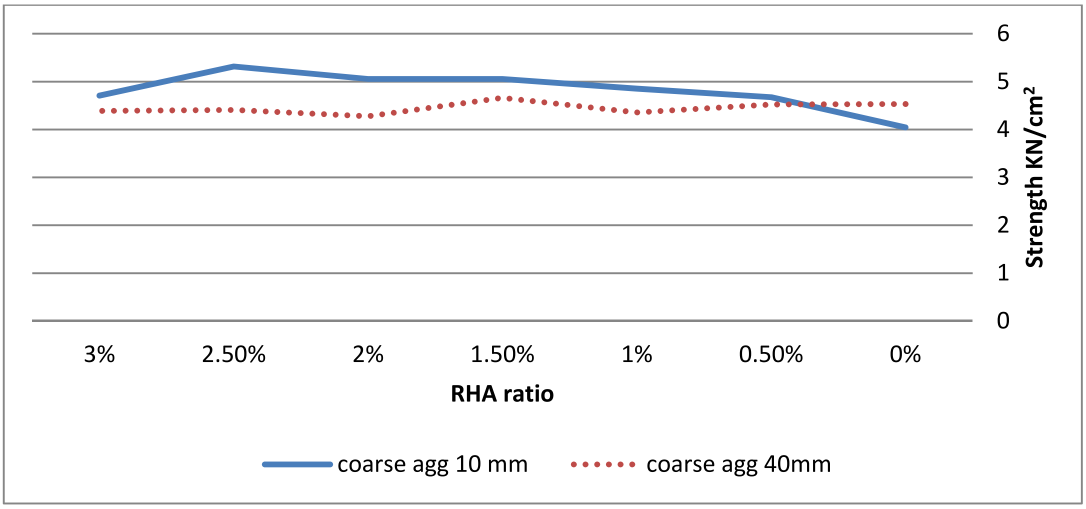

Fig. 1: Effect of RHA on the concrete compressive strength for different aggregate size

For concrete mixes using coarse aggregate of 10 mm size, the test results indicate that compressive strength of the specimens with RHA exceeded the control specimen. It was noted that increasing the RHA from 0.5% to 2.5%, increases the concrete compressive strength from 15% to 31.5%. However, increasing the RHA further, decreases the concrete compressive strength, but still higher than that of the control specimen. The optimum compressive strength for this concrete mix was obtained with RHA percentage of 2.5%.

Concrete mixes using coarse aggregate of 40 mm size, the test results indicate that adding the RHA to the concrete decreases, generally, the compressive strength of the specimens lower than the compressive strength of the control specimen.

The results illustrate that increasing the size of coarse aggregate has negative effects on the compressive strength of the concrete in the presence of RHA.

Effect of Heat on Compressive Strength:

In this test the cubes were put in the oven in 120o degrees according to the Egyptian Code Specifications for 2 hours then they were tested for compressive strength. Figure 2 shows the effect of heat on the compressive strength for different ratios of RHA.

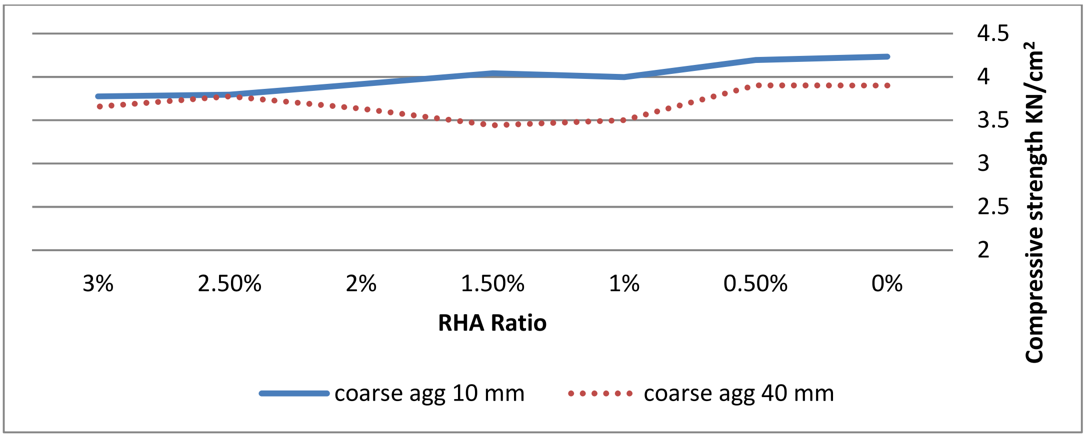

Fig.2: Effect of heat on the concrete compressive strength for different ratios of RHA and different aggregate size

For 10 and 40 mm aggregate size, the test results show dramatic effects of the heat on the compressive strength of the concrete in the presence of RHA in the concrete mix. In both cases of aggregate size and RHA ratios the heat negatively affected the compressive strength of the concrete lower than that of the control specimen.

Indirect Tensile strength:

The test was done on 15*30 cm cylinders. Figure 3 shows the tensile strength. These specimens were tested to indirect tensile strength. One specimen to each ratio was tested. Using the sensors and computer the tensile load and tensile strength were known. Figure 4 shows the test machine.

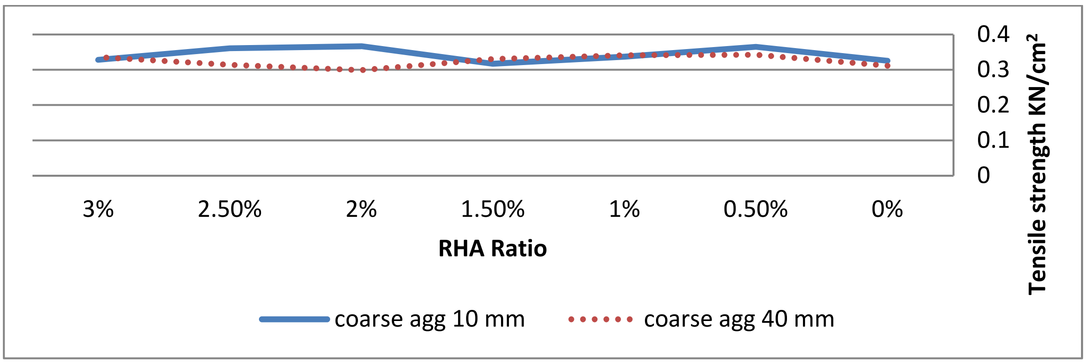

Fig.3: Effect of RHA on the concrete indirect tensile strength for different aggregate sizes

For concrete mixes using coarse aggregate of 10 mm size, the test results show, in general, that the use of RHA improves the concrete tensile strength. An exception was noted for ratio of 1.5 %. This may due to some draw back in this test. It could be noted that the peak point is at 0.5%.

For concrete mixes using coarse aggregate of 40 mm size, the test results show that the tensile strength increases when using RHA with ratio up to 1.5%. Increasing the RHA further decreases the tensile strength of concrete. It could be noted that the peak point is at 0.5%.

Stress Strain Relationship:

Cylinders of 15 cm radius and 15 cm height were used in this test. This test method covers determination of (1) chord modulus of elasticity (Young's) and (2) Poisson's ratio of molded concrete cylinders and diamond-drilled concrete cores when under longitudinal compressive stress. These specimens were tested to indirect tensile strength and using the sensors and computer. The stress strain relationship was drawn. Figure 4 shows the test machine. Figure 5&6 show the stress strain relationship for this test for mixes 10mm & 40 mm respectively.

Fig. 4: test machines.

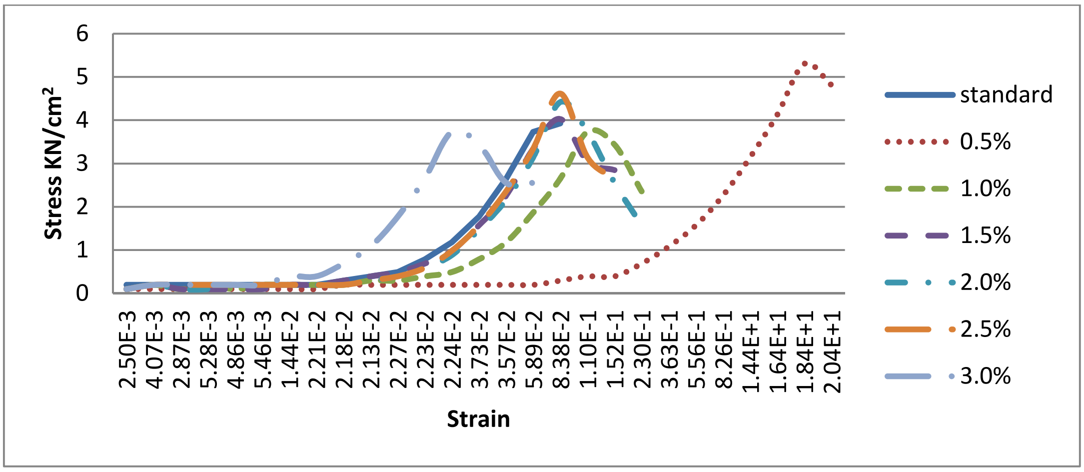

Fig. 5: Effect of RHA on the concrete stress strain relationship for aggregate with maximum size 10 mm

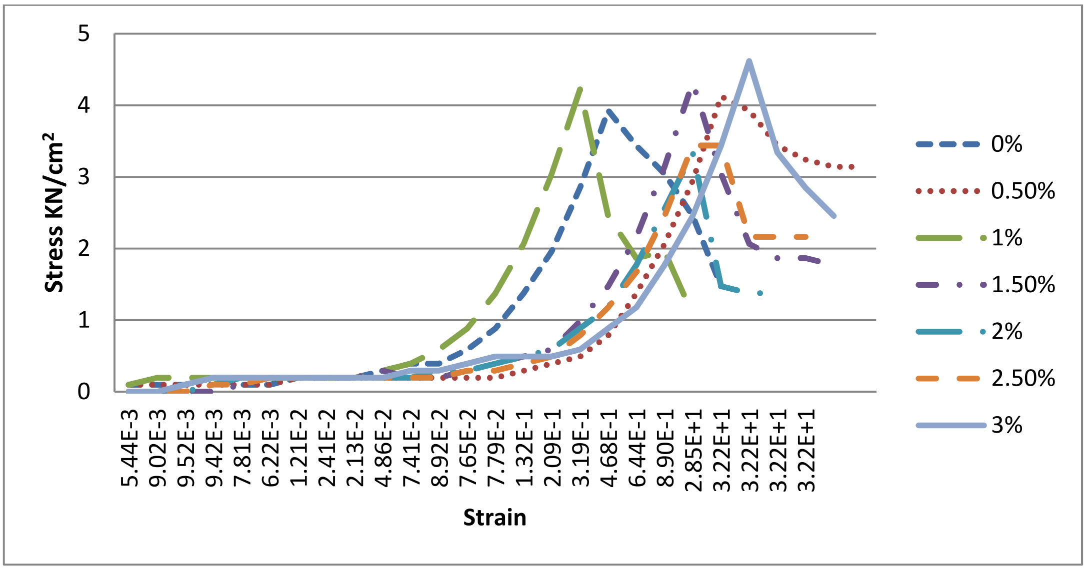

Fig.6: Effect of RHA on the concrete stress strain relationship for aggregate with maximum size 40 mm

For mix 10 mm, Fig .5 shows that in general adding RHA to the concrete increases its elasticity except at ratio 3% which made the concrete brittle material as shown above and the test results indicate that 0.5% ratio of RHA has the best elasticity on the stress strain curve.

For mix 40 mm, fig .6 shows that in general adding RHA to the concrete increases its elasticity except at ratio 1% which made the concrete brittle material as shown above and the test results indicate that 0.5% and ratios of RHA have the best elasticity on the stress strain curve.

Conclusion:

From the previous it can be concluded that:

For mix 40 mm:

1- The peak point for compressive strength occurred when 1.5% RHA is admixed with cement.
2- The heat made the peak point moved from 1.5% to 0% (standard specimen).
3- The best ratio in indirect tensile strength is ratio 0.5%.

For mix 10 mm:

4- The peak point for compressive strength occurred when 2.5% RHA is admixed with cement.
5- The heat moved peak point of compressive strength from 2.5% to 0.5%.

6- The best value in indirect tensile strength is 0.5% ratio.

For both mixes:

7- Increasing the maximum size for coarse aggregate moved the peak point for compressive strength from 2.5% (10mm) to 1.5% (40mm).

8- Increasing the maximum size for coarse aggregate had no effect for indirect tensile strength (the peak point is 0.5%).

9- Increasing the maximum size for coarse aggregate moved the peak point for effect of heat on compressive strength from 0.5% (10mm) to 0% (40mm).

The effect of different mixes, with variation of RHA, heat of hydration, time, and chemical components, on mass concrete is still under research.

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