Investigation The Properties Of Concrete Containing Rice Husk Ash To Reduction The Seepage In Canals.

S. I. Khassaf, A. T. Jasim, F.K. Mahdi

Abstract: In this research effect of rice husk ash (RHA) on Fresh and Hardened Properties of concrete which used to reduction the seepage in the canal lining was studied. To establish the suitable proportion of RHA for the partial replacement of cement, Concrete specimens was molded with 10%, 20%, and 30% of (RHA) replacing the cement, and measured it to workability, compressive strength, splitting tensile strength, dryings shrinkage, The results were compared with the concrete mix that does not contain RHA. The obtained results indicated that it was a significant reduction of workability in fresh concrete with the increase amount of RHA content in concrete, and it was an increase in the compressive strength and splitting tensile strength by increased of RHA% until 20% , The maximum increment is around 10.5%and 11% for the compressive strength and splitting tensile strength respectively then it were decrease with the increase of RHA to 30%, the decrease was around 17 % and 10.5% for compressive strength and tensile splitting strength respectively. The test of drying shrinkage indicated that it was decreased with increased of RHA%, the maximum decreased given by 30% RHA it was about 28% of normal concrete shrinkage after 90 days age.

Key word: Concrete properties, Rice Husk Ash, Seepage, canal.

1 Introduction

Rice husk ash, a by-product of rice processing, is produced in large quantities globally every year, About 500 million tons of rice paddy is produced in the world an annually[(1)]. Rice milling generates, a byproduct know as husk. This surrounds the paddy grain. During milling of paddy about 78 % of weight is received as rice, broken rice and bran .Rest 22 % of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the balance 25 % of the weight of this husk is converted into ash during the firing process, is known as rice husk ash (RHA)[(2)]. and due to the difficulty involved in its disposal, can lead to RHA becoming an environmental hazard in rice producing countries, potentially adding to air and water pollution. The use of RHA in cement or concrete as a supplementary cementing material has been increased recently. Supplementary use of RHA in cement or concrete is not a new technique but it was started since early 1970**.** Since then Many Research and development in various parts of the world, have shown that rice husk ash (RHA) can be used as a partial replacement for cement in concrete because of its very high silica content, where rice plant is one of the plants that absorbs silica from the soil and assimilates it into its structure during the growth[(3)]. it stands out as an ecofriendly, sustainable and durable option for concrete.

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So this research was of great importance to study the possibility of adding rice husk ash to cement used in the concrete lining canals, Since this material is available, and improves the properties of concrete, especially in reducing the leakage phenomenon**.** In rice producing countries like Iraq, RHA-concrete has the potential to provide a low-cost construction material produced from locally sourced, abundant materials while having the added benefit of providing a means to dispose of an agricultural waste product. Iraq provides an ideal location to explore the potential for in low-cost concrete.**Mehta(1979)**[(4)] suggested that essentially amorphous silica can be produced by maintaining the combustion temperature below 500°C under oxidizing conditions for prolonged periods or up to 680 °C with a hold time less than 1 min. **Yeoh et al (1979)**[(5)] report that RHA can remain in the amorphous form at combustion temperatures of up to 900°C if the combustion time is less than 1 hour, while crystalline silica is produced at 1000°C with combustion time greater than 5 min.**Hwang and Wu (1989)**[(6)] were studied the effect of different burning temperatures and the chemical composition of rice husk (Taiwan RHA). It was observed that at 400°C, polysaccharides begin to depolymerize. Above 400oC, dehydration of sugar units occurs. The study found that RHA produced by burning rice husk between 600 and 700°C temperatures for 2 hours, contains 90-95% SiO2. At 700°C, the sugar units decompose. At temperatures above 700°C, unsaturated products react together and form a highly reactive carbonic residue. **Al-kadhi, (2002)**[(7)] in his investigation the burning of rice husks was carried out in controlled temperature in order to establish the optimum burning temperature. It was found that the combustion temperature of about 550°C and duration time of 2 hours produced an ash with optimum properties.

2 Experimental Work

2.1. Materials

2.1.1 Cement

Sulfate resisting Portland cement (Type V) was used in this study. The results indicate that the available cement conforms to the Iraqi specification (I-O-S) (No.5/1984)[(8)].

2.1.2 Fine Aggregate (F.A)
Normal weight natural sand was used as fine aggregate in this study. The results show that the physical and chemical properties of fine aggregate used in this work conform to the requirements of Iraqi specifications No . 45/1984[9].

2.1.3 Coarse Aggregate (C.A)
Crushed gravel of nominal maximum size 14mm was used in this work. The results show that the used coarse aggregate conform to the requirements of Iraqi specification No.45/1984[9].

2.1.4 Rice Husk Ash (RHA)
The Rice Husks Ash (RHA) used in this investigation was obtained from Al- Abasia Farms in Kufa city. Burning of rice husks was carried out in a furnace with controlled in order to establish the optimum burning temperature and burning time. The combustion temperature was about 550°C and duration time was 2 hours produced an ash with optimum properties[7]. The result of chemical and physical analysis of the rice husk ash used in the study is given in table(1).

Table (1) Chemical analysis and surface area of used rice husk ash*.

Oxide composition	Oxide content %
SiO_2	90.18
Al_2O_3	0.51
Fe_2O_3	0.17
CaO	2.64
MgO	0.70
SO_3	1.25
Loss On Ignition	2.30
Surface area (blaine method) M^2/Kg	97.75

* Physical analysis was conducted by Al-Kufa cement factory.

2.1.5 Mixing water
Potable water was used throughout this investigation for both mixing and curing of concrete.

2.2 Pozzolanic Activity Index of Rice Husk Ash (RHA)
For the assessment of pozzolanic activity with cement , the method described in the ASTM C311- 2004[10] was used. The pozzolanic activity of rice husk ash was found to be 110 % which conform to the requirement of ASTM C618- 2005 (min. 75 percent)[11].

2.3 Concrete Mixes
In this investigation concrete mixes with 10%, 20% and 30% of cement replacement by rice husk ash (RHA) in addition to normal lining concrete mix (MR) were used. The normal concrete mix (MR) was designed to give a 28-day characteristic compressive strength of 28 MPa and workability of (70 ± 5 mm), the design of reference mix was performed in according with ACI 211.1 2005[12]. The details of the mixes used throughout this investigation are given in table (2).

Table (2) details of the mixes used throughout this study.

Mix symbo	Cement conten (Kg/m^3)	F.A (Kg/m)	C.A (Kg/m^3)	RHA (Kg/m^3)	Water (Kg/m^3)	Slump (mm)
MR	350	660	1185	0	205	70
M10	315	660	1185	35	205	55
M20	280	660	1185	70	205	45
M30	245	660	1185	105	205	15

2.4 Mixing, Casting and curing of Concrete Specimens
Mixing process carried out by using a rotary type mixer for all mixes. steel moulds were used in all the tests throughout this investigation. Before casting each specimen , the moulds were carefully oiled to be ready for casting fresh concrete. Concrete was placed by means of scoop in layers of approximately 50 mm depth. Each layer was compacted by means of rodding. The specimens were demolded after 24 hours from casting , marked and then completely immersed in tap water until the time of testing.

2.5 Testing of Fresh and Hardened concrete

2.5.1 Workability test
Slump test was used to determine the workability of concrete mixture according to ASTM C143- 2005[13] .

2.5.2 Compressive Strength
Concrete compressive strength was measured on 150 mm cubes corresponding to B.S 1881 part 116,1989[14] and by using a ELE testing machine with capacity of 2000KN .

2.5.3 Splitting Tensile Strength
Cylinders of 150 mm diameter and 300 mm high were used in this test and the loads was applied continuously up to failure. Test was done according to ASTM C496 -07[15] .

2.5.4 Length Change Test
This test was carried out in accordance with ASTM C157-2005 [16] using 100x100x400 mm prism specimens to measure the change in length of the hardened concrete and by using mechanical extensometer as shown in plate (1) All specimens were immersed in water for 7 days then tow points were defined with demic points on each of tow opposite side and stored in the laboratory at about (23± 2 °C and 50 ± 5 percent relative humidity) for 90 days. Many reading , for the change in length of the specimens , were recorded throughout that period.

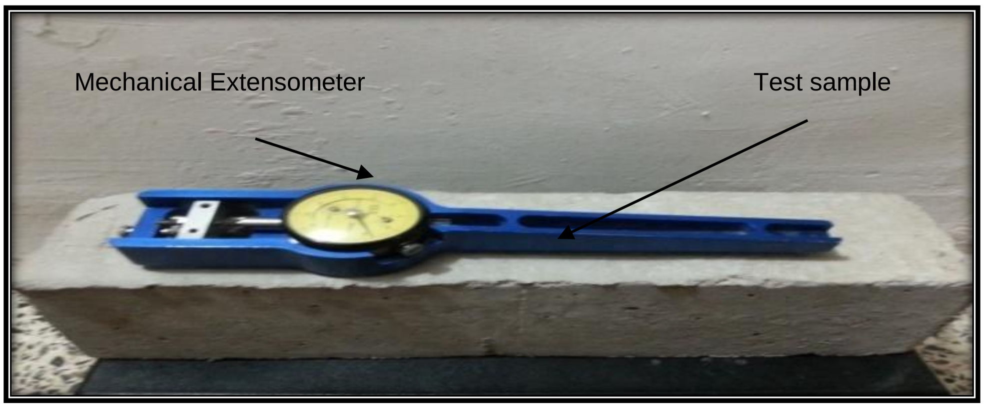

Plate (1) Mechanical Extensometer used in the length change Test.

3 Results and Discussion

3.1Workability
As evident in table (2) the workability (slump) of concrete mixes varies from 70, 50, 35, and 15 mm for concrete mixes (MR, M10, M20 and M30) respectively. According to ASTM C143- 2005[13], the results of test indicated that the slump of mixes was accepted. From table (2) it is clearly seen that is when the amount of replacement of OPC with RHA increases, the workability of the concrete mixes decreases. The reasons being, concrete containing RHA requires more water for a given consistency due to its absorptive character of cellular RHA particles and of high fineness (this increases its specific surface area).

3.2Compressive Strength
The detailed results for compressive strength including the average strength are given in table (3). and presented graphically in Fig. (1). The gain in compressive strength continued to occur until the age of 90 days where the highest strength was achieved for all concretes due to greater hydration of cementing materials. However, the largest strength development noticed between 7 and 28 days, as can be seen from Fig.(1). The compressive strength at the age of 28 days was in the range of 21 to 29 MPa for different concrete mixes. It shows that the compressive strength of RHA concrete, in early ages which are slightly lower than reference mix as the percentage of RHA replacement increases. This happens as a result of the fact that in the early ages the addition of RHA reduces the amount of cement by 10–30%, the volume of capillary pores then increases, accumulating $Ca(OH)_2$ on the interface. As a result, the structure is less compact, causing the strength to be lower than that of the concrete specimens without RHA.

Table (3). Compressive strength results of concrete mixes.

Mix Designation	Compressive strength (MPa)			
	7 Days	28 Days	56 Days	90Days
MR	21.29	28.71	32.75	34.27
M10%	19.86	26.16	34.32	35.81
M20%	17.65	25.85	35.95	37.86
M30%	15.8	20.92	24.29	28.5

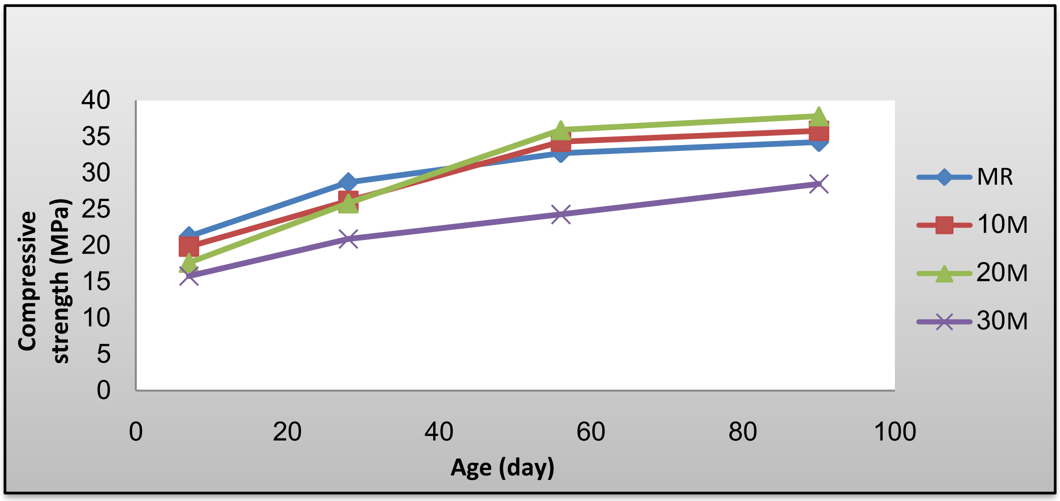

Fig.(1) Compressive strength development in various aged of curing.

Comparison of the data for 56 and 90 days of curing ages shows that the compressive strength of concretes with up to 20% RHA replacement attain values more than that of control concrete specimens due to the capacity of the pozolan of fixing the calcium hidroxide, generated during the reactions of hydrate of cement[17], from Fig.(1) indicated that at age 90 days the compressive strength of 30% RHA replacement concrete, it decrease to 17% than reference mix , this suggests that large amounts of RHA have an adverse effect and reduced the strength of concrete. The maximum strength is achieved with 20% replacement of RHA for the cement in concrete. The increment is around 10.5% than the control sample. Therefore 20% of RHA can be identified as the optimum percentage to replace the cement in concrete.

3.3 Splitting Tensile Strength

The results of splitting tensile strength for mixes with different (RHA replacement) are shown in table (4) and Fig. (2) by observing the results, it can be seen that strength development is about the same order as those in compression test. In other words, the tensile strength for both RHA and normal lining concrete will increase with age, and at early ages, the tensile strength of RHA concrete was slightly higher than normal lining concrete at the 28 ages by 8% for 10% RHA replacement concrete, while it was lower than normal concrete in (20 - 30) % RHA replacement concrete by 6.8%and 13.6% respectively.

Table (4) Results of Splitting Tensile Strength Test.

Mix Designation	Splitting tensile strength (Mpa)			
	7 Days	28 Days	56 Days	90 Days
MR	2.01	2.5	2.62	2.75
M10%	1.8	2.7	2.85	2.96
M20%	1.3	2.33	2.87	3.05
M30%	1.09	2.16	2.35	2.46

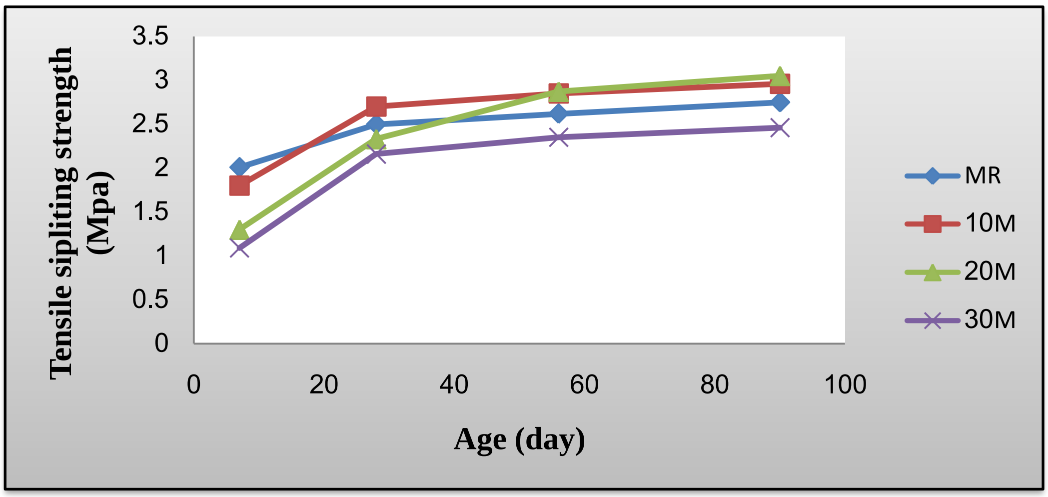

Fig. (2) results of splitting tensile strength of mixes at various curing aged.

From Fig.(2) It can be clearly seen that at the later ages (56,90) the splitting tensile strength value increases with RHA content up to 20%. The splitting tensile strength was higher than that in control mix in age of 90 days by 7.63% and 10.9% for 10% and 20% RHA respectively. Then at 30% RHA replacement the splitting tensile strength less than that of normal concrete by 10.3% and 10.5% in age of 56 and 90 days. Thus, it can be concluding that the maximum tensile strength is resulted with 20% replacement[(18)].

3.4 Drying Shrinkage

The test results of average drying shrinkage strain of two prism samples (100* 100* 400 mm) made with different concrete mixes up to 90 days given in Fig.(3). generally the test results reveal that the high amounts of drying shrinkage showed at early aged due to rapid loss of moisture from the surface of the specimens. Fig.(3) indicated that for the RHA specimens the drying shrinkage was less than that of the concrete specimens without (RHA)and it was decrease with the increase of the RHA% replacement concrete. This may be attributed to lower cement content compared to control mix. As well as to the pore size and grain size refinement processes which strengthen the mechanical interlocking in the transition zone. the maximum decreased given by 30% RHA it was about 27.8% of shrinkage than control concrete mix for 90 days age.

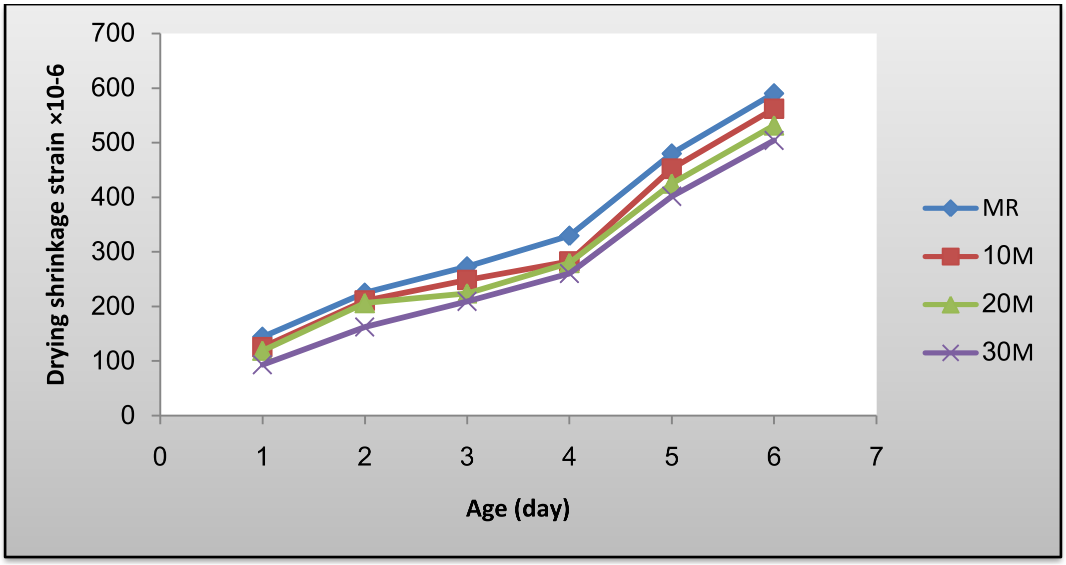

Fig.(3) Shrinkage value versus time with/without RHA

Conclusion

From the experiments and analysis of results of findings in this research work, the following facts are established about RHA replacement concrete lining canals.

1. There is a significant reduction of workability in fresh lining concrete with the increase amount of RHA content in concrete.
2. The partial replacement of cement by RHA indicates that at long term ages, the RHA concrete showed higher compressive strength in comparison with that of the concrete without RHA.
3. Based on the results of Split Tensile Strength test, it is convenient to state that there is substantial increase in Tensile Strength due to the addition of RHA.
4. From the results of drying shrinkage test ,it can concluding that the adding of rice husk ash (RHA) to concrete will decrease the drying shrinkage with the increase of RHA% replacement.

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