EFFECTS OF DIFFERENT AGGRESSIVE CONDITIONS ON CEMENT MORTARS CONTAINING RICE HUSK ASH

C. Demirel [1], B. Öztoprak[2], and O. Şimşek[3]

[1]*Department of Construction, Kırklareli University, Kırklareli, Turkey*
[2]*Department of Construction, Bolu İzzet BaysalUniversity, Bolu, Turkey*
[3]*Department of Civil Engineering, Gazi University, Ankara, Turkey*

E-mail: candemirel@klu.edu.tr

Abstract

The rice husk is an organic waste and is the result of the removal of the grains of the paddy grains during the grinding process of paddy. The rice husk ash is obtained by incinerating the rice husk.

In this study, 40x40x160 mm prisms were produced for the bending and compressive strengths by replacing the cement 10%, 20% and 30% of the weight of the rice husk ash. Produced mortar samples were stored at 20 ± 3 ºC temperature for 7, 28 and 90 days under three different conditions as drinking, waste and sea water. Concretes produced by rice husk ash replacement are less permeable and more resistant to aggressive waters. An economy will also be achieved at the same time by replacing the rice husk ash with cement.

Keywords: Rice Husk Ash, Cement Mortars, Bending and Compressive Strengths

1. INTRODUCTION

There are many types of materials used as mineral admixtures in concrete production. Mineral admixtures are grouped into three groups according to the sources they are obtained. These include natural admixtures such as volcanic ash, truss and stone dust; artificial materials such as fly ash and silica fume which are obtained as side products of an industry with no direct relation to concrete production; and heat-processed materials such as burnt clay, burnt shale and rice husk ash. Almost all of the materials, apart from stone dust, used as mineral admixtures in concrete are materials of pozzolanic nature [1].

Amorphous silica is obtained by burning the rice husk at temperatures lower than 700 ºC. The ash resulting from the burning of rice husk is a highly reactive pozzolanic material. Rice husk ash contains high amounts of SiO2 and its reactivity with lime depends mainly on two factors. These are amorphous silica content and specific surface. The amorphous phase in rice husk ash is first obtained when Si-O generated from sintering and decomposing of opaline and hydro silica during the melting process is mixed at temperatures below 600 ºC. It is stated that if ash is elicited amok, it will have weak pozzolanic properties. However, rice husk ash with high reactivity can be obtained by burning the rice husk in a controlled manner. Therefore, the reactivity of the rice husk ash, a pozzolanic material, depends on the crystal / amorphous ratio it contains. Thus, for the characterization of rice husk ash, it is very important to determine the ratio of amorphous silica in contains. This ash can be used as a good pozzolan in cementitious materials by grinding until it reaches a very fine grain size. Pozzolanic indexes of this type vary depending on the degree of grinding and combustion temperatures. Reactive rice husk ash can be used in the production of high quality concrete, but also reduces the porosity of concrete and Ca (OH) 2 ratio [2, 3, 4, 5, 6].

Sensale (2006), in his study, prepared the concrete samples he produced with rice husk ash substituted cement with 0.32-0.40 and 0.50 water / cement ratios and obtained the rice husk ash which he substituted by 10% to 20% in cement from the two different regions. According to the results of the study, he stated that only 90 day reinforced concrete gives higher compressive strength values than control concrete [7].

Expansion test with 5% sulphate solution has been conducted and it has been stated that as a result of 360-day measurements, 40% of rice husk ash-substituted cements expand much less than normal cement. In pH measurements with sodium sulphate solution, it has been stated that pH values decrease as the admixture ratio increases according to 90 and 180 day measurements [4].

In this literature study, the effects of the rice husk ash, which is one of the mineral admixtures and which has the feature of pozzolanic material, on the physical and mechanical properties of the concrete under aggressive conditions have been investigated.

2. MATERIAL AND METHODS

In this study, CEM I 42.5cement obtained from Limak Cement Plant in Ankara was used.

Rice husk was obtained from Edirne province and generated by burning in clay pots at 700 ^{o}C. The husks were burned in the oven at 700 ^{o}C for approximately 3 hours.

In the preparation of mortar samples, Rilem Standard Sand, produced by Trakya Limak Factory, and as mixing water, Ankara city water supply were used.

Physical and chemical properties of cement and rice husk ash are shown in Table 1.

Table 1. Physical and chemical properties of cement and rice husk ash

Chemical composition	Cement (%)	Rice husk Ash (%)
SiO_2	20.35	91.15
Al_2O_3	5.98	3.84
Fe_2O_3	3.06	1.87
CaO	63.35	0.81
MgO	1.89	0.59
SO_3	2.71	-
Na_2O	0.58	0.17
K_2O	0.88	0.21

In the study, cement mortar mixtures; standard sand, cement and water ratios were prepared to be 3: 1: 0.5, respectively. They were manufactured in 40 x 40 x 160 mm size in compliance with TS-EN 196-1 [8] to determine the mechanical properties of mortars. The produced mortar samples were removed from the mold after 24 hours at 20 ° C and they were matured for 7, 28, 90 days in the municipal water, sea water and waste water curing pools.

Table 2. Particle size distribution of standard sand

Square eye aperture (mm)	Cumulative retained (%)
2.00	0
1.60	7±5
1.00	33±5
0.50	67±5
0.16	87±5
0.08	99±1

Pressure and flexural strength tests were performed according to TS EN 196-1. The compressive strength device is set at the appropriate capacity and at the N / s loading speed (2400 ± 200) for the test. Systems that can adjust the loading speed and record results are used in the device. The half prisms obtained after the bending test were placed between the plates of the device by centring in a way not to exceed ± 5 mm. Loading with device and at (2400±200) N/s speed continued until the prism broke [8].

2. RESULTS AND DISCUSSION

The compressive strength of the samples containing 10% rice husk ash in the network water cure was 10.38%, 9.08% and 7.03% more than the control concrete 7th, 28th, 90th days respectively. Despite the increase in the strength of the concrete containing 10% rice husk ash, a systematic reduction in the compressive strength of the concrete is observed as the amount of ash in the concrete increases.

Table 3. Compressive Strength Values

Samples	**Network Water**			**Sea Water**			**Waste Water**		
	7thday	**28thday**	**90thday**	**7thday**	**28thday**	**90thday**	**7thday**	**28thday**	**90thday**
%0	30.52	38.63	49.92	25.44	26.49	20.57	26.58	28.64	21.54
%10	33.69	42.14	53.43	28.76	35.08	49.66	31.39	38.67	48.42
%20	24.12	36.03	39.14	18.14	30.49	31.39	20.32	35.58	33.44
%30	15.74	20.76	23.18	12.39	26.33	25.21	13.20	28.13	19.63

Samples containing 10% and 20% rice husk ash in sea water and wastewater cures have given a higher compressive strength value than the reference sample. High values as in seawater cure of, respectively, 32.42%, 15.10%, and in waste water cure of, respectively, 34.91%, 24.23% have been obtained.

The fact that the strengths of the samples containing rice husk ash result in high values in aggressive waters compared to the reference sample show that the use of rice husk ash reduces permeability.

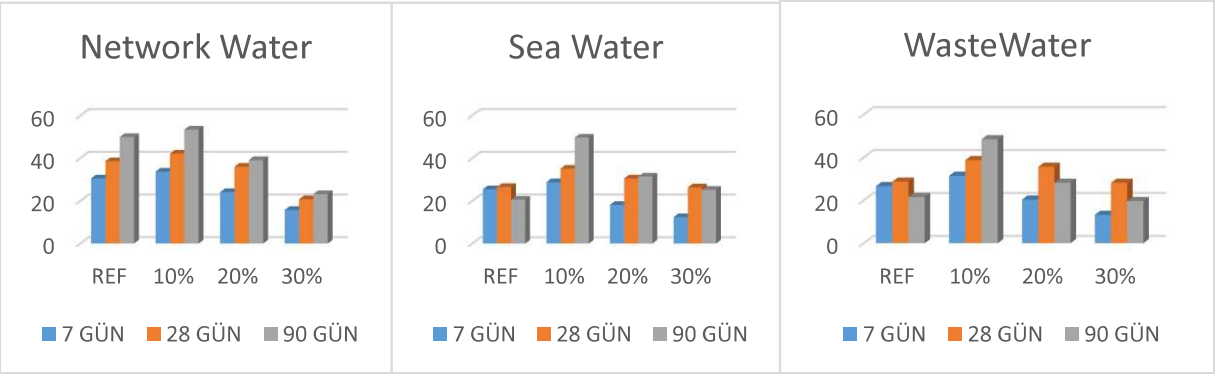

Figure 1. Compressive strength graphs of rice husk ash samples.

The fact that the strengths of the samples containing rice husk ash result in high values in aggressive waters compared to the reference sample show that the use of rice husk ash reduces permeability.

4. CONCLUSION

The results obtained in this study have showed that the rice husk, a waste product, could be burned in a controlled manner and used as a pozzolan. The conducted pozzolanic activity experiments showed that the rice husk ash had pozzolanic activity as a result of the reaction with lime and cement. The pozzolanic activity of rice husk ash is within the limits specified in the standards.

Water requirements of concrete samples prepared by adding rice husk ash at the rates 10%, 20, 30% of the cement weight into the concrete have increased. For this reason, a certain amount of reduction has been observed in the strength of the concrete samples with high content of rice husk ash. Plasticizer can be used to eliminate this situation.

It has been observed that the use of rice husk ash in aggressive waters increases the compressive strength. Samples containing 10% and 20% rice husk ash in seawater and wastewater cures have been observed to give higher compressive strength values compared to the reference sample.

Rice husk ash has been shown to have a greater impact on the strength of the concrete at later ages rather than its strength at early age.

The concrete produced by substituting the rice husk ash to the cement is less permeable and thus more resistant to aggressive waters. Economicality is achieved by adding rice husk ash in cement.

REFERENCES

[1] Erdoğan, T. Y., 2007, "Beton", MetuPress, 2. Baskı, Ankara.

[2] G. Görhanand O. Şimşek, Effect of Rice HuskAsh on PhysicalandMechanicalProperties of Concrete, Electronic Journal of ConstructionTechnologiesVol: 7, No: 1, 107-117, 2011.

[3] Chandrasekhar, S., Satyanarayana K. G., Pramada, P. N., Raghavan, P., Gupta, T. N., , "Processing, propertiesandapplications of reactivesilicafromricehusk- An overview", *Journal of MaterialsScience,* **38** (15), 3159-3168, 2003.

[4] Chindaprasirt, P., Kanchanda, P., "Sulfateresistance of blended cements containing fly ash and rice huskash", Construction and BuildingMaterials, 21 (6), 1356-1361, 2007.

[5] Paya, J., Monzo, J., Borrachero, M. V., Mellado, A., Ordonez, L. M., "Determination of amorphoussilica in ricehuskashby a rapidanalyticalmethod", CementandConcreteResearch, 31 (2), 227-231, 2001.

[6] Saraswathy, V., Song, H. W., "Corrosionperformance of ricehuskashblendedconcrete", Construction andBuildingMaterials, 21 (8), 1779-1784, 2007.

[7] Sensale, G. R., "Strengthdevelopment of concretewithrice-huskash", Cement&ConcreteComposites, 28 (2), 158-160, 2006.

[8] TS EN 196–1, Çimento Deney Metotları- Bölüm 1: Dayanım, TSE, 2002.

[9] TS 639/T1, Uçucu Küller-Çimentoda Kullanılan, Türk Standartları Enstitüsü, Ankara, 1998.