IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 05, Issue 07 (July. 2015), ||V2|| PP 25-30

Incorporation of Rice Husk Ash as Cement Replacement

Muhammad Aleem[1], Istehsan-ur-Rahim[2], Umair Anwar Awan[2], Usman Afzal[2], Usman Haseeb[2]

[1]*(Department of Civil Engineering, University of South Asia, Lahore, Pakistan)*
[2]*(Department of Civil Engineering, University of South Asia, Lahore, Pakistan)*

Abstract: - Concrete is one of the important icon of construction industry. The use of concrete in construction industry intensified due to rapid development and research. After water, concrete is the second most frequently used material worldwide. The assimilation of waste material in concrete is very common from the last few decades, because of their technical tendency regarding environmental pollution and reduction of cost as well. During the production of cement, a large amount of carbon dioxide (greenhouse gas) releases which effects the environment badly. This work is carried out by using Rice Husk Ash (RHA) in concrete as a partial replacement of Ordinary Portland Cement (OPC). RHA is a byproduct of farming scum. RHA contains a bulky amount of silicon dioxide. The pozzolanic reactivity of RHA boost to use it as a cementious material in concrete. OPC was replaced with RHA at 0%, 5%, 10% and 15%. Addition of RHA in concrete is a sustainable approach, it reduces the pollution and provides strength and reduces the cost as well. Tests were performed on fresh as well as hardened concrete after 7, 14 and 28 days of curing in water, Hydrochloric acid and in sulfuric acid. The value of compressive strength of incorporated sample is more as compared to controlled sample. Results indicates that the addition of RHA improves the properties of concrete which includes packing density. It increases the strength and durability of concrete in term of sulphate and chloride resistance.

Keywords: - *Rice Husk Ash, Cementious, Compressive Strength, Ordinary Portland Cement, Pozzolanic*

I. INTRODUCTION

The Rice husk (RH) is the agricultural residue which is obtained from the covering of rice grains during the milling process. Manufacturing of rice in the world is more than 700 million tones. Rice husk comprises 75-90% organic matter such as lignin, cellulose, etc. and rest inorganic components like alkalis, silica and trace elements [1]. Rice Husk Ash (RHA) is a by-product as a results of RH burning. The production of RHA is abundant in areas where rice crops are more. The most difficult problem is the disposal of RHA and due to the difficulty involved in its disposal RHA has become environmental hazard. Lots of approaches are being thought of for disposing them. Open burning of RH do not produces a good quality of ash and is banned in many countries due to the problem of pollution [10].It is usually dumped into water streams, and as far as the landfilling is concerned, it causes environmental pollution. The earlier studies shows that the high content of silica can be used as a cementious material. With the development of material sciences and technologies, a lot of research work has been done to improve the properties of concrete. As the main constituent of concrete is cement. The production of Cement is the greatest generation of CO_2 and harmful effects including global warming, regional acid rain and reduction in non-renewable resources, each ton of cement produces 1 to 1.25 tons of CO_2 [2]. As RHA have cementious nature, so utility of this waste for the purpose of benefit that provides safe environment friendly disposal of RHA. Due to its pozzolanic behavior and filling ability RHA will be beneficial to use it in concrete.

RHA in concrete acts accelerator because of having high silica content that shorten the setting time through absorption of surrounding water and provides several advantages which includes durability, improved strength, reduces the cost of cement and the most important in all of that is environmental benefits related to disposal and reduction in the emission of carbon dioxide [3]. It is the sustainable approach by adding RHA, the voids present in between the cement particles are filled and it improves the Interfacial Transition Zone (ITZ) due to its pozzolanic result. The decrease in bleeding water results in a stronger ITZ between aggregate particle and cement paste which provides more impermeable and durable concrete. Workability of concrete having RHA will be improved by densification the mixture [10]. RHA not only improves the properties and durability of concrete but also reduces the amount of cement consumed in construction processes.

Earlier studies pertaining to merged RHA to concrete are not recent. Use of RHA in concrete was untested in 1924 [4] up to 1973 investigation has been done on the pozzolanic reactivity of RHA [5]. Mehta has shown significant reduction in porosity of cement paste with RHA addition and established that combustion of RH under organized temperature produces amorphous form which contains silica [6]. In 1972 Mehta publishes his first article which includes the use of rice husk [7]. Rodrý´guez de Sensale stated that the mortars and concrete containing RHA have compressive values superior to that of OPC concrete [8]. In most of the cases concrete and mortars enclosing RHA improves durability at different ages [9]

II. RESEARCH OBJECTIVE

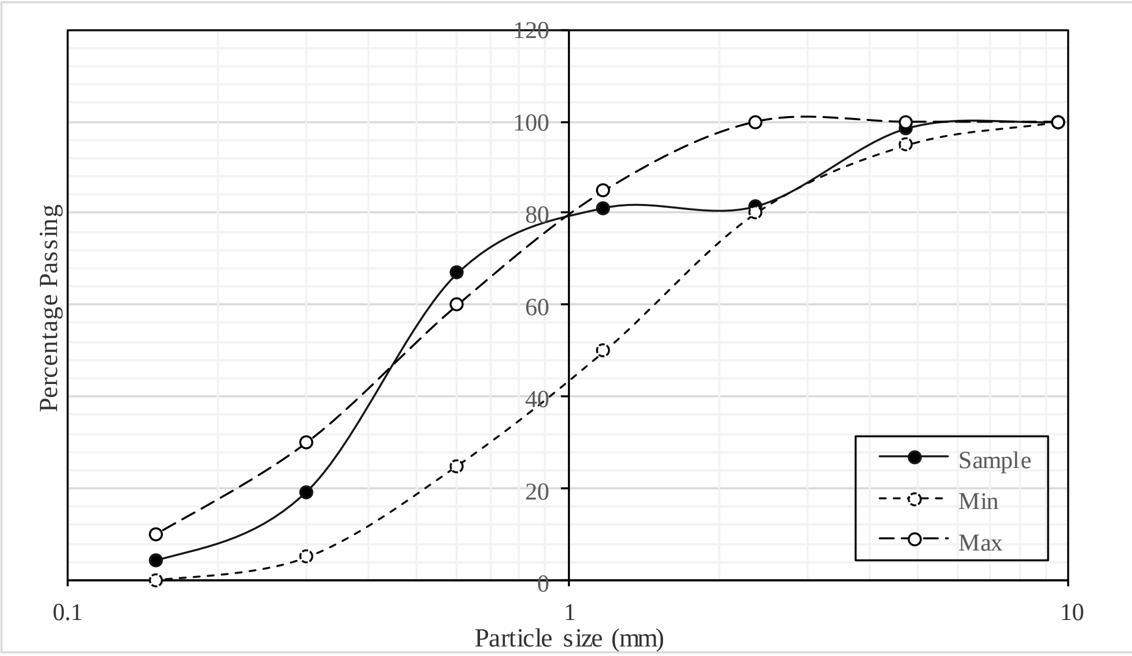
The main objective of this research work is to maintain sustainability by the use of rice husk ash as partial replacement of cement that provides strength and durability to concrete. The use of RHA was 0%, 5%, 10% and 15%. This research will discover the role of RHA as cement replacement in the concrete under different curing conditions including water, sulfuric acid and hydrochloric acid.

III. MATERIAL SELECTION

Broad categories of materials were used in concrete, RHA was collected from Gujranwala about 100 kilograms. They are using Rice Husk (RH) as a fuel in large kiln due to electricity shortage. RH was burnt in kilns at a temperature range of 800°C to 1000°C and no admixtures were added. The used sand is of Lawrencepur sand which is free from impurities, organic contamination and obeys to ASTM C 33. Locally best available virgin Margalla crush was used because it conforms the standards and provides good workability. OPC was used in which the composition and properties is in compliance with the ASTM C-150.

IV. GRINDING AND SIEVING

First of all sample was grinded to make it smaller in size and to remove the unburnt particles from the sample afterwards sieve analysis was done in accordance to ASTM- C-136. RHA was sieved from sieve No.200 so that its particle size may become comparable with that of cement particle. RHA passing the sieve was used filtering decreases the visible black color unburnt carbon particles hence improving the quality of ash.



V. CASTING OF SPECIMEN

After the material selection and sieving, casting of sample was being done. Required number of moulds were cleaned and oiled before moulding so that demoulding can be done easily without any damage. 108 cylinders were casted for determination of compressive strength. 9 samples were prepared for 7 days strength in which 3 samples were cured in water, 3 were cured in Hydrochloric acid(HCL) and last 3 were cured in sulfuric acid(H_2SO_4) in which we take the average of these three for 14 and 28 days strength.

VI. CURING OF SPECIMEN

Proper curing of concrete is one of the major step in making high quality concrete. The physical properties of concrete largely depend on the hydration of cement and the resultant microstructure of the hydrated cement. It is observed that 80-85% of the eventual strength is reached in first 28 days and hence this criteria is to be considered for design [11]. The compulsion of curing arises from the fact that hydration of cement take place only in water filled capillaries therefore, loss of water by evaporation from these capillaries must be prevented. In this work prepared samples were cured using water, Sulfuric Acid and Hydrochloric Acid.

6.1 SULFURIC ACID

Historical name of this acid is oil of vitriol. Sulfuric acid is a highly eroding, tough mineral acid with the molecular formula H_2SO_4. It is a pungent-ethereal, colorless to slightly yellow viscous liquid which is soluble in water at all concentrations. Sometimes, it is dyed dark brown during production to alert people to its hazards. Sulfuric acid at a high concentration can cause very serious damage upon contact, as it not only causes chemical burns via hydrolysis, but also secondary thermal burns via dehydration. It burns the cornea and can lead to permanent blindness if splashed onto eyes.

6.2 HYDROCHLORIC ACID

Hydrochloric acid is a clear, colorless, highly pungent solution of hydrogen chloride (HCl) in water. It is a highly corrosive, strong acid with many industrial uses. Hydrochloric acid is found naturally in gastric acid. Historically called spirits of salt, hydrochloric acid was produced from vitriol (sulfuric acid) and common salt. We poured 1ml acid for 1 litre of water to dilute the both acids. So that it could not harmful for the skin while putting and taking of specimens.

VII. RESULTS AND DISCUSSIONS

Two types of tests were performed, first one on fresh concrete and other was on hardened concrete. On fresh concrete slump cone test was performed. For finding the properties of hardened concrete simple compression test was performed. In other words, it involved the determination of workability and compressive strength of the concrete at different level of replacement.

7.1. SLUMP TEST

Test performed just after mixing was slump test to find the workability of concrete. It was performed in accordance to ASTM-C143. Table#1 showing the values of controlled and different incorporation of RHA. Fig.1 depicts the concrete while performing Slump test.

Table#1: Slump Values

Sample	Batch No		
	1	2	3
Controlled Concrete	75mm	76mm	74mm
5% Replaced Ash	78mm	80mm	81mm
10% Replaced Ash	76mm	75mm	77mm
15% Replaced Ash	70mm	72mm	73mm

Figure 1

7.2. COMPRESSION TEST

Compressive strength is usually considered as one of the most important properties of concrete and a major indicator of general quality control. Factors influencing the strength of concrete include the types and quality of materials, the mixture proportion, the construction methods, the curing condition, and the test method. From the microscopic point of view, both the degree of hydration and the porosity play important roles. The greater the volume of the pores, the lower the strength of the concrete will be. After standard curing, the compressive strength of concrete specimen was to be determined at 7, 14 and 28 days. For determining maximum compressive loads carried by various cubes we had used 2000 KN capacity controlled compression machine. ASTM C39/C39M 12a test method load was being applied at a rate of 15 MPA per minute. The summary of test results are shown below in tabular form and graphically as well. The values for 10% replacement is more as compared to controlled, 0%, 5% and 15%. The strength at 10% replacement is better than the other replacements because it is nearly to the optimum value of strength in the presence of Rice husk Ash. So it is economical to use 10% Rice husk Ash as a replacement for Mega projects.

VIII. TABLES AND GRAPHS

Table#2: Mix 0 (Controlled Concrete) Mpa

Days	7				14				28			
	1	2	3	Average	1	2	3	Average	1	2	3	Average
H_2O	30.3	29	29.6	29.63	32.33	32	33.2	32.51	37.5	38.24	38.11	37.95
HCl	25.21	24.43	24.85	24.83	28.4	27.2	27.5	27.7	33.22	35.5	34.78	34.5
H_2SO_4	21.75	21.56	21.7	21.67	26	25.2	24.8	25.33	30.32	30.76	32.46	31.18

Table#3: Mix 5 (5% Replacement) Mpa

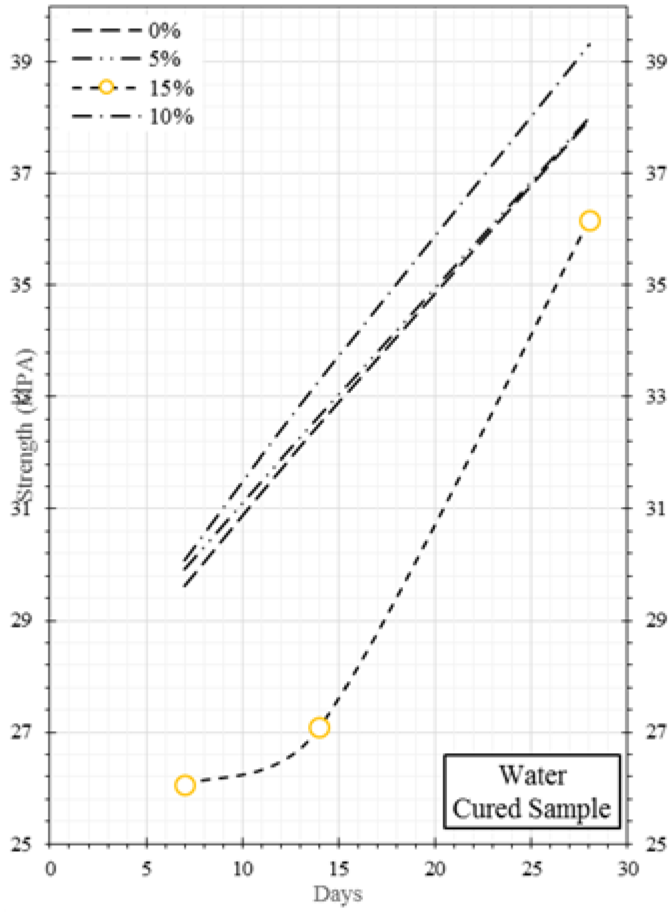
Days	7				14				28			
	1	2	3	Average	1	2	3	Average	1	2	3	Average
H_2O	29.9	29.7	30.13	29.91	32.9	32.31	32.75	32.65	38.1	38.02	37.9	38.0
HCl	20.05	20.46	21.23	20.58	23.53	24.12	24.39	24.01	33.2	32	32.94	32.71
H_2SO_4	20.19	19.48	18.77	19.48	23.09	22.83	22.08	22.67	29.27	29.1	29.19	29.19

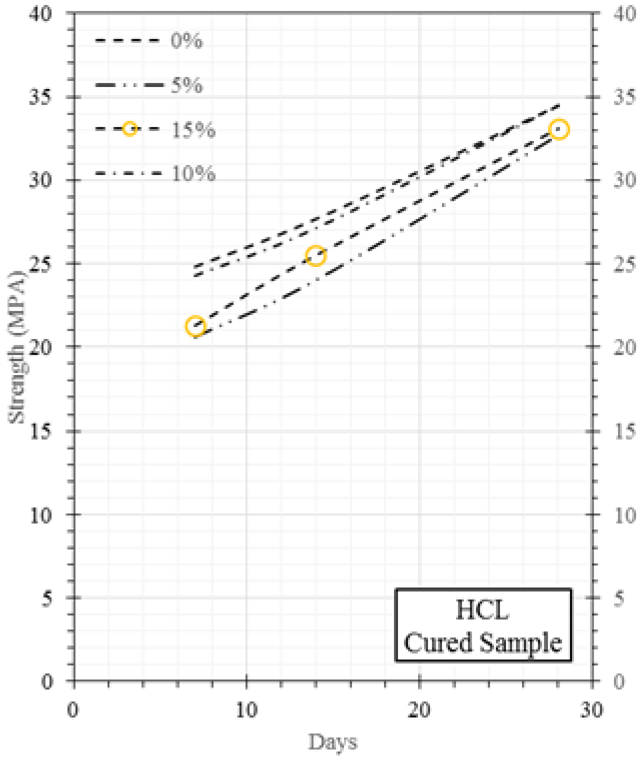
Table#4: Mix 10 (10% Replacement) Mpa

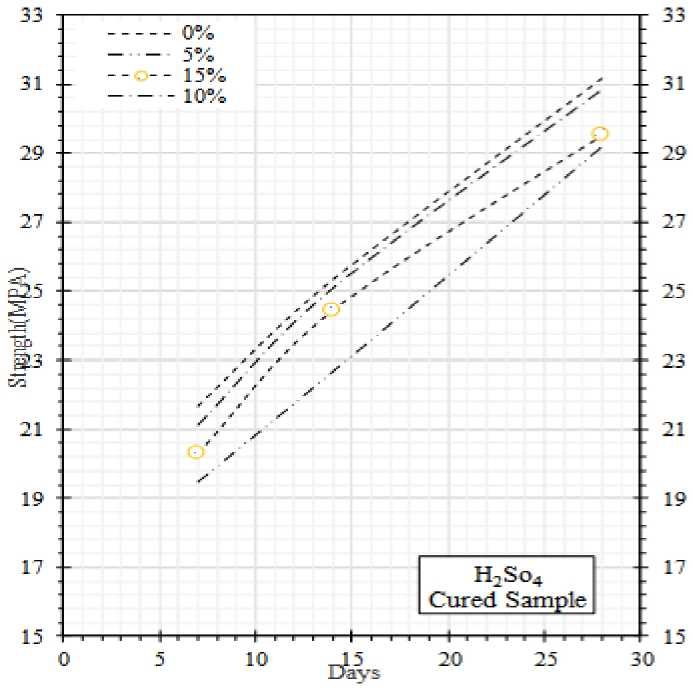
Days	7				14				28			
	1	2	3	Average	1	2	3	Average	1	2	3	Average
H_2O	30.3	29.8	30.12	30.07	33.67	32.98	33.23	33.29	39.01	39.45	39.50	39.32
HCl	23.71	25.2	23.98	24.3	27.55	26.85	27.01	27.14	35.1	34.98	33.21	34.43
H_2SO_4	21	20.9	21.52	21.14	25.11	24.2	25.98	25.1	30.19	30.41	31.99	30.86

Table#5: Mix 15 (15% Replacement) Mpa

Days	7				14				28			
	1	2	3	Average	1	2	3	Average	1	2	3	Average
H_2O	26.56	25.67	25.98	26.07	27	27.3	26.98	27.09	34.44	36.98	37.1	36.17
HCl	20.1	21.74	22	21.28	25.2	26	25.29	25.5	32.38	33.88	33	33.09
H_2SO_4	19.44	21.32	20.13	20.3	23.52	25.23	24.56	24.44	29.19	29.25	30.12	29.52


0%
5%
15%
10%
Strength (MPA)
Days
Water
Cured Sample


0%
5%
15%
10%
Strength (MPA)
Days
HCL
Cured Sample



IX. CONCLUSIONS

- Use of RHA is feasible for the production of Low cost concrete and also reduces the environmental pollution.
- RHA increases the strength and durability of concrete in term of sulphate and chloride resistance.
- The addition of RHA decreases Ca $(OH)_2$ quantity because the excess silica present in RHA reacts with $Ca(OH)_2$ and produces C-S-H gel which is the main strengthening constituent to increase the strength and durability of concrete.
- Use of RHA increase the packing density of concrete which result in impervious concrete.
- The use of RHA in concrete leads to saving in material cost so use of RHA is sustainable approach towards the use of cement.

REFERENCES

[1] Madhumita Sarangi S. Bhattacharyya and R. C. Behera Effect of temperature on morphology and phase transformations of Nano-crystalline silica obtained from rice husk, Phase Transitions 82: 5, 377 — 386
[2] Muga Helen, Development of Appropriate and Sustainable Construction material, Michigan Technological University, May 23, 2005
[3] Supplementary Cementing Materials, R. Siddique, M. Iqbal Khan page 232
[4] A. A. Ramezanianpour, M. Mahdi khani, Gh. Ahmadibeni "The Effect of Rice Husk Ash on Mechanical Properties and Durability of Sustainable Concretes" International Journal of Civil Engineering. Vol. 7, No. 2, June 2009
[5] METHA, P. K., Rice husk ash – a unique supplementary cementing material, in: V.M. Malhotra (Ed), Proceedings of the International Symposium on Advances in Concrete Technology. CANMET/ACI, Athens, Greece, May, 1992, pp. 407-430.
[6] S.K. Agarwal, "Pozzolanic activity of various siliceous materials", Cement and Concrete
[7] Research, Volume 36, Issue 9, September 2006,
[8] Ramazanpour, Ali Akbar, Optimized production of rice husk ash and the effect of concrete made with the ashes in alkaline reactions, Fourth National Congress of Civil Engineering, Tehran University, Ordibehesht
[9] Gemma Rodrýguez de Sensale, "Strength development of concrete with rice husk ash",Cement & Concrete Composites, No. 28 (2006) PP. 158–160.
[10] Prinya Chindaprasirt, Sumrerng Rukzon and Vute Sirivivatnanon, "Strength, porosity and corrosion resistance of ternary blend Portland cement, rice husk ash and fly ash mortar", Construction and Building Materials.
[11] Satish Chandra, waste materials used in concrete manufacturing
[12] M L Gambhir, Concrete Technology (Third Edition)