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STUDY OF PERFORMANCE OF CEMENT MORTAR BY PARTIAL REPLACEMENT OF CEMENT USING RICE HUSK ASH

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Abstract - *Cement is the main ingredient of concrete. It has both cohesive and adhesive properties when mixed with water, which makes it capable of binding material fragments into a compact whole. Cements are classified as calcium silicate and calcium aluminate. Due to less availability of lime stone a major material for production of cement the cost of cement has gone high, which makes construction costs go high. Recently pozzolonic materials are being used as partial replacement for cement. One such pozzolonic material is rice husk ash (RHA). In this project we find the optimum amount of RHA that can partially replace cement. In our project first we have done material testing of the materials like cement, sand, RHA. The tests that were performed were normal consistency, initial setting time, final setting time and bulk density test of sand. For our test we have used cement mortar for showing the strength variation of cement by partial replacement of cement by RHA. We have used cubic moulds of 70.6 mm. The cubes were cured for 7 days and 28 days. The tests done on hardened cement mortar are compressive strength, density test and water absorption test. The strength variations were recorded and reported.*

Key Words: ***OPC, Rice husk ash, Cement mortar, Compressive strength***

1. INTRODUCTION

The annual production of rice paddy is 120 million tonnes. It is estimated that 1000 Kg of rice grain produce 200 Kg of rice husk. After burning about 20% of rice husk or 40 Kg would become rice husk ash. Rice husk ash is one of the promising pozzolonic material with high percentage of silica. Another beneficial factor is that the issue of disposal of the husk is solved. Rice husk ash gives better results when the particles are equal or finer than cement particles. Rice husk ash can be used in building construction in rural areas where availability of rice husk is in plenty. Rice husk ash has been used as a building material as well as for making light weight bricks. It has also been used for preparation of insulating blocks and found to have very high resistance to temperature. It should be taken into account that the rice husk ash used has suitable silica content. Care should be taken to see that the rice husk is burnt under controlled temperature and controlled environment. The rice husk ash after burning should be grinded properly to obtain suitable and uniform particle size. When all this is kept in mind then only we get the best rice husk ash for partial replacement of cement.
The project is done to reduce the cost of cement and its manufacture. The project is very useful for construction in rural areas where RHA is available. It can be mainly done for construction of structures whose imposed load is less. Earlier researches were mainly based on concrete cubes but very less research was done on mortar cubes. So we have done testing on cement mortar cubes.

In the past some researches have been done by partially replacing cement with rice husk ash using different percentages of rice husk ash. Below an overview of different studies has been represented. M.U DABAI et al,presented a paper on use of waste materials like rice husk ash in construction. Rice husk ash was tested physically and chemically. Cement was replaced in different percentages like 0%, 10%, 20%, 30%, 40% and 50% by weight with rice husk ash. Compressive strength tests were carried out on mortar cubes after the curing age of 3, 7, 14 and 28 days. The cubes showed reduction in strength as percentage of rice husk ash increased. But early strength gain was more. The chemical analysis revealed that rice husk ash had more silica content (68.12%). EZIEFULA U.G. et al presented a paper in which he investigated the variation of OPC-RHA composites strength with percentages RHA. 231 concrete cubes, 231 sand crete cubes and 231 soil crete cubes of 150mm x150mm x150 mm were produced at percentage OPC replacement with RHA of 0% (control), 5%, 10%, 15%, 20% 25%, 30%,35%,40%,45% and 50% and crushed to obtain compressive strength at 3, 7, 14, 21 and 28, 50 and 90 days of curing. The strength decreased with increase in RHA percentage. The results suggested with good quality control of concreting process 5% to 30% OPC replacement with RHA could be suitable for reinforced concrete works. OBILADE I.O et al 2013 presented a research paper on the properties of rice husk ash (RHA) when used as a partial replacement for OPC in concrete. OPC was replaced with RHA by weight at 0%, 5%, 10%, 15%, 20% and 25%. 0% served as a control. Compacting factor test was carried on fresh concrete while compressive strength was carried on hardened concrete after 7, 14 and 28 days of curing in water. The results revealed the compacting factor decreased as percentage of RHA increased in concrete. The compressive strength decreased with increase in RHA percentage. GODWIN A. AKEKE, MAURICE E. EPHRAIM, AKOBO and JOSEPH O. UKPATA et al 2013 investigated the

effects of introducing RHA as a partial replacement of OPC in concrete. Cubes were casted and compressive and flexural strength was noted after 3, 7, 14 and 28 days. This study showed that RHA can be used as cement replacing material up to certain percentages.

S.I. KHASSAF, A.T. JASIM and F.K. MAHDI et al 2009 researched on effect of RHA on fresh and hardened concrete and used to reduce seepage in canals. Concrete specimen were moulded with 10%, 20% and 30% RHA replacing the cement and its workability, compressive strength ,split tensile strength and drying shrinkage were measured. The results were compared with concrete mixes not containing RHA. The results showed a significant reduction in workability, compressive strength and split tensile strength results as percentage of RHA increased. The test of drying shrinkage indicated that it was decreased with increase of RHA %.

2. METHODOLOGY AND MATERIALS

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 annually. Rice milling generates a by- product known as husk. 22% of the weight of paddy is received as husk. The husk is used as a fuel in the rice mills to generate steam for the parboiling process. 25% of the husk is converted into rice husk ash (RHA). The rice husk ash used had a moisture content of 30%. The specific gravity of rice husk ash was found to be 2.0.The rice husk ash was procured from Chandra Rice Mill Chennai. The test results indicate that RHA has more silica content than ordinary Portland cement (OPC). This results in gain of early strength. The high silica content makes RHA suitable as a cement replacing material. The specific gravity of RHA is lower than OPC. The above results show that RHA can be used as a super pozolan.

Fig1.Rice Husk

Cement mortar is prepared to assess the strength of cement. In the preparation of cement mortar only fine aggregates and cement were used and coarse aggregates were not used. The fine aggregates were used to give body to mortar and also to bind the mortar properly. If only cement is used without fine aggregates then the mortar cubes will fail under lower loads.

The cement mortar which was prepared was in the ratio of 1:3 i.e. if 100 gm of cement is used then 300 gm of sand will be required to prepare the cement mortar. The mould used for preparation of mortar cubes had a dimension of 70.6 mm x70.6 mm x 70.6 mm. It is required to calculate the amount of cement, sand (fine aggregate) and water required for preparation of one cement mortar cube.

Table 1. Mix Proportion

Mix Designation	OPC (%)	RICE HUSK ASH (%)
Mix1	100	0
Mix2	95	5
Mix3	90	10
Mix3	85	15
Mix4	80	20

2.2 Preparation of mortar cubes

The mould used for preparation of cubes is of dimension 70.6 mm x 70.6 mm x 70.6 mm. This is the standard mould size specified for cement mortar cubes. The moulds were first properly greased and oiled so as to make the surface smooth so that removal of the cubes is easy after the setting process. Then the cement mortar was filled in the moulds and compacted in a mortar cube vibrator. This vibration was done for a period of almost 2 minutes. Mortar was added to the mould such that the mould is filled up to the top. Then these cubes were kept at a temperature of $27^0C \pm 2^0C$ in moist condition for 24 hours. After the drying the cubes were removed from the mould and they were kept for curing in a curing tank. It was kept in mind that the cubes does not break while removal from the moulds. If some damage happens to the cubes they have to be discarded and new cubes have to be casted

Fig.2 Moulds filled with cement mortar

3. RESULTS AND OBSERVATION

3.1 Normal Consistency Test

The normal consistency value will help us to perform other tests on cement mortar. This is the first and most important test done on cement. The normal consistency value is used to find initial setting time, final setting time,

etc. we have blended the cement with RHA and found the normal consistency for different blends like 5% RHA, 10% RHA, 15% RHA and 20% RHA.

Table.2 Normal consistency

Mix Designation	Normal Consistency
Mix1	29
Mix2	34
Mix3	38
Mix3	47
Mix4	59

3.2 Initial and Final Setting Time Test

Initial Setting Time

The initials setting time is defined as that period after which the vicat's plunger can penetrate up to 33 mm to 35 mm. This test is done to record the time after which the cement will start setting. It gives us an idea of in how much time the concrete should be transported or used in the site.

Final Setting Time

The final setting time is the time after which the vicat's needle of 1 cm dia. fails to give an impression on the surface of cement paste. This is the time at which the cement is set finally and now it will be hard in nature. This test shows the time period after which the cement will set finally.

3.3 Water Absorption Test

This test is performed to find the amount of water absorbed by the mortar cubes. Different mortar cubes with different percentage of RHA showed different water absorption values. The test results are shown below.

Table.3 Consistency Test Results

% RHA	Consistency
0	8
5	9
10	11
15	12
20	13

3.4 Compressive Strength Test

The compressive strength of different mortar mixes after 7 days and 28 days curing period are mentioned below.
Size of specimen: 70.6 mm x 70.6 mm x 70.6 mm cubes

The compressive strength is the most important and repeatedly specified test in the testing of cement mortar.

Table4. Compressive strength for different mix

Mix Designation	**Compressive Strength (N/mm²)**	
	7 Days	28 Days
Mix1	38.90	54.32
Mix2	34.77	46.64
Mix3	28.86	37.33
Mix3	25.36	33.15
Mix4	20.73	30.4

4. CONCLUSION

From the experiments and analysis of results of findings in this project work, we established the following facts,

1.Adding RHA increases the initial and final setting time.

2.Addition of RHA will increase the normal consistency values drastically.

3.Finer RHA particles will give better strength values.

4.RHA contains high amount of silica (SiO2) and calcium oxide (CaO).

5.RHA has low specific gravity and it can be used for producing light weight building materials.

6.RHA is a very useful industry waste product that can be used as partial replacement of cement.

7.RHA when available locally will reduce the cost of construction.

8.The partial replacement of RHA can be done in the range of 5% to 10%.

9.The physical and chemical property of RHA is very much similar to that of ordinary Portland cement and hence can be used as a mineral admixture.

10.Using RHA will help to reduce the cement requirement which in turn will reduce its production and the major greenhouse gas CO2 emitted will be reduced.

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