IMPROVING STRENGTH OF CONCRETE THROUGH PARTIAL USAGE OF RICE HUSK ASH

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Abstract - *Cement is generally considered the most expensive ingredient of the concrete and its demand is also increasing day by day. This demand for cement and concrete can be met by the partial cement replacement. Energy and cost savings can result when industrial and agricultural by-products such as fly ash, silica fumes, pond ash, and marble dust powder are used as a partial replacement. Amongst these various products, use of rice husk ash in the production of concrete is very important for India. India is one of the largest rice producers in the world. India produces about 122 million ton of paddy every year. It has been estimated that each ton can lead to 40 kg of rice husk ash. Rice husk, when burnt in a controlled manner does not cause pollution. When properly burnt it produces high* SiO_2 *content and thus it has excellent pozzolonic properties. Various researchers have shown that rice husk ash can increase the strength and impermeability of the concrete. The research work presented in this paper mainly deals with evaluating one type of commercially available rice husk ash (RHA) and to determine the properties such as workability, mechanical properties (compressive strength, split tensile strength and flexural strength) and durability properties. The details of improvement in compressive strength have been illustrated and evaluated in this paper.*

***Key Words*: Compressive strength, Concrete, Rice husk ash, Workability**

1. INTRODUCTION

results in improving the compressive strength. Concrete is the most widely used material in the world for construction. Concrete has been in use for centuries and its main constituent is cement. Cement is the binding material in concrete; however, it is the most expensive ingredient of concrete. Its production is based on the availability of raw materials which are either calcareous materials such as lime stone or chalk or argillaceous materials such as shale and clay. These materials are limited on our planet earth and getting depleted day by day. Another problem with the concrete is its high energy requirements and CO_2 emissions in making of Portland concrete [1-2].

The use of pozzolanic materials in concrete has been increasing day by day. These materials not only reduce the amount of the cement in the concrete but also have been known to enhance the properties such as durability, strength and impermeability of the concrete [3]. Incorporation of these materials reduces the problem of waste disposal as most of them are byproducts of industrial and agricultural wastes. Different types of pozzolanic materials are in use today such as fly ash, granulated blast furnace slag, marble powder [4]. In Indian scenario use of rice husk ash is of great importance as 122 million of rice husk is produced here every year [2].**Kumar *et. al*** performed experimental work with Rice Husk Ash as a replacement for Portland Pozzolona cement in concrete and measured the strength parameters of concrete by conducting Compressive strength and flexural strength test at 3, 7, 28 and 56 days. All these tests were conducted according to the Indian standards. It was concluded that the concrete in which 7.5% replacement with RHA was made came to be optimum in both the compressive and flexural strength at 28 days [5].

The Compressive strength of concrete is one of the most important characteristics of concrete.**Nair *et.al***have beenreported improvement in compressive and flexural strength of concrete by use of RHA in concrete. It was observed that for particular water to binder ratio (0.4) the compressive strength of concrete at 7 days and 28 day was maximum when the replacement of OPC with RHA is kept at 25percent. RHA- High strength concrete showed a reduction in density compared with conventional concrete. Slump cone test was carried out on all the mixes. It was found out that that the dosage of superplasticizer increased with the increase of RHA content. This was attributed to the porosity of the RHA sample [6].

Silica (SiO_2) from pozzolanic material in presence of water reacts with Calcium Hydroxide (Hydration product of concrete) and gives CSH (Calcium Silicate Hydrate) which is the main product responsible for the strength of the concrete matrix; hence, the strength of concrete increases[7].**Habeeb *et. al***first investigated the effect of grinding on the particle size and the surface area and then they performed XRD analysis and found out the presence of amorphous silica in the rice husk ash. Also, the effect of RHA average particle size and percentage on concrete workability, fresh density, superplasticizer (SP) content and the compressive strength was seen [8].

2. EXPERIMENTAL METHODS

Materials and mix proportion: Various materials were used in the project whose nature and sources have been described below:

Rice husk ash: Rice husk ash was collected from a rice mill at ***KGR AGRO FUSIONS PVT LTD, Ludhiana***, Punjab, India who are the commercial suppliers of Rice Husk Ash. The Rice husk ash is amorphous in nature. Rice husk are the shells which are removed from the paddy during dehusking of paddy. Rice husk is useless from the domestic and agricultural point of view. It cannot be even used for feeding animals as its nutritional value is negligible. When burnt an ash is produced which is known as rice husk ash which has been found pozzolanic in nature by researchers.

Superplasticizer: The super plasticizer used was **Conplast-SP-430**.Conplast SP430 is Sulphonated Naphthalene Polymer (SNF type) which is brown in colour. It can give up to 25 percent water reduction without loss of workability to produce high quality concrete which can reduce permeability.

Cement: The cement used for experimentation purpose obtained from jaypee constructions private limited darlaghat (h.p). The cement was Portland Pozzolona Cement (fly ash based) conforming to Part 1 of IS 1489:1991.

Fine aggregate: Locally available sand which is conforming to the **zone 4** according to indian road congress (2008) has been utilised in this experiment.

Coarse aggregate: Locally available coarse aggregates were used which have the maximum nominal aggregate size of **20mm**.

Sulphuric acid: Sulphuric acid has been purchased from

Quali-tech chemicals and was used in acid attack.

The table 1 illustrated below contains the mix proportion of various ingredients which deals with the parameters of mix designation and control mix which further

Table -1: Mix Proportion

Mix-Designation	M1	M2	M3	M4	M5
Rice Husk Ash Present %	0	2.5	5	7.5	10
w/c ratio	0.28	0.28	0.28	0.28	0.28
Cement (Kg/m^3)	465	453.38	441.75	430.3	418.5
Rice Husk Ash (Kg/m^3)	0	11.63	23.25	34.88	46.5
Sand (Kg/m^3)	561.76	560.19	559.40	557.4	556.24
Coarse Aggregate (Kg/m^3)	1280.88	1277.29	1275.49	1270	1268.30
Water (Kg/m^3)	130	130	130	130	130

Note: M1-Control Mix (0% RHA), M2 (2.5% RHA), M3 (5% RHA), M4 (7.5% RHA), M5 (10%RHA)

3. COMPRESSIVE STRENGTH TEST

The results of improvement in compressive strength through addition of rice husk ash have been illustrated further. In total, 30 cubes were casted with 6 cubes for each percentage (0, 2.5, 5, 7.5, and 10) and 3 cubes of each percentage were checked for 14 and 28 days compressive strength. The results of 14 days are illustrated further, through table 2-3 and chart 1-2.

3.1 Compressive Strength after 14 days

The table 2 illustrated below includes control mix M1,M2,M3,M4,M5 corresponding to compressive load of each sample after 14 days and table 3 shown below contains the increase in strength(%) corresponding to average load of each mix after 14 days.

Table-2: Compressive load corresponding to each sample after 14 days.

Sample (3 each)	Compressive Load(KN)	Avg Load(KN)
M1	1041,1033,1051	1040
M2	1096,1093,1106	1098
M3	1113,1110,1118	1114
M4	1184,1190,1179	1184
M5	1066,1073,1054	1062

Table- 3: Compressive strength & % increase in strength corresponding to average load of each mix after 14 days.

Sample	Average load(kN)	Compressive Strength(MPa)	Percentage increase in Strength due to RHA addition (%)
M1	1040	46.2	-
M2	1098	48.8	5.23
M3	1114	49.5	7.14
M4	1184	52.6	13.85
M5	1062	47.2	2.16

Note: M1-Control Mix (0% RHA), M2-2.5 % RHA, M3-5% RHA, M4- 7.5% RHA, M5-10%RHA

The chart below contains two parameters i.e. Compressive strength(Mpa) and % Replacement of RHA that includes samples M1,M2,M3,M4 and M5 corresponding to an increase in compressive strength after 14 days at 0%,2.5%.5%,7.5% and 10% in the form of Histogram.

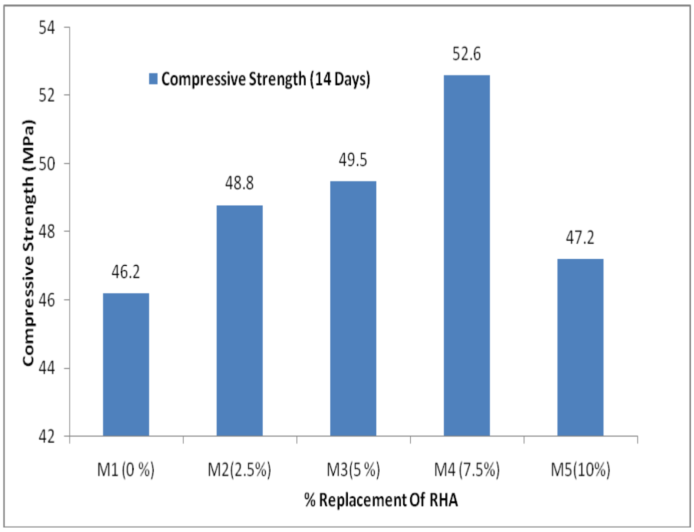

Chart -1: Histogram showing compressive strength after 14 days

The chart below includes two parameters %Replacement of RHA and Compressive strength (Mpa). The graph is increasing upto 7.5% and then decreasing upto 10%. So we found out that 7.5% is the optimum value of Rice Husk Ash at 14 days.

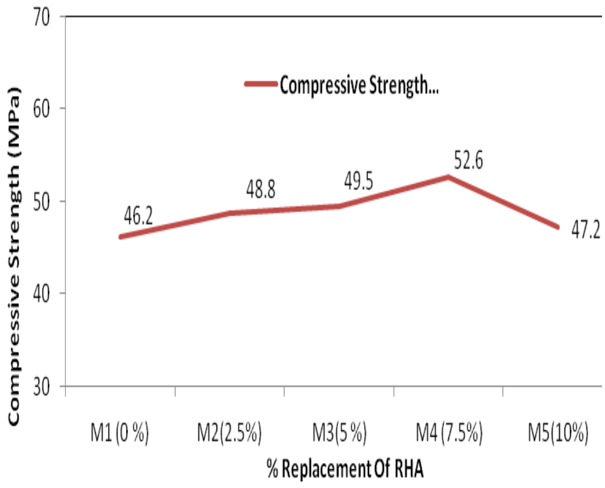

Chart -2: Pareto Chart showing Compressive Strength after 14 days

3. CONCLUSIONS

- Compressive Strength Test is of utmost importance and it is what we use to grade concrete (i.e. M30, M40, M60 etc).
- It is necessary to conduct this test in 14 days because first of all we get an idea if our mix design correct or not and secondly as we have used rice husk ash with PPC, the pozzolonic reactivity show its effect (increase in strength) in the later ages so that is the reason we went for 14 days testing instead of 7 days testing.
- 15 cubes were casted with 3 cubes for each percentage i.e (0,2.5,5,7.5,10) and each were tested at 14 days and the compressive strength came out to be (46.2,48.8,49.5,52.6,47.2) respectively.
- The graph is increasing upto 7.5 % and then decreasing upto 10 %, so we found out that 7.5 % is the optimum value of rice husk ash at 14 days as shown in the charts 1 and 2.

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