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"EXPERIMENTAL INVESTIGATION ON THE INFLUENCE OF RICE HUSK ASH ON THE STRENGTH OF CONCRETE"

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Abstract: Concrete is a major civil engineering construction material, because the ingredients of concrete are locally available materials. Generally, the cement is used as major binding material. The usage of cement in concrete causes lot of environmental pollution due to emission of greenhouse gases so that, it is necessary to reduce usage of cement by introducing new supplementary cementitious materials which are the by-products of industries to reduce debris. Rice husk ash (RHA) is an agricultural based pozzolanic material, generated by rice mills in huge quantities. This paper summarizes the experimental work on concrete in which Plain Portland cement (PPC) cement were replaced by Rice husk ash (RHA). Concrete specimens were prepared with 2.5%, 5%, 7.5%, and 10% 12.5% and 15% % RHA as a replacement of cement by weight, the most important mechanical property of concrete is compressive strength and it is evaluated on 150 mm sized cubes. The compressive strength is obtained for 7 and 28 days strength and results are analysed.

Keywords: Rice husk ash, Ordinary Portland cement (O.P.C.), Compressive strength, Workability, Split tensile Strength

I. INTRODUCTION

Concrete is a widely used construction material for various types of structures due to its structural stability and strength. All thematerials required producing such huge quantities of concrete come from the earth's crust. Thus, it depletes its resources every yearcreating ecological strains. On other hand, human activities on the Earth produce solid waste in considerable quantities of over 2500MT per year, including industrial wastes, agricultural wastes and wastes from rural and urban societies. Recent technologicaladvancements has shown that these materials are valuable as inorganic and organic resources and can produce various useful products. Amongst the solid wastes, the most prominent ones are fly ash, blast furnace slag, rice husk, silica fume and demolished construction materials. From the middle of 20th century, there had been an increase in the consumption of mineral admixtures by the cement and concrete industries. The increasing demand for cement and concrete is met by partial cement replacement. Substantial energy and cost savings can result when industrial by-products are used as a partial replacement for the energy of intense Portland cement. The use of by-product is an environmental friendly method of disposal of large quantities of materials that would otherwise, pollute land, water and air. Most of the increase in cement demand will be met by the use of supplementary cementing materials.

The RHA, by controlled burn and grinding, has been used as a pozzolanic material in concrete. Using of RHA provides several advantages, such as improved strength and durability properties, and environmental benefits related to the disposal of wastematerials and to reduced carbon dioxide emissions. Up to now, little research has been done to investigate the use of RHA as a supplementary material in cement and concrete production. For example, Malleswara & Patnaikuni published in Paper they burnt rice husk in a drumincinerator for RHA production and researched the particle-size effect on the strength of RHA blended gap-graded Portland cementconcrete. This study investigates the compressive strength of concrete containing residual RHA that is generatedwhen burning rice husk pellets and RHA as received after grinding residual RHA. The effect of partial replacement of cement withdifferent percentages of ground RHA on the compressive strength of concrete is examined.

II LITRATURE REVIEW:

Some of the early researches have examined the use of rice husk ash (RHA) in concrete.

1. **Khan and Khan (2020)** Flyash and rice husk ash are the most common pozzolan and is being used worldwide in concrete works. It is generally realized that the use of pozzolan improves the properties of mortar and concrete. Several papers have been published on the study of performance of fly ash and rice husk ash separately in blended concrete. However, only limited papers are available in the field of the combined performance of fly ash and rice husk ash. The objective of present investigation is to evaluate the combined effect of fly ash(Class F) and rice husk ash (RHA) with an additive, egg shell powder (ESP) as the supplementary cementitious material with reference to the mechanical properties of hardened concretes and to probe the optimal level of replacement.

2. **Arokiaprakash et al. (2018)** The properties of concrete made from partial replacement of sand with quarry dust and rice husk ash to cement and 100% replacement of recycled concrete aggregate to coarse aggregate studied experimentally in laboratory conditions in an attempt to propose an eco-friendly material concrete. The M25 grade (IS code 456-2000) of concrete considered as reference mix and suggested design mixes are obtaining from the partial replacement of its cement, sand and coarse aggregate proportions. The test specimens made from the proposed design mixes are of 150 mm x 150 mm x 150 mm cube for the compression, 100 mm x 300 mm cylinder for the tension, and 500 mm x 150 mm x 150 mm size of the beam for the flexural test prepared as per standards for the experimental study. The workability of the trail mixes also studied due to the addition of fine particles such as quarry dust and rice husk ash. The results revealed that the strength increased significantly in compression, tension and flexure at an optimum mix proportion (M-15).
3. **Binyamien et al. (2017)** The objective of this study is to investigate the effects of Rice Husk Ash, with different replacement levels, on the strength and durability of concrete. Three types of rice husk ash with different chemical composition and physical properties were used for this study. Ordinary Portland Cement (OPC) type 52.5 N was replaced with 5%, 10%, 15%, 20%, 30%, 40% and 50% RHA (by weight) for strength test, additional samples with 60% RHA replacement were used for durability experiments. The ratio of water/cementitious material was kept at a constant value of 0.50. Superplasticizer was used to maintain a consistent workability of the fresh concrete. The compressive strength was measured after 7, 28 and 90 days, while splitting tensile strength was obtained at age of 28 and 90 days. The migration coefficient of chloride ion penetration was evaluated using non-steady-state migration tests [Mr. Laiq Ahmad Khan, &Mr. Jahid Khan (2020)] at 28 days age. The results revealed that the RHA properties (silica form, fineness, silica percentage and loss on ignition) have a direct impact on the development of strength at long-term age [2.Arokiaprakash and et.al. (2018)]. Experiments showed that even with 50% replacement of OPC with RHA, concrete has a higher strength and durability performance compared to OPC concrete. This may be attributed to the fact that increasing replacement ratios of RHA leads to a reduction in porosity, which in turn increases the strength and durability of concrete.
4. **Akhter (2017)** Rice Husk is generated in the rice mills when paddy grains are separated. About 108 tonnes of rice husk is generated annually in the world. 200kg ofhusk is produced from 1 tonne of paddy.This RHA is regarded as a waste and has disposal problem because of the fact that it consumes a vast area for dumping. Lots of ways are being thought of for disposing it by making commercial use of this RHA. RHA can be used as a replacement for concrete .In this paper different contents of Rice Husk Ash are added to concrete to study the influence on its properties. In this study, cement was replaced by waste RHA as 5%,10%,15%and 20% by weight for M-25 mix. The concrete specimens were tested for compressive strength at 7 and 28 days of age and the results obtained were compared with those of normal concrete. Also slump test was carried out on fresh concrete containing different percentage of RHA. The results concluded the permissibility of using waste RHA as partial replacement of cement up to 10% by weight of cement.
5. **Kumar et al. (2017)** About 20 million tonnes of Rice Husk & 4 million tonnes of RHA is produced annually and is a great environmental threat, causing damage to the land and the surrounding area in which it is dumped. In the conversion of Rice Husks to ash, the combustion process removes the organic matter and leaves silica rich residue. on its mechanical properties has been studied. Samples with 10% RHA replacing the cement have been tested. The main aim of this project is to study the mechanical properties of concrete including steel and polyester fibres of M25 grade with 0.5%, 1% and 1.5% by volume of concrete. In this study I'm using steel fibres of length 25mm and diameter 0.6mm leading to aspect ratio of 50. The polyester fibres of length 12mm and 20-40 microns in diameter are used in this project.

III EXPERIMENTAL PROGRAM:

Materials Used: The various material used in the preparation of concrete are cement, sand, cement coarse aggregates, rice husk ash (RHA) and water.

Rice husk ash:- Rice husk ash is a pozzalanic material which is obtained from paddy of local area in district- Jabalpur. It can be burnt into ash that fulfills the physical characteristics and chemical composition of mineral admixtures. Pozzolanic activity of rice husk ash (RHA) depends on (i) silica content, (ii) silica crystallization phase, and (iii) size and surface area of ash particles. In addition, ash must contain only a small amount of carbon. RHA that has amorphous silica content and large surface area can be produced by combustion of rice husk at controlled temperature. The physical and chemical properties are listed in table 1 and table2 respectively.

Fig -1: Rice Husk

Fig -2: Rice Husk Ash

Table 1 .Typical physical properties of RHA.

Property	Value
Appearance	Very fine powder
Colour	Grey
Mineralogy	Non-crystalline
Odour	Odourless
Specific gravity	2.3

Table 2. Typical chemical composition of RHA

Compound	Percentage composition
Calcium oxide (CaO)	2.2
Silicon oxides (SiO_2)	86.94
Aluminum oxide (Al_2O_3)	0.2
Iron oxide (Fe_2O_3)	0.1
Magnesium oxide (MgO)	0.6
Sodium oxide (Na_2O)	0.8
Potassium oxide (K_2O)	2.3
Loss on ignition (LOI)	4.4

Cement: Plain Portland Cement (43 Grades) which is available in market is used.

Fine Aggregate: The natural river sand available in local market which passes through 4.75mm sieve with specific gravity of 2.62.Conforming to Zone II.

Coarse Aggregate: Crushed granite conforming to IS 383 - 1970 is used in this study. Coarse aggregate passing through 20mmand retained on 16 mm sieve and specific gravity 2.82 was used.

Water: Water is an important ingredient of concrete as it actively participated in chemical reaction with cement, clean portablewater which is available in our college campus is used.

Mix Proportion: The mixture proportion for the controlled concrete of M-10 to M25 grade was arrived from the trial mix as per IS 10262-2009.

Table 3. Mix proportions

S.no.	Mix	Cement (Kg/m^3)	Rice husk ash (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)	Water (Kg/m^3)	w/c ratio
1.	M0	372	0	692	1216	186	0.5
2.	M5	353.4	18.6	692	1216	186	0.5
3.	M10	334.8	37.2	692	1216	186	0.5
4.	M15	316.2	55.8	692	1216	186	0.5
5.	M20	297.6	74.4	692	1216	186	0.5

IV METHODOLOGY:

Replacement levels of PPC by RHA of 0, 5%, 10%, and 15% were chosen for this research work. Batching was carried out by weighing as per calculated amount of each concrete constituent according to the mix ratio of 1:1.86:3.26 and M-25 grade of concrete was adopted. The constituents were then mixed thoroughly until a uniform mix was obtained. Water was then added and the mix was repeated. The fresh concrete mix was then placed in a mold of size 150 mm, compacted, and left for 24 hr. before testing Compressive specimens were tested at the ages of 7 and 28 days.

V RESULT AND DISCUSSION

WORKABILITY OF CONCRETE

Table 4. Workability test for M-25 Grade

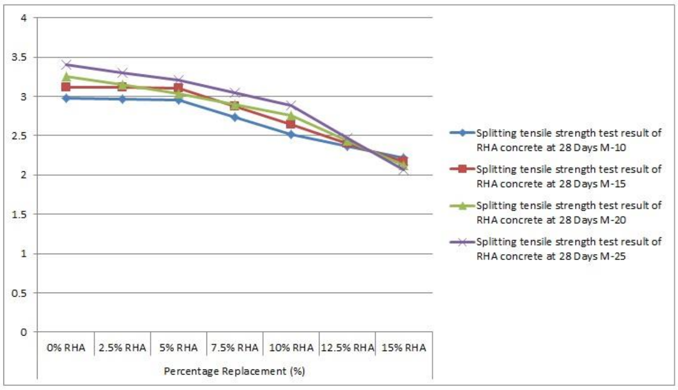
S.No	**Grade of concrete**	**Slump Values**			
		0	**5**	**10**	**15**
1	M-25	20	19	17	7

SPLITTING TENSILE STRENGTH OF CONCRETE

THE RESULTS OF SPLITTING TENSILE STRENGTH TEST PRESENTED IN TABLE 5. THE TEST WAS CARRIED OUT OBTAIN SPLITTING TENSILE STRENGTH OF CONCRETE AT THE AGE OF 28 DAYS.

Table 5. Splitting tensile strength test result of RHA concrete at 28 Days

Grade of concrete		M-10	M-15	M-20	M-25
Percentage Replacement (%)	0% RHA	2.98	3.12	3.26	3.40
	2.5% RHA	2.97	3.115	3.15	3.305
	5% RHA	2.96	3.11	3.04	3.21
	7.5% RHA	2.74	2.875	2.9	3.045
	10% RHA	2.52	2.64	2.76	2.88
	12.5% RHA	2.37	2.405	2.44	2.475
	15% RHA	2.22	2.17	2.12	2.07



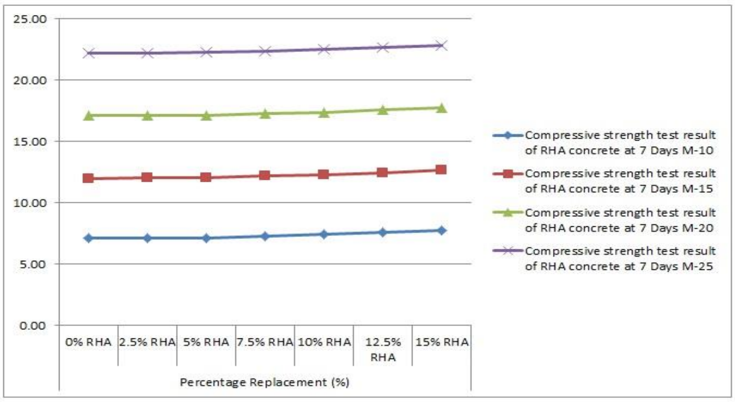
Graph-01: 28 days Split Tensile strength of concrete for M-10 to M-25 grade concrete

Compressive Strength:-

The results of compressive strength presented in Table 6. The test was carried out obtain compressive strength of concrete at the age of 7 and 28 days. The cubes were tested using Compression Testing Machine (CTM) of capacity 2000KN available in structureslab. The maximum compressive strength is observed at 10% replacement of rice husk ash. If higher percentages of ash were used, then compressive strengths decreased. There is a significant impurities present in RHA like alumina , free lime and others.

Table 6. Compressive strength test result of RHA concrete at 7 Days

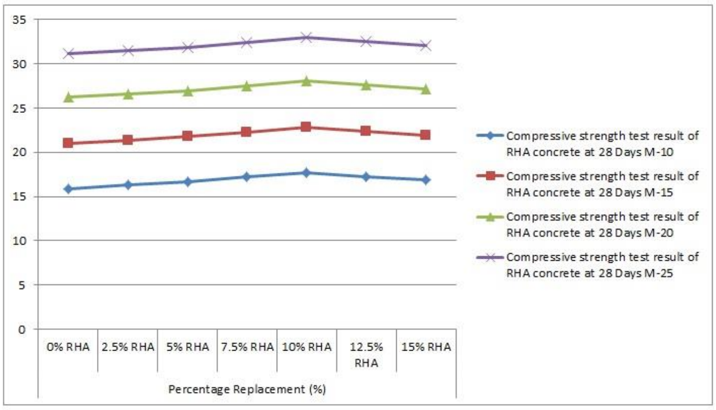
Grade of concrete		M-10	M-15	M-20	M-25
Percentage Replacement (%)	0% RHA	7.10	12.00	17.10	22.20
	2.5% RHA	7.13	12.03	17.13	22.23
	5% RHA	7.15	12.05	17.15	22.25
	7.5% RHA	7.28	12.18	17.28	22.38
	10% RHA	7.40	12.30	17.40	22.50
	12.5% RHA	7.58	12.48	17.58	22.68
	15% RHA	7.75	12.65	17.75	22.85



Graph-02: 07 days compressive strength of concrete for M-10 grade concrete

Table 9. Compressive strength test result of RHA concrete at 28 Days

Grade of concrete		M-10	M-15	M-20	M-25
Percentage Replacement (%)	0% RHA	15.92	21.02	26.22	31.12
	2.5% RHA	16.28	21.38	26.58	31.48
	5% RHA	16.65	21.75	26.95	31.85
	7.5% RHA	17.19	22.29	27.49	32.39
	10% RHA	17.73	22.83	28.03	32.93
	12.5% RHA	17.29	22.39	27.59	32.49
	15% RHA	16.85	21.95	27.15	32.05



Graph-03: 28 days compressive strength of concrete for M-10 to M-25 grade concrete

VI CONCLUSION:

1. From test results, it is found that the 10.20% higher compressive strength is attained compared to conventional concrete.
2. There is strength 0.5-1% reduction with the addition of RHA due to the impurities present in RHA like free lime, alumina andother raw minerals.
3. However, strength achieved is highest when 15% RHA is replaced with cement at 7 days of age.
4. The strength is greater when 10% of RHA is replaced with cement at 28 days of age.
5. When the RHA addition is greater than 10% for 28 days old concrete cubes, the strength produced by the concrete gets reduced than the target strength.
6. If RHA replacement is more than 15% for 7 days old cubes, compressive strength gets reduced.

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