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EXPERIMENTAL INVESTIGATION OF EGGSHELL POWDER AND RICE HUSK ASH AS PARTIAL REPLACEMENT OF CEMENT

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Abstract

This paper summarizes the research work on the properties of Rice Husk Ash and Egg shell powder when used as a partial replacement for Ordinary Portland cement in concrete.OPC was replaced with RHA by weight at 10% and 15% replacement served as the control. And the OPC was partially replaced with Egg shell powder by weight at 4% and 5%. Compacting factor test was carried out on fresh concrete while compressive strength test was carried out on hardened concrete specimens after 28 days curing in water. The results revealed that the compacting factor decreased as the percentage replacement of OPC with RHA and Egg shell powder increased.

Keywords

Egg shell powder, Rice husk ash, cement mortar, compressive test, split tensile strength, flexural strength

1. Introduction

Rice husk ash

In rice mill during the milling of paddy near about 78% of weight is received as rice, broken rice and bran. The rest 22% of the weight of paddy is received as husk. This husk is also used as fuel in the rice mills for the boilers for processing paddy and also used in a small power plant for producing energy. Rice husk contains about 75% organic volatile matter which burns up and the balance 25 % of the weight of this husk is converted into ash during the firing process, which is known as rice husk ash (RHA). For making rice husk ash rice husk is burnt approximately 48 hours under uncontrolled combustion process. The burning temperature is within the range of 600 to 850 C0. The ash obtained ground in a ball mill near about for 30 minutes and color of rice husk ash is seen as grey. This RHA contains around 85%-90% amorphous silica. India is a major rice producing country, about 20 million tons of RHA is produced annually. This RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped. Lots of ways are being thought of for disposing it by making commercial use of this RHA. In the present investigation, Portland cement was partially replaced by Rice husk ash at various percentages to study compressive and flexural strength.

Fig 1: Rice Husk Ash

Egg shell powder

Eggshell consists of several mutually growing layers of CaCO3, the innermost layer-maxillary 3 layer grows on the outermost egg membrane and creates the base on which palisade layer constitutes the thickest part of the eggshell. The top layer is a vertical layer covered by the organic cuticle. The eggshell primarily contains calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell to be dried and use as a source of calcium in animal feeds. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and harsh weather conditions. It is the fine

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grained powder with suitable proportion which is sieved to the required size before use with concrete/mortar. In the present investigation, Portland cement was partially replaced by Egg shell powder at various percentages to study compressive and flexural strength.

Fig 2:Egg Shell Powder

2. MATERIAL USED AND THEIR PROPERTIES

Materials Used

Cement:

Portland cement has become the most widely used material of its kind. Portland cement is a carefully controlled combination of lime, silica, alumina and iron oxide. When mixed with water, Portland cement undergoes hydration-a change in the chemical composition of the ingredients in crystals of various complex silicates are formed, causing the mass to harden and set.

Specific gravity: 3.13
Initial setting time: 32min
Final setting time: 410min
Fineness: 8% (residueIS 90 sieve)

Sand:

Sand accounts for at least 75% of the volume of masonry mortar and grout. Manufactured sands have sharp, angular grains, while natural sands obtained from banks, pits and river beds have particles that are smooth and more rounds

Specific gravity: 2.6

Aggregate:

Aggregate are important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. In this project the 20mm size aggregates are used.

Maximum size: 20mm
Specific gravity: 2.62
Elongation index: 25.62%
Flakiness index: 10.30%
Water absorption: 0.100%
Surface texture: rough
Particle size: angular

Fig 3: Cement

Fig 4: Sand

Methods

A. Mix Proportioning

The grades of concrete M20 having nominal mix proportion of 1:1.5:3 was used by weight and w/c ratio was fixed according to the slump requirement of 60mm.For this concrete mix, Egg shell powder and Rice Husk Ash for partial replacement of cement6. Combination of materials

Table 1: Cement+RHS+ESP

S.NO	MIX DESINATION	CEMET (IN PERCENTAGE)	RHA(IN PERCENTAGE)	ESP(IN PERCENTAGE)
1	M_{X0}	100	0	0
2	M_{X1}	90	10	0
3	M_{X2}	85	15	0
4	M_{X3}	96	0	4
5	M_{X4}	95	0	5
6	M_{X5}	86	10	4
7	M_{X6}	80	15	5

B.Casting

Mould of size 150 X 150 X 150 mm was used to cast specimens for compression test. Aggregate of size less than 20 mm and greater than 12.5 mm were used. The specimens were cast, tested at the age of 7 and 28 days after curing

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Fig 5: Casting

C.Curing

Curing of concrete is defined as the process of maintaining the moisture and temperature conditions of concrete for hydration reaction for normally. So that concrete develops hardened properties over time. The specimen tested on 28days curing of concrete.

Fig 6: Curing

3. RESULTS AND DISCUSSION

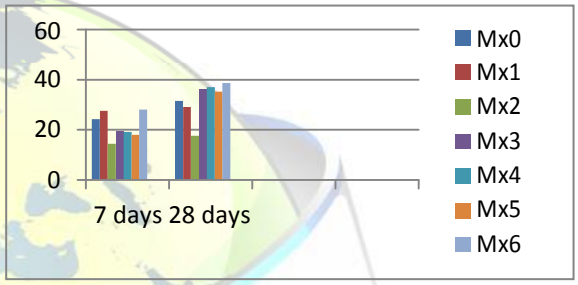
Compressive Strength Test

The cube specimens were tested for compressive strength at the end of 7days and 28 days. The specimens were tested after surface of the specimen dried. The load was applied on the smooth shock and increased continuously until the failure of the specimen. The maximum load withstand by the specimens is noted, mean compressive strength is determined and presented in the following tables.

Fig 7: Compressive Test

Table 2: Test results for Compressive strength

S.No	Mix Designation	Compression test after no. Of days (Mpa)	
		7 Days	28 Days
1	M_{X0}	24.23	31.51
2	M_{X1}	27.6	29.3
3	M_{X2}	14.4	17.6
4	M_{X3}	19.5	36.2
5	M_{X4}	19.3	37
6	M_{X5}	18.01	35.21
7	M_{X6}	28.12	38.67



Graph 1: Compressive Strength of Concrete

Flexural Strength of concrete

Flexural strength by means of beam specimens of concrete. Beams were investigated after 7and 28 days of curing for Flexural Strength. It was seen that highest flexural strength was attained at Mx_3. and thereafter at Mx_4, the flexural strength is decrease.

Fig 8:Flexural strength Test

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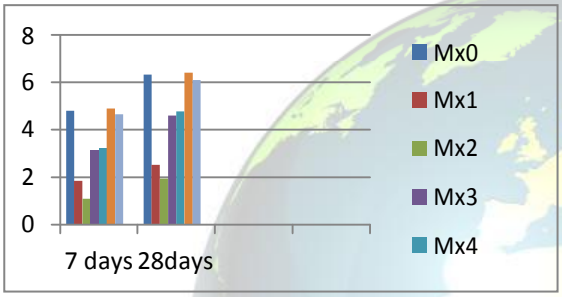
Table 3: Test results for Flexural Strength

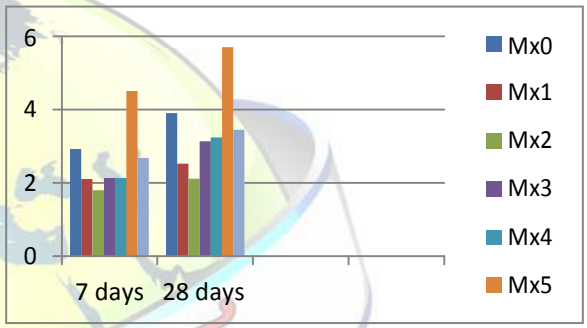
S.No	Mix Designation	Flexural test after no. Of days (Mpa)	
		7 Days	28 Days
1	M_{X0}	4.8	6.32
2	M_{X1}	1.85	2.53
3	M_{X2}	1.1	1.94
4	M_{X3}	3.15	4.6
5	M_{X4}	3.23	4.78
6	M_{X5}	4.9	6.4
7	M_{X6}	4.65	6.1



Graph 2: Flexural Strength of Concrete

Table 4: Test results for Splitting Tensile Strength

S.No	Mix Designation	Tensile test after no. Of days (Mpa)	
		7 Days	28 Days
1	M_{X0}	2.92	3.9
2	M_{X1}	2.1	2.52
3	M_{X2}	1.8	2.11
4	M_{X3}	2.108	3.137
5	M_{X4}	2.128	3.237
6	M_{X5}	4.5	5.7
7	M_{X6}	2.68	3.45



Graph 3: Splitting Tensile Strength of Concrete

Splitting Tensile strength of concrete

The splitting tensile strengths of concrete after 7 and 28 days of curing the splitting tensile strength value boost Mx1 to Mx_3 and then at Mx_4, the splitting tensile strength is decrease.

Fig 9: Split Tensile Test

8. Conclusions

Based on the Results presented above, the following conclusions can be drawn:

1. Rice husk ash (RHA) contains 87.68 – 91 % silica and Egg shell powder contains 93.70% calcium carbonate.

2. Based on the results of these works it can be concluded that RHA and ESP mixed cubes has equal strength with that of conventional concrete cubes.

3. Compressive and tensile strength improves with the increase in the percentage of Rice Husk Ash and Egg shell powder of 7 and 28 days curing.

4. Better mechanical and physical properties of concrete can be obtained with the replacement of cement with rice husk ash and Egg shell powder in Mx_4 mix

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