Innovative use of Rice Husk Ash Fly Ash and Egg Shell Powder in Concrete

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Abstract— Throughout the world, concrete is being widely used for the construction of most of the buildings, bridges etc. Hence, it has been properly labeled as the backbone to the infrastructure development of a nation. Currently, our country is taking major initiatives to improve and develop its infrastructure by constructing express highways, power projects and industrial structures to emerge as a major economic power and it has been estimated that the infrastructure segment in our country is expected to see investments to the tune of Rs.4356 billion by the year 2009. To meet out this rapid infrastructure development a huge quantity of concrete is required. Unfortunately, India is not self-sufficient in the production of cement, the main ingredient of concrete and the demand for exceeds the supply and makes the construction activities very costlier. Hence, currently, the entire construction industry is in search of a suitable and effective the waste product that would considerably minimize the use of cement and ultimately reduce the construction cost. Few of such products have already been identified like Rice Husk Ash (RHA), Fly Ash, Silica Fumes, Egg shell etc. Amongst these RHA and Egg shells are known to have good prospects in minimizing the usage of cement.

Key words: Concrete, characterization, eggshell power (ESP), Rice Husk Ash (RHA), Fly Ash (FA)

I. INTRODUCTION

A. 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 small power plants 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 C^0. The ash obtained is 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 replaced by rice husk ash at various percentages to study compressive and flexural strength. [1]

B. Fly Ash:

Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity. These micron-sized earth elements consist primarily of silica, alumina and iron. When mixed with lime and water the fly ash forms a cementitious compound with properties very similar to that of Portland cement. Because of this similarity, fly ash can be used to replace portion of cement in the concrete, providing some distinct quality advantages. [2]

C. Egg Shell Powder:

It is estimated that roughly 90 million tons of hen egg are generated throughout the world every year. In India 77.7 billion eggs are produced in the year 2010-2011. Tamil Nadu having share of around 20 %, is ranked second with almost 2,000 core eggs created in the state every year. The next in the list of prominent egg producing states in India comprise Maharashtra, Haryana, Punjab and West Bengal. [3]

Eggshell is generally thrown away as a waste. The egg shell also creates some allergies when kept for a longer time in garbage. Disposal is a problem. It creates undesirable smell which can cause irritation. The main ingredient in eggshells is calcium carbonate (the same brittle white stuff that chalk, limestone, cave stalactites, sea shells, coral, and pearls are made of). The shell itself is about 95% CaCO3 (which is also the main ingredient in sea shells). The remaining 5% includes Magnesium, Aluminum, Phosphorous, Sodium, Potassium, Zinc, Iron and Copper. [4]

II. PHYSICAL PROPERTY OF CEMENT, RHA, FA AND ESP [3]

Material	Specific gravity	Finesse modules/ Finesse (%)
Cement	3.10	1%
Rice husk ash	1.98	1.6%
Fly ash	2.07	2.5%
Egg shell powder	1.89	4.1%

Table 1: Physical Property of Cement, Rha, Fa And Esp

III. CHEMICAL ANALYSIS [5]

SiO_2	21.3
CaO	63.14
Fe_20_3	3.77
Al_20_3	5.41
MgO	1.2
Na_2O	0.56
K_2O	0.67

Table 2: Chemical Analysis for Cement

SiO_2	92.89
Fe_2O_3	0.43
Al_2O_3	0.18

CaO	1.03
MgO	0.35
SO_3	0.1
$Al_2O_3 + Fe_2O_3$	0.61
Na_2O	3.56
K_2O	0.72

Table 3: Chemical Analysis for Rice Husk Ash

SiO2	53.68
Al2O3	23.07
Fe2O3	10.03
CaO	2.98
MgO	2.16
Na2O	0.52
K2O	0.94
SO3	0.18

Table 4: Chemical Analysis For Fly Ash

CaO	50.7
SiO_2	0.09
Al_2O_3	0.03
MgO	0.01
Fe_2O_3	0.02
Na_2O	0.19
P_2O_5	0.24
SrO	0.13
NiO	0.001
SO_3	0.57
Cl	0.219

Table 5: Chemical Analysis for Egg Shell Powder

IV. COMBINATION OF MATERIALS

Sr. No	Mix Design	Cement (%)	RHS (%)	FA (%)	ESP (%)
1	Mx_0	100	0	0	0
2	Mx_1	90	2.5	2.5	5
3	Mx_2	85	5	5	5
4	Mx_3	80	7.5	7.5	5
5	Mx_4	75	10	10	5
6	Mx_5	65	15	15	5

Table 6: Cement + Rhs + Fa + Esp

V. TEST ON HARDENED CONCRETE

Tests were done as per following codes of Bureau of Indian Standards. The test for compressive strength on cubes were measured at 7, 14 and 28 days of curing as per IS : 516 1959, test for flexural strength on beam was measured at 28 days of curing as per IS: 516 1959 and test for split tensile strength on cylinder was measured at 28 days of curing as per IS : 5816 1999.

A. Compressive Strength Test:

Concrete cube of 150 x 150 x 150 mm dimensions were cast for testing compressive strength. Vibration was given to the moulds using table vibrator. After 24 hours the cubes placed in curing tank for 7, 14 and 28 days curing. After curing these cubes were tested on digital compression testing machine as per I.S. 516-1959.

Sr. No.	Mix Design	Compression test (Mpa)		
		7 days	14 days	28 days
1	Mx_0	24.23	27.68	31.51
2	Mx_1	26.70	32.60	36.49
3	Mx_2	26.96	34.74	37.53
4	Mx_3	27.34	34.88	37.98
5	Mx_4	28.12	34.96	38.67
6	Mx_5	31.00	35.24	40.18

Table 7: Test Results for Compressive Strength

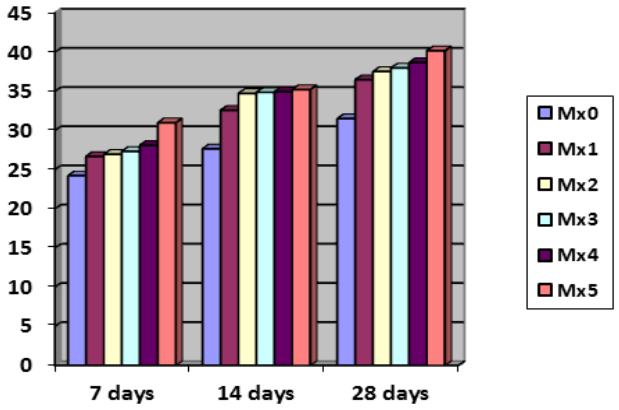

Fig. 1: Graph 1 Compressive Strength of Concrete

B. Flexural Strength of Concrete:

Flexural tensile 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 Mx4, the flexural strength is decrease.

Sr. No.	Mix Design.	Flexural test (Mpa)	
		7 days	28 days
1	Mx_0	4.80	6.32
2	Mx_1	4.87	6.41
3	Mx_2	5.29	6.55
4	Mx_3	5.30	6.67
5	Mx_4	4.89	6.45
6	Mx_5	4.65	6.1

Table 8: Flexural Strength of Concrete

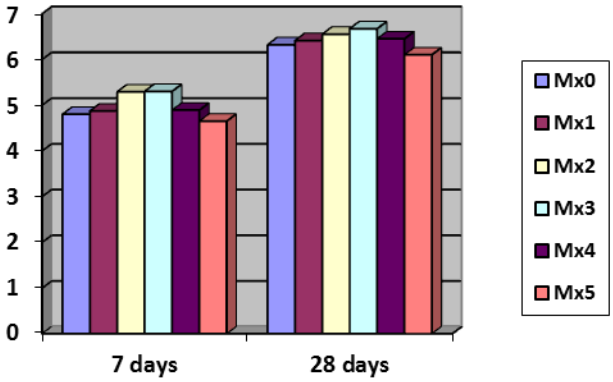

Fig. 2: Graph 2 Flexural Strength of Concrete

C. Splitting Tensile Strength of Concrete:

The splitting tensile strengths of concrete after 7 and 28 days of curing the splitting tensile strength value boosts Mx_1 to Mx_3.and then at Mx4, the splitting tensile strength is decrease.

Sr. No.	Mix Design	Splitting Test (Mpa)	
		7 days	28 days
1	Mx_0	2.92	3.90
2	Mx_1	3.05	3.98
3	Mx_2	3.27	4.12

4	Mx_3	3.70	4.33
5	Mx_4	3.13	4.1
6	Mx_5	2.68	3.45

Table 9: Test Results for Splitting Tensile Strength

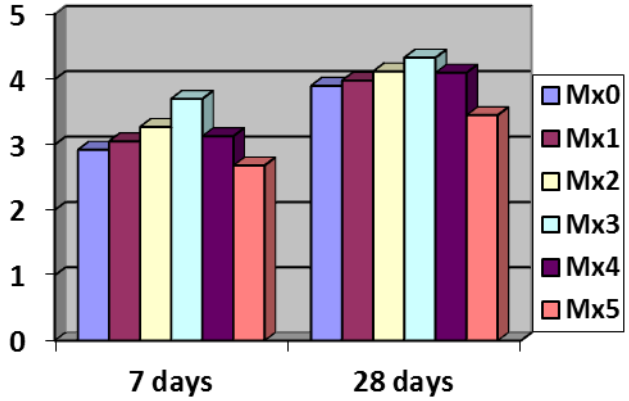

Fig. 3: Graph 3 Splitting Tensile Strength of Concrete.

VI. CONCLUSION

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

1) Rice husk ash (RHA) and Fly ash (FA) contains 90 % and 53.68 % silica and Egg shell powder contains 93.70% calcium carbonate.
2) Based on the results of these works it can be concluded that RHA, FA 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 Fly ash 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 Fly ash in Mx_4 mix.

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