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Mechanical Properties of Concrete using Rise Husk Ash (RHA), Egg Shell Powder (ESP) and Fly Ash (FA) as Partial Replacement of Cement

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ABSTRACT: In the last decades, the use of residue in civil construction, especially in addition concrete, has been subject of many researches due to, besides to reduce the environmental polluters factors, it may lead several improvements of the concrete properties. The world rice harvest is estimated in 600 million tons per year. Considering that 22% of the grain is husk, and 22% A part from this, extraction of natural aggregates This report evaluates how different contents of rice husk ash (RHA) added to concrete may influence its physical and mechanical properties. Samples with dimensions and generation of industrial, agricultural and domestic waste also leads to environment degradation. The use of these waste materials not only helps to reduce the use of natural resources also helps to mitigate the environment pollution. The basic objective of this research is to investigate the effect of Waste Rice Husk (RHA) as partial replacement of fine aggregates and Sugarcane Bagasse ash Ash (SCBA) as partial replacement of cement in concrete. This research work examined the potential use of Sugarcane Bagasse ash Ash (SCBA) as a partial replacement material. SCBA has been partially replaced in the ratio of 0%, 10% ,20% and 30% with and without addition of steel fibre by weight of cement in concrete. M25 Grade of concrete were adopted throughout the study This study primarily deals with the characteristics of concrete, including compressive strength, workability and thermal stability of all concrete mixes at elevated temperature. Twenty five mixes of concrete were prepared at different replacement levels of RHA (0%, 10%, 20%, 30% & 40%) with fine aggregates and SCBA (0%, 5%, 10%, 15% & 20%) with cement. The water/cement ratio in all the mixes was keptat 0.55. The workability of concrete was tested immediately after preparing the concrete whereas the compressive strength of concrete was tested after 28 and 60 days of curing. Based on the test results, a combination of 10% RHA and 10% SCBA is the most significant for high strength and economical concrete. This research also indicates that the contribution of RHA and SCBA doesn't change the thermal properties of concrete.

KEYWORDS: Waste Rice Husk, Sugarcane bagasse ash, OPC cement, Workability, Compressive strength Waste Rice Husk, Sugarcane bagasse ash, OPC cement, Workability, Compressive strength

I. INTRODUCTION

There It has been observed that numerous study reports have come to light regarding the evaluation of the individual effectiveness of concrete made with a blend of fly ash and rice husk ash. However, there are few study reports that focused on the combined execution of fly ash and rice husk ash. The primary goal of the current investigation is to precisely evaluate Fly ash, Rice Husk Ash (RHA), and Egg Shell Powder (ESP) in order to investigate the viability of using these materials as cement substitutes in the concrete industry. The most versatile pozzolan is fly ash, which is widely used in all concrete construction projects. It is universally acknowledged that the employment of fine fly ash upgrades the qualities of mortar and concrete. Although the addition of fly ash increases the porosity of the paste, the average pore size decreases, leaving a minimally porous paste. In light of the use of fly ash, the interfacial domain of the interface between aggregate and matrix also becomes refined. In India, the total production of coal ash is thought to have exceeded 10 metric tonnes in 2010. Several researchers have turned to the use of large volumes of Class F fly ashes in concrete in an effort to scale up the employment of fly ash and to fine-tune the properties of the material.

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The additional pozzolanic agent derived from agricultural by-products like rice husk ash (RHA) is becoming a popular subject of ongoing research. Ash from rice husks contains a significant amount of non-crystalline or amorphous silica, which is a form of silicon. Consequently, it is a pozzolanic substance that can be used to create additional cementitious objects. Rice husk is a byproduct of agriculture made from the outer layer of rice grains during milling. 20% of the 500 million tonnes of paddy produced worldwide come from it. Eggshells are agricultural waste products made in places like bakeries, fast food restaurants, and chicken coops. Because they can harm the environment, they contain environmental problems and contamination that must be properly handled. The effectiveness of applying eggshells to advantageous application constitutes a concept worth accepting in the ever-increasing tasks to convert waste to wealth. It is generally acknowledged that calcium compounds make up the majority of the eggshell. Eggshell is composed of 93.70% calcium carbonate (in calcium), 4.20% organic matter, 1.30% magnesium carbonate, and 0.8% calcium phosphate, according to Okonkwo. Around 90 million tonnes of hen eggs are produced worldwide each year, according to estimates. Agencies Meat production in the country has increased from 6.69 million tonnes in 2014-15 to 8.80 million tonnes in 2020-21 (Provisional), the survey said. India ranks third in production of eggs and eight in meat production in the world, said The Economic Survey 2021-22. State wise Egg Production, Andhra Pradesh (20.45%) and Tamil Nadu (16.49%) are the top egg producers in the country. Next comes Telangana (12.98%), West Bengal (8.60%), and Karnataka (6.24%).The next in the list of prominent egg producing states in India comprise Maharashtra, Haryana and Punjab.

With this end in view, tests were performed in three stages as per normal test processes. In the initial stage, chemical composition, physical traits, and categorization of Fly ash (FA), Rise husk ash (RHA) and Egg shell powder (ESP) were executed. This comprised assessment of normal steadiness, preliminary setting period, concluding setting period and compressive strength of RHA blended cements. In the second stage, investigation on concrete specimens was performed. This consisted of experiments on compressive strength, splitting tensile strength and flexural strength. In the third phase, coefficient of water absorption, sorptivity, resistance to chloride ion penetration and diffusion coefficient were estimated. All the tests were executed in triplicate and mean values are recorded and communicated.

II. OBJECTIVE OF VIEW

The main objective of this study is to experimentally investigate the suitability of Rise Husk Ash (RHA), Egg Shell Powder (ESP), and Fly Ash (FA) used as a partial replacement of cement in concrete and compare it with conventional concrete. The following were also considered:

1. To investigate the structural behavior of concrete that has been blended with rise husk ash, egg shell powder, and fly ash (FA).
2. To determine the percentage that gives the maximum workability of multi-blended concrete when compared to conventional concrete.
3. To determine the percentage that gives the maximum Compressive strength of multi-blended concrete when compared to conventional concrete.
4. To determine the percentage that gives the maximum Flexural strength of multi-blended concrete when compared to conventional concrete.
5. to investigate the suitability of using Fly Ash (FA), Rise Husk Ash (RHA), and Egg Shell Powder (ESP) as partial replacements for cement.

III. METHODOLOGY

The Rise Husk Ash, fly ash and Egg Shell Ash was collected from other sources and polishing locations and dried before use. Rise Husk Ash, fly ash and Egg Shell Ash and cement were thoroughly combined first. Sand and additional coarse aggregate were added to the mixture. The components were combined in dry conditions for a brief period of time. In a typical concrete mixer, the dry mix was added to water containing super plasticizer after each component had been thoroughly mixed. A concrete mixture was produced to make 150 x 150 x 150 mm (6 in x 6 in) cubes, 100 x 100 x 500 mm (4 in x 20 in) beams, and 150 x 150 x 300 mm (6 in x 12 in) cylinders. Concrete was poured into the moulds and then compacted using the samples were then taken out.

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Table No. 1; The final trial batch quantities per cubic meter of concrete

Cement	Water	Fine aggregate	Coarse aggregate
kg/m^3	kg/m^3	kg/m^3	kg/m^3
370	**160.43**	**705.84**	**1157.46**
1	**0.43**	**1.90**	**3.13**

Table No. 2; The Final Trial Batches percentages of Rise Husk Ash , fly ash and Egg Shell Ash Per of Concrete M25

Mix Code	Cement %	RHA %	FA %	Fine Aggregate %	Coarse Aggregate %	ESP %	W/ C ratio
M-0	100	0	0	100	100	0	0.43
M-1	70	5	25	100	100	5	0.43
M-2	70	10	20	100	100	5	0.43
M-3	70	15	15	100	100	5	0.43
M-4	70	20	10	100	100	5	0.43
M-5	70	25	5	100	100	5	0.43

Table No. 3; The Final Trial Batches Quantities of Rise Husk Ash , fly ash and Egg Shell Ash Per of Concrete M25

Mix Code	Cement (kg/m^3)	RHA (kg/m^3)	FA (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	ESP (kg/m^3)	W/ C ratio (kg/m^3)
M-0	370.00	0.00	0.00	705.00	1157.00	0.00	160.00
M-1	259.00	18.50	92.50	705.00	1157.00	18.50	160.00
M-2	259.00	37.00	74.00	705.00	1157.00	18.50	160.00
M-3	259.00	55.50	55.50	705.00	1157.00	18.50	160.00
M-4	259.00	74.00	37.00	705.00	1157.00	18.50	160.00
M-5	259.00	92.50	18.50	705.00	1157.00	18.50	160.00

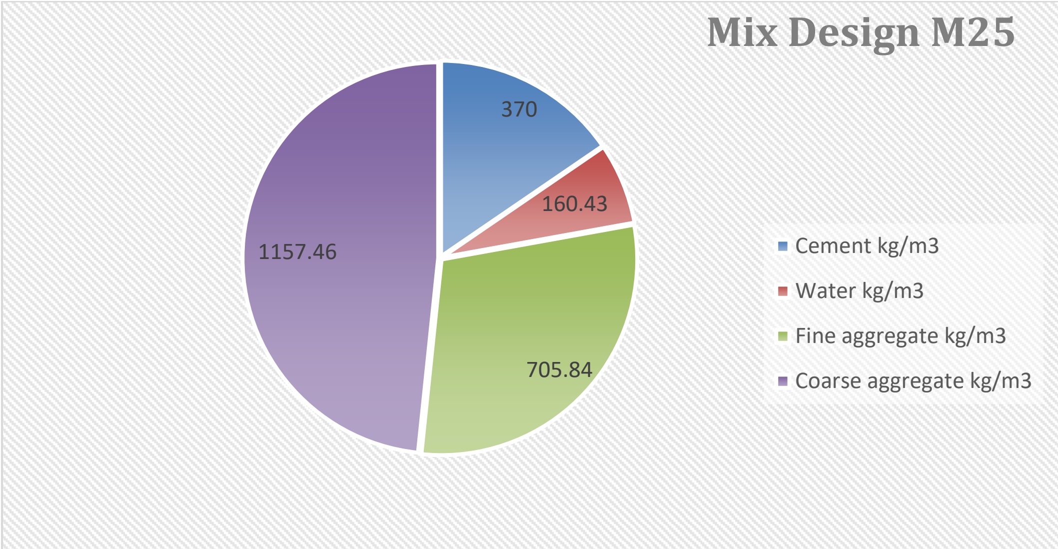


Figure no. 1; M25 Mix Design (mix ratio)

IV. RESULTS AND DISCUSSION

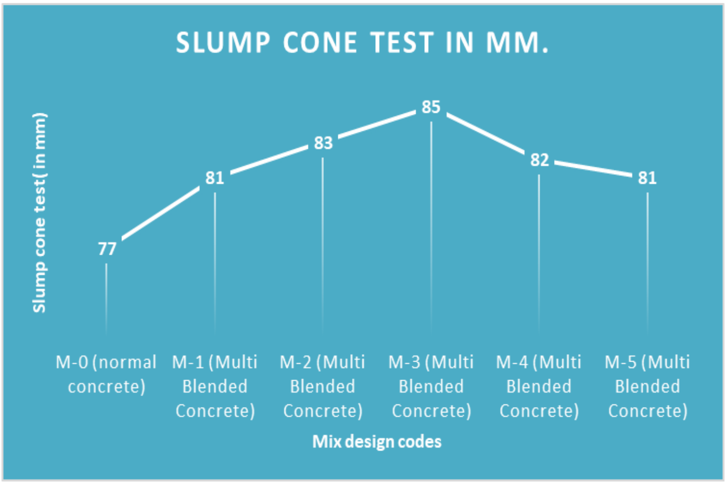
Experiment Work Fresh Concrete

Fresh concrete properties such as slump, unit weight, temperature and Air-content, compaction factor were determined according to Indian Standard Specification IS: 1199-1959.

Slump Cone Test:

Mix design codes	Slump cone test in mm.
M-0 (normal concrete)	77
M-1 (Multi Blended Concrete)	81
M-2 (Multi Blended Concrete)	83
M-3 (Multi Blended Concrete)	85
M-4 (Multi Blended Concrete)	82
M-5 (Multi Blended Concrete)	81

Table No.4 : Workability of various concrete mixes desi4gn for slump cone test



Graph No. 2: Workability of various concrete mixes design

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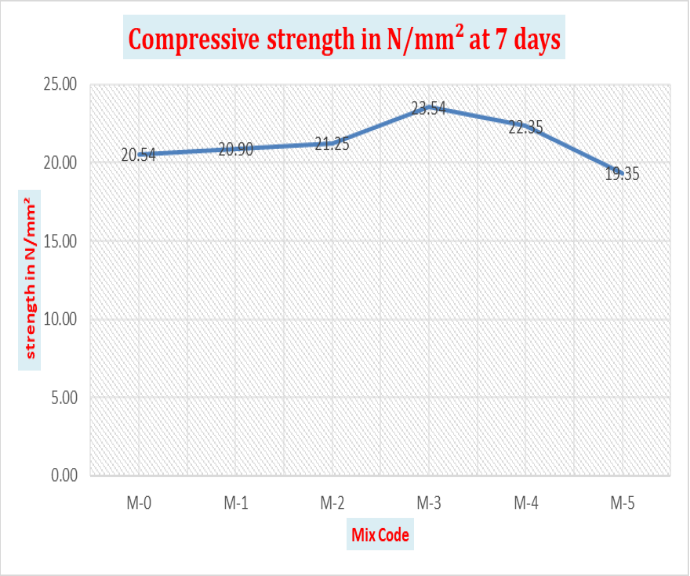
Compressive Strength of Concrete (IS: 516-1959)

Mix Code	**Compressive strength in N/mm² at 7 days**	**% Increase in strength at 7 days**
M-0	20.54	0
M-1	20.90	1.75
M-2	21.25	3.46
M-3	23.54	14.61
M-4	22.35	8.81
M-5	19.35	-5.79

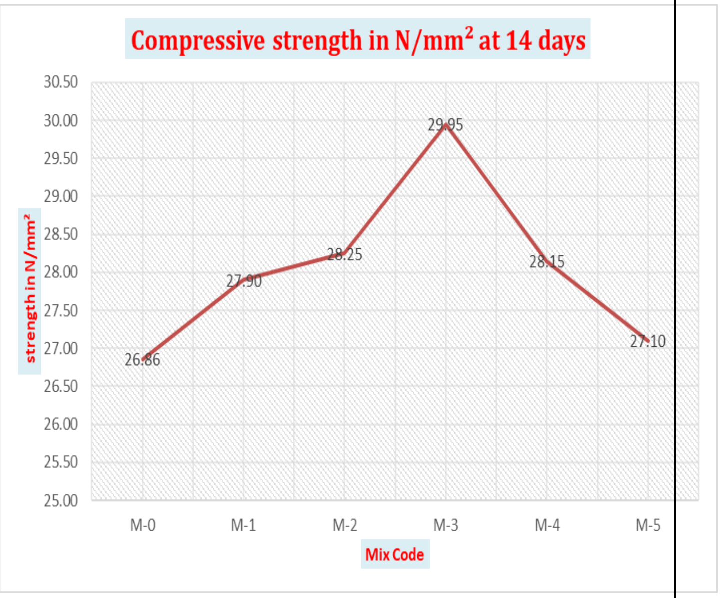
Table No. 5: Compressive strength in N/mm² at 7 days



Graph No. 3 : Compressive strength in N/mm² at 7 days

Mix Code	Compressive strength in N/mm² at 14 days	% Increase in strength at 14 days
M-0	26.86	0
M-1	27.90	3.87
M-2	28.25	5.17
M-3	29.95	11.50
M-4	28.15	4.80
M-5	27.10	0.89

Table No. 6: Compressive strength in N/mm² at 14 day



Graph No. 4 : Compressive strength in N/mm² at 28 days

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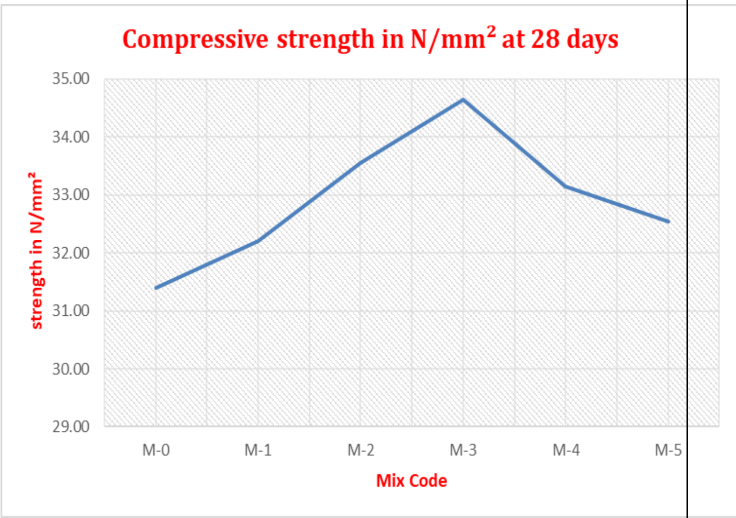
Mix Code	Compressive strength in N/mm² at 28 days	% Increase in strength at 28 days
M-0	31.40	0
M-1	32.20	2.55
M-2	33.55	6.85
M-3	34.65	10.35
M-4	33.15	5.57
M-5	32.54	3.63

Table No. 7: Compressive strength in N/mm² at 7 day



Graph No. 5 : Compressive strength in N/mm² at 28 days

V. CONCLUSIONS

1. The concrete mix made using Rise Husk Ash (RHA), Egg Shell Powder (ESP), and Fly Ash (FA) as partial replacement of Cement showed good workability and Fluidity similar to normal concrete mixes.
2. The workability of concrete increased with the addition of Rise Husk Ash (RHA), Egg Shell Powder (ESP), AND Fly Ash (FA) as partial replacement of Cement.
3. Mix design codes Slump cone test in mm.
4. M-3 (Multi Blended Concrete) 85mm
5. The compressive strength of concrete increased with the addition of Rise Husk Ash (RHA), Egg Shell Powder (ESP), AND Fly Ash (FA) as partial replacement of Cement. (at 7 days,14 days, and 28 days).

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