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Literature Review: Experimental Study on the Properties of sustainable concrete

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Abstract: *Concrete is today the largest consumable material in the world that utilizes the natural resources such as sand, crushed stone and water. Due to the depletion of these natural resources for concreting, research is being carried out nowadays to reduce the consumption of these resources. In our project, we tend to utilize egg shell and rice husk by partially replacing it in concrete. The egg shell is equally replaced for fine aggregate in percentages of 5%, 7.5%, 10%, 12.5% and 15% during the manufacture of concrete. The concrete is cast in cubes and cylinders and it is tested for compressive strength to find the optimum percentage of their replacement.*

The suitability of rice husk as an alternative to sand in concrete production was studied here. Rice husk is an agricultural waste obtained from the rice. For this, various properties of concrete mainly workability, bulk density, water absorption, compressive strength and flexural strength were experimentally determined with the partial replacement of sand by rice husk at 0, 10, 20, 30, 40 and 50 percent respectively. M20 grade of concrete was prepared at 0.60 water cement ratio considering weight batching. The experimental results showed that the workability of the concrete increased with the increase in percent replacement of sand by rice husk. Similarly, the water absorption also increased while the bulk density, compressive strength and flexural strength of the samples decreased with the increasing amount of rice husk content in the mixtures. The research suggested that up to 10 percent replacement of sand by rice husk, the concrete so produced could be used for building compressive and flexural members of the structure.

Keywords: concrete – rice husk – egg shell –compressive strength

I. INTRODUCTION

In various civil engineering works, the concrete is used extensively worldwide. As a composite material, the constituents of concrete include binding material (mostly cement), aggregates (fine and coarse) and water. In concrete work, the main function of fine aggregate or sand is to produce workability and uniformity in the mix due to its well graded nature. According to the Indian Standard Soil Classification System, the soil having grain size ranging between 0.075mm to 4.75mm is considered as sand.

With the concern rising about the environmental conservation, the issues of degradation and pollution of environment have become the hot topic in today's world. As concrete composes the sand as essential constituents, the main source of it is, naturally flowing rivers. On the extraction of huge amount of sand from rivers not only causes the shortage of it but also creates the serious problem to the environment. Erosion and failure of river banks, lowering of river beds and damage of structures

situated closer to the rivers are the major adverse effects of it. According to Obilade, the use of agricultural and industrial wastes to complement other traditional materials in construct in provides both practical and economic advantages. In the world, to find the best alternative of the concrete constituents, various experiments have been carried out by the replacement of certain portion of concrete constituents with materials such as rice husk ash, corn cob ash, fly ash, hemp etc. Also with the replacement of fine aggregate partially by rubber, saw dust and waste paper, waste glass

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powder or polyethylene aggregates etc., the study of various physical and mechanical properties of concrete had been carried out.

Eggshell consists of several mutually growing layers of $CaCO_3$. In the innermost layer of 3 layers, that grows on the outermost egg membrane 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 egg shell primarily contains calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell to be dried and can be used 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 grained powder with suitable proportion which is sieved to the required size before use with concrete/mortar.

II. METHODOLOGY

2.1 Materials

The materials used in this experimental research work were cement, fine and coarse aggregates or gravel, rice husk and water. Cement used was Ordinary Portland Cement of Shivam brand. Fine and coarse aggregates available in Institute of Engineering, Similarly rice husk and egg shell used for the experiment was collected from local mills,. The water used was free from impurities.

2.2 Experimental Works – Rice Husk

The physical properties of materials were determined at first. As per IS[10] and [11], the normal consistency, soundness, initial and final setting time, compressive strength and specific gravity of cement were determined as 31%, 2 mm, 64 minutes, 280 minutes, 58.30 N/mm^2 and 3.15 respectively. Water absorption and specific gravity of aggregates were determined as 2.74 and 1.42% respectively for fine aggregates and 2.70 and 1.19% respectively for coarse aggregates. Sieve analysis was performed as per IS[12] to determine the particle size distribution of rice husk, sand and gravel. From the fineness modulus, the average size of particle of sand was found between 0.3mm to 0.6mm while coarse aggregate was found between 20mm to 25mm and rice husk was found between 1.7mm to 2.0mm. At 0%, 10%, 20%, 30%, 40% and 50% respectively, the sand was partially replaced by rice husk. The rice husk used was first soaked in water for 24 hours and then allowed to remain in atmosphere for 1 hour before using in the mix. Mix proportions considering M15 grade of concrete with 0.60 water cement ratio for different percent replacement of sand by rice husk was determined according to IS[13] and [14] shown in Table 1.

Table 1: Mix Proportions

	water	cement	rice husk	sand	gravel
0%	0.60	1	-	1.95	3.87
10%	0.60	1	0.195	1.755	3.87
20%	0.60	1	0.390	1.560	3.87
30%	0.60	1	0.585	1.365	3.87
40%	0.60	1	0.780	1.170	3.87
50%	0.60	1	0.975	0.975	3.87

The concrete was manually mixed, placed in three layers compaction. As per slump tests were performed to determine the workability of fresh concretes. After the 24 hours of sample preparation, they were cured in curing tank for 28 days. As per the bulk density, water absorption and compressive strength were determined afterwards taking the average of three cube samples for each different mix. Similarly, the flexural strength was determined taking the average of three beam samples considering three point loadings.

2.3 Experimental Works – Egg shell

ADVANTAGES OF EGG SHELL

- Considerable reduction in alkali-silica and sulphate expansions.
- Meets the most stringent environmental regulations nationwide.
- Ideal for painting in occupied spaces.

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- Excellent durability and washable finish.
- Resist mold and mildew on the paint film.
- Saves money, less material required.
- Meets strict performance and aesthetic requirements

EXPERIMENTAL METHODOLOGY

Initially the materials used in concrete are tested for its basic properties. In the obtained mix proportions egg shell and ceramic waste is partially replaced for fine aggregate and coarse aggregate respectively in percentages of 5, 7.5, 10, 12.5 and 15. The concrete specimens are casted for the above mix proportions and cured in potable water till the date of testing. Then the specimens are tested for cube compressive test and cylinder is tested for split tensile test

A) COMPRESSIVE STRENGTH

The compressive test is carried out on concrete cubical in shape.
15cmX15cmX15cm.The test was carried out in the compression testing machine. Concrete cubes with Egg shell and ceramic waste with plain cement concrete were tested at 7 days , 14 days and 28 days. The grade of concrete mix is M20 and percentage of admixtures is 5% 7.5% 10% 12.5% 15% with respect to aggregates in concrete.

$$\text{Compressive strength} = \frac{\text{load}\quad (\text{N/mm}^2)}{\text{c/s area of cube}}$$

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