Impact of Partial Substitution of Cement with Cow Dung Ash and Rice Husk Ash on Performance of Concrete

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ABSTRACT: Rice Husk Ash (RHA) and Cow Dung Ash (CDA) are agriculturally based pozzolanic materials, these materials are available in huge quantities. This final year project report highlights and presents the results of the study on the use of Cow Dung Ash and Rice Husk Ash as partial replacement of cement in concrete. The experiments were conducted to study the impacts of adding Cow Dung Ash and Rice Husk Ash in several percentages by weight (0%, 5%, 10%, 15%, and 20%) of cement and cure for periods of 28 days before testing for compression strength. The consistency, workability, sieve analysis of aggregates were also tested in this research study. The Compressive test results are 37.75 N/mm2, 31.25 N/mm2, 31.25N/mm2 and 25.25 N/mm2 for 0%, 5%, 10% and 15% replacement of cement with Cow Dung Ash and Rice Husk Ash respectively at 28days. The Workability results gives 45mm, 49mm, 56mm, 68mm and 75mm respectively for 0%,5%, 10%, 15%, and 20% replacement of cement with Cow Dung Ash and Rice Husk Ash. The consistency test results are 0.29, 0.32, 0.36, 0.41 and 0.43 for 0%, 5%, 10%, 15% and 20% replacement of cement with Cow Dung Ash and Rice Husk Ash respectively. The bulk density results are 2452.53 kg/m3, 2370.8 kg/m3, 2380.0 kg/m3 and 2348.5 kg/m3 for 0%, 5%, 10% and 15% replacement of cement with Cow Dung Ash and Rice Husk Ash respectively. The main highlights, it should be highlighted that the more quantity of water is required to standard consistency as the percentages of Cow Dung Ash and Rice Husk Ash are added. Dung Ash and Rice Husk Ash concrete is recommended for use when a ten percentage (10%) of Cow Dung Ash and rice husk ash are not exceeded.

KEYWORDS: Cow dung ash, Rice husk ash, workability, standard consistency, Slump test, bulk density, compressive strength.

I. INTRODUCTION

Concrete is a vital man-made composite construction material that is mostly being used in modern construction industry worldwide where we live in. This useful construction material is obtained by mixing appropriate proportion of aggregates (fine and coarse), cement, supplementary cementing materials, water and additives that allow the mixture to set and harden with time. The demand of cement in construction concrete technology is highly needed day by day to fill the gaps in infrastructural development such as buildings, highways, bridges, tunnels, parking, stadium, railway, airport, hydraulic structures due to industrialization and commercial centers (Pavithra, 2016). The cement production in manufacturing industries leads to the negative effects to the environment due to emitting of polluted gases like carbon dioxide (CO_2) that leads to the air pollution which has more effects on the climate change and global warming (Pavithra, 2016). The cement manufacturing factory produces about 6 percent of all CO_2 emitted in atmosphere, 0.9 tons of carbon dioxide is produced by 20 bags of cement manufactured (Arun Kumar & Nazeer, 2014). Supplementary binding materials such fumes as cow dung ash, sawdust, fly ash, silica, rice husk ash enable concrete technology to use millions of tons of byproducts materials that would be waste disposal problems (Mehta, 2004). Therefore, as the civil engineers are responsible for bridging gaps and filling the voids, they always searching for the construction industry which is friendly to the environment. There is a need to search for supplementary cementitious materials for utilization as partial replacement for cement.

The population in developing countries like India are highly increasing day by day. So, they need infrastructures facilities such as buildings, highways, hydraulic structures, airports, parking to accommodate them effectively. Those infrastructures require construction materials primarily concrete and others. Nowadays, the cost of building materials especially plastering and cementitious materials in Rwanda is very high. Environmentally, cement manufacturing industries produces fumes which contributes to the air pollutions which leads to the global warming and climatic change. Additionally, large amount of agricultural wastes produced in manufacturing industries like rice husk has been causing waste disposal problems. This has encouraged people to use other available local materials like cow dung and fly ash, clay, which are cheap to acquire. This research focuses on use of cow dung ash and rice husk ash as partial replacement of cement in concrete.

RESEARCH OBJECTIVES:

1. To determine the techniques for improving economical concrete with partial replacement cement by cow dung ash and rice husk ash at appropriate percentages.
2. To examine the effectiveness of using CDA and RHA as partial replacement of cement by studying strength parameters.
3. To investigate the compressive strength and of concrete with CDA and RHA to that of normal concrete.
4. To use supplementary cementitious materials to produce concrete which is affordable and structural light in weight.
5. To minimize the environmental effects resulted from the production of cement by using alternative local available cementitious materials as partial replacement.
6. To promote the usage of local available wastes with the aim preservation of environment.
7. To minimize the usage of the raw material large replacement is done using the various by product materials that are available in the present day.
8. To use locally available material and to reduce the cost of producing concrete.
9. To enhance available local materials to improve economical concrete with partial replacement cement by cow dung ash and rice husk ash at appropriate percentages in search of solution to the above dual problem.

II. RELATED WORK

(Varshney, 2015) reported that the RHA agricultural wastes based on pozzolanic material, generated during rice milling. During milling, 80% weight of rice grains are obtained and 20% remained are rice hulls.

(SHETTY, 2005) discussed that RHA is obtained by burning rice husk in controlled temperature with aim of protecting environmental pollution. RHA has high SiO2 content so that can be used as concrete admixture. RHA displays high pozzolanic characteristics and adds to high impermeability and thigh strength of concrete. RHA basically comprise of amorphous silica (SiO2), 5% of carbon and 2% of K2O. In USA, the trade name of highly pozzolanic RHA is known as "Agrosilca", the specific surface of RHA varies between 40 to 100 m2/g.

(Dabai & Muhammad, 2009) studied the effect of RHA as cement admixture by testing the compressive strength of cement cubes produced by replacing cement percentages with the RHA. The results Cleary showed that suitable strength of concrete at 28 days obtained with RHA could be replace for OPC at 10% and 20% of replacement. (Gambhir, 2006) highlighted that the average composition of RHA is 90% amorphous silica, 5% of carbon, and 2% of K2O.

(Smith & Wheeler , 1979) found that cow dung is Nitrogen rich material, calcium, phosphorous and potassium. (Pavithra, 2016) reported that dry cow dung is utilized as fuel energy for domestic intention, which generates solid waste ash and observed that cow dung ash in cement concrete is durable as compared to the normal concrete strength.

(Ojedokun & Adeniran, 2014) studied on CDA as partial replacement of cementing material in concrete, they highlighted that setting times increases as the percentages of CDA is added. Finally, they advocated to use CDA concrete only when 10% of CDA is added. They recommend that CDA is suitable for certain floor and wall which are not subjugated to the heavy loads and is not to use for structures related to the water.

(Kumar & Reddy, 2015) searched on cement replacement in concrete by CDA and found that 5% of CDA replacement increases the compressive strength. It observed that the 5% of CDA replace cement in mortar.

(Omoniyi, et al., 2014) highlighted that initial and final setting time increases by 12.2%-59.3%and2.74%-43.90% respectively as the % of CDA increases, this indicates that CDA is a set retarder. The compressive strength results pointed increases with curing time and deceases with increases of CDA content.

(Sruthy & Krishnan et etal, 2017) studied on normal concrete strength to that of concrete with CDA, they foregrounded that concrete strength increases when 8% CDA replace cement.

III. Materials Used

1. **Cow Dung Ash:**

The cow dung was collected from local areas in Koraput, Odisha. The cow dung was dried by exposing them to the sunlight, dried cakes were used to cook and CDA collected as wastes.

Fig. 1: Cow Dung Ash

2. **Rice Husk Ash:**

The RHA was collected from N.K Enterprises, Jharsuguda, Odisha. After milling the rice grains, rice husks as waste are collected for any intended purpose and others are burnt. It was brought in Materials and Concrete Laboratory and then sieved on 90micron ASTM sieve.

Fig. 2: Rice Husk Ash

3. **Cement:**

Cement used in this work was manufactured by Ultratech and is available on market countrywide. The grade of cement was 32.5N is highly being used in construction industry in India. The standard consistency in the laboratory. All the tests were carried out in compliance with procedure laid down in IS 12269 – 1987.

4. **Fine Aggregate:**

The sand used in this research study was no deleterious materials and prepared in accordance with IS 383:1970.

5. **Coarse Aggregate:**

In this research, CA of 6.3-25mm maximum size were used. Proper inspection was carried out to ensure that it was free from impurities materials as complied by IS 383:1970.

6. **Water:**

This is the least expensive but most important ingredient of concrete. Here, normal tap water has been used for the preparation of concrete.

IV. Experimental results

1. **Consistency limit:**

This test is carried out to determine the standard water required to produce workable paste of cement and conforming IS4031-1988. The RHA and CDA are mixed with cement to produce paste as a percentage of weight of cement. The results obtained for consistency limit test are as follow in table below. The test result show that the much water is required to obtain the desired consistency as the percentage of CDA and RHA increase. The consistency limit curve is show in figure below.

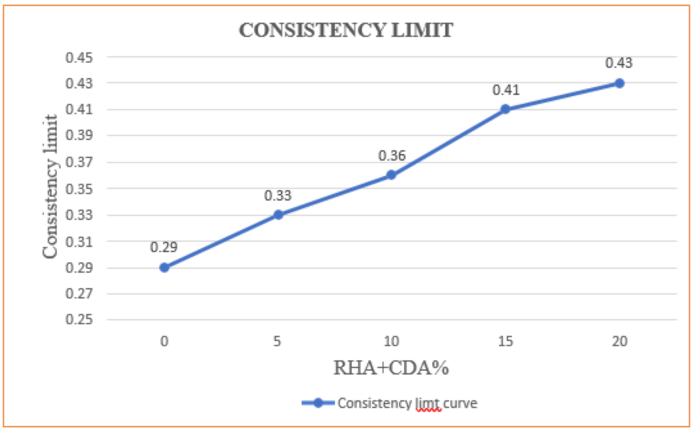

Fig. 3: Consistency curve for RHA+CDA concrete mix

2. Gradation Curve for Fine Aggregate:

This test is carried out to find the distribution particles of fine aggregates passing through the standard set of sieves complying the test procedure is given IS: 2386 (Part I). The sample of sand was dried and then sieved in these set of sieves 4.75mm, 3,36mm, 1.18mm, 600mm, 300mm, 150mm and pan.

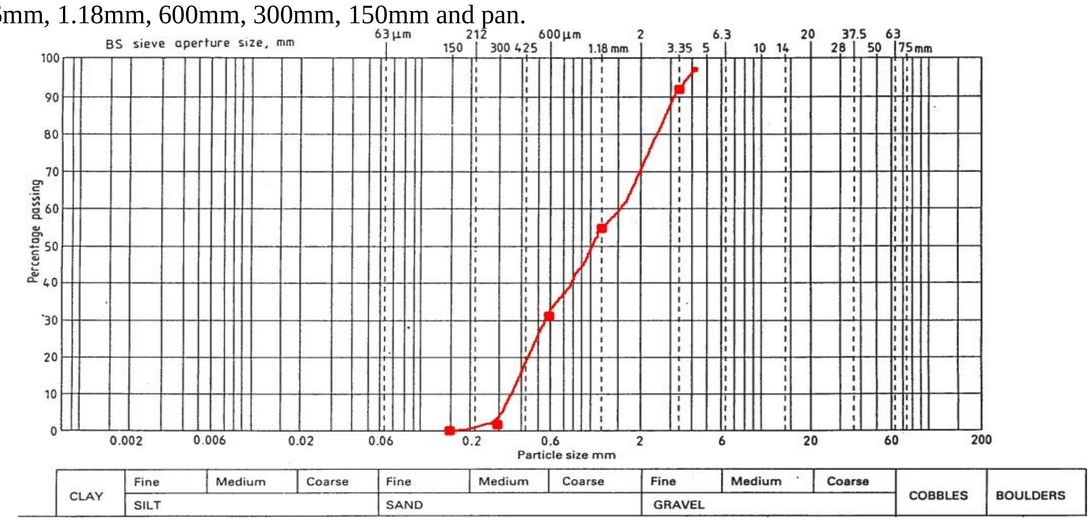

Fig. 4: Gradation Curve for Fine Aggregate

3. Gradation Curve for Coarse Aggregate:

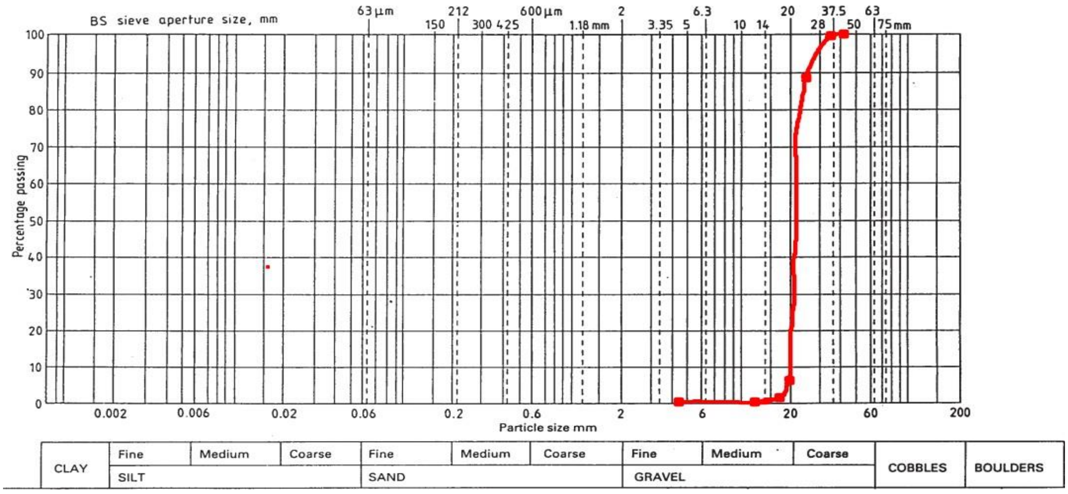

Fig. 5: Gradation Curve for Coarse Aggregate

4. Slump Test:

Workability implies the ease to work with which concrete mix is handling and it can be determined by cone slump test as per IS1199-1988. The following figure shows the workability of each mix of concrete varying the % of RHA+CDA with the highest workability value of 75 is obtained for 20% of RHA+CDA in cement.

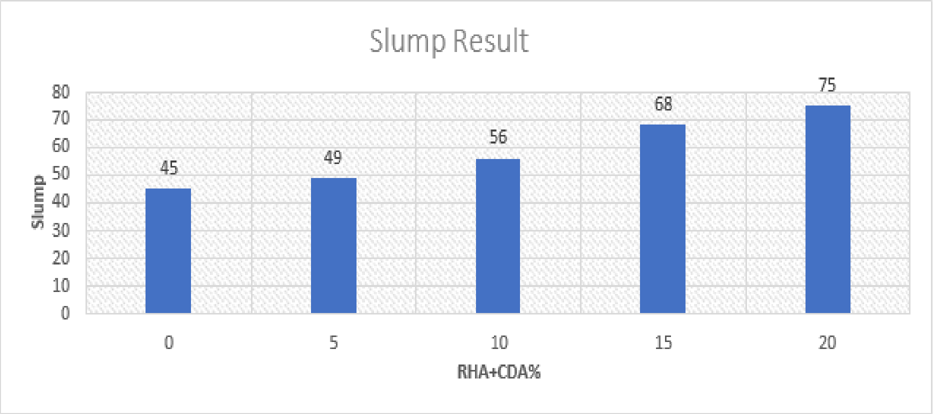

Fig. 6: Slump values for various RHA+CDA% mix

5. Density of Concrete Results:

The Density of the cubes decreases as the percentage content of CDA+RHA increases; this reveals that the lightness in weight of specimen is due to the presence of CDA+RHA and the higher the percentage of CDA+RHA the lighter the specimen. Also, the result reveals that the Density of specimen increases with age. The following bar chart represents that the highest densities obtained on 14 curing days.

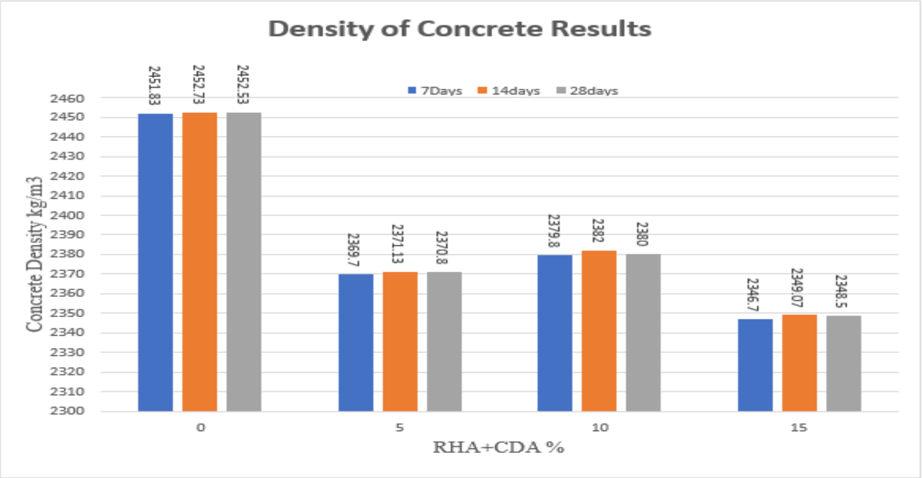

Fig. 7: Density results for various RHA+CDA% mix at 7,14,28 days curing

6. Compressive Strength Results:

Figure below clearly shows the pattern of the Cube Strength with various percentages of CDA+RHA against curing time, the Cube Strength is highest at 28 days with 37.75N/mm2 at 0% while the lowest Cube Strength is recorded at 28 days with 25.25 N/mm2 at 15%. The compressive strength of concrete deceases with increases percentages of CDA+RHA as shown in figure 12. The bar chart represents that the compressive strength of concrete remains constant on replacementof 5% and 10%.

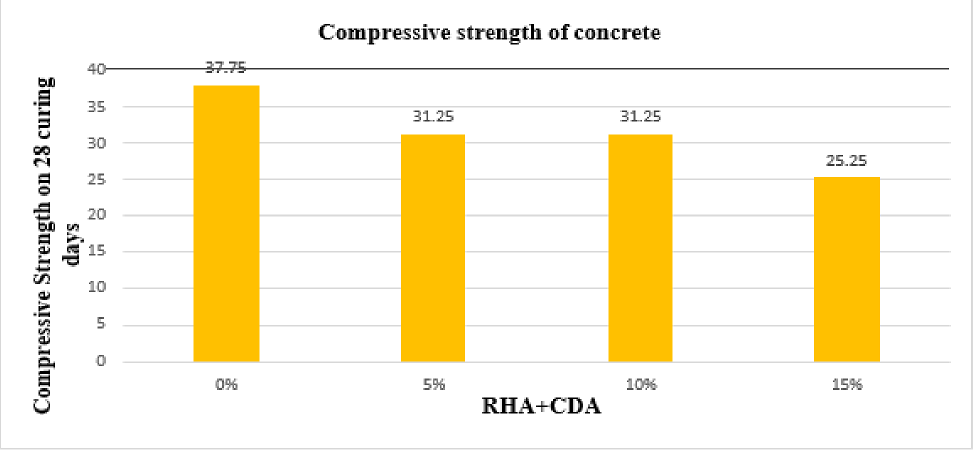

Fig. 8: Compressive strength results for various RHA+CDA% mix at 28 days curing

V. CONCLUSION

1. Cow Dung Ash and Rice Husk Ash concrete can be made to perform well in certain floor and wall applications when a ten percentage (10%) replacement is not exceeded.
2. The Cow Dung Ash and Rice Husk Ash requires more quantity of water as the percentage increases in the concrete, therefore it has a serious limitation that must be understood before it is put to use.
3. The Cow Dung Ash and Rice Husk Ash have an advantage that offers lightness of weight that makes it useful construction material.
4. More water is required to achieve the standard consistency as the amount of CDA+RHA increases.
5. Compressive strength decreases as the CDA+RHA content increases and increases as the curing period is prolonged.
6. With strength as a criterion, CDA+RHA of no more than 15% can be used to produce good and quality mortar and concrete.

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