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Research on Mechanical Properties of Brick Aggregate Concrete as Partial Replacement of Rice Husk Ash in OPC

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ABSTRACT

The objective of this research was to determine the mechanical properties, including among others compressive strength, split tensile strength, flexural strength test of a brick aggregate concrete (BAC) containing rice husk ash (RHA) as a partial replacement of cement and coarse aggregate. Concrete cylinders with 150-mm diameter and 300-mm height were cast using 0–25% RHA as a partial replacement of cement with water-to-binder ratios of 0.50 and replacement of coarse aggregate with Brick Aggregate as 10% constantly. The experimental results indicated that increased gradually with the increasing RHA up to 15%. However, the maximum values of these were observed with 15% RHA. By contrast, of BAC constant 10%. It was observed that mechanical properties of BAC were influenced significantly due to the inclusion of 15% RHA as a partial replacement of cement with a water-to-binder ratio of 0.50.

Keywords: Brick aggregate concrete (BAC); Rice husk ash (RHA); Compressive strength; Tensile strength; Flexural strength.

I. INTRODUCTION

Concrete is a composite material composed of gravels or crushed stones (coarse aggregate), sand (fine aggregate) and hydrated cement. Concrete, in the broadest sense, is any product or mass made by the use of a cementing medium. Generally, this medium is the product of reaction between hydraulic cement and water. For concrete to be good concrete it has to be satisfactory in its hardened state and also in its fresh state while being transported from the mixer and placed in the formwork. The requirements in the fresh state are that the consistence of the mix is such that the concrete can be compacted and also that the mix is cohesive enough to be transported and placed without segregation.As far as the hardened state is considered, the usual requirement is a satisfactory compressive strength. Many properties of concrete are related to its compressive strength such as density, impermeability, durability, resistance to abrasion, resistance to impact, tensile strength, and resistance to sulphates.

Aggregate:The coarse aggregate are granular materials obtained from rocks and crushed stones. They may be also obtained from synthetic material like slag, shale, fly ash and clay for use in light-weight concrete.

The sand obtained from river beds or quarries is used as fine aggregate. The fine aggregate along with the hydrated cement paste fill the space between the coarse aggregate.

Rice Husk Ash

India is a major rice producing country. Rice milling generates a byproduct know as husk. This surrounds the paddy grain. During milling of paddy about 78 % of weight is received as rice, broken rice and bran. Rest 22 % of the weight of paddy is received as husk and the husk generated during milling is mostly used as a fuel in the boilers for processing paddy, producing energy through direct combustion or by gasification. Rice husk is an agricultural residue which accounts for 20% of the 700 million tons of rice produced annually worldwide. 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 them by making commercial use of this RHA.

Rice husk is one of the most widely available agricultural wastes in many rice producing countries around the world. Burning of RH in ambient atmosphere leaves a residue, called rice husk ash. For every 1000 kgs of paddy milled, about 220 kgs (22 %) of husk is produced, and when this husk is burnt in the boilers, about 55 kgs (25 %) of RHA is generated. Rice husk removal during rice refining, creates disposal problem due to less commercial interest.The produced partially burnt husk from the brick kiln when used as a fuel also contributes to the problem of disposal and efforts are being made to overcome this environmental issue by utilizing this material as a supplementary cementing material. The chemical composition of rice husk ash is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions.

Brick Aggregate

The aggregates are usually derived from natural sources but in regions such as Bangladesh and parts of West Bengal, India where natural rock deposits are scarce, burnt-clay bricks are used as an alternative source of coarse aggregate. Here, construction of rigid pavement, small-to medium-span bridges and culverts and buildings up to six stories high using crushed brick (brick aggregate) concrete is quite common.

In Bangladesh, brick aggregates are easily available and much cheaper than crushed stone aggregate. Also concrete with compressive strength of around 20 MPa are easily achieved by using crushed normal strength brick and following the usual practice of concrete-making. Besides the unit weight of brick aggregate concrete has been reported to be much less than that of stone aggregate concrete. And the use of brick aggregate instead of stone aggregate in various components of a building structure can result in a significant reduction of dead load on column as well as foundation.

Hence, the replacement (partly or fully) of stone aggregate by brick aggregate may yield cost-effectiveness in making concrete.

Objectives

Several studies have already been performed on the properties of brick aggregate concrete (BAC). However, they did not use RHA as a partial replacement of cement in making concrete. Therefore, the aim of the present study was to investigate the various properties of BAC containing RHA as a partial replacement of cement, such as workability, compressive strength, tensile strength, Flexural strength.

II. LITERATURE REVIEW

This chapter deals with the review of literature related to strength properties of concrete made from Brick Aggregates as a replacement of coarse aggregate and effect of Rice Husk Ash on strength properties of concrete with ordinary Portland cement.

1.Ghassan Abood Habeeb, Hilmi Bin Mahmud: Investigated the properties of rice husk ash (RHA) produced by using a Ferro-cement furnace. The effect of grinding on the particle size and the surface area was first investigated, and then the XRD analysis was conducted to verify the presence of amorphous silica in the ash. RHA concrete gave excellent improvement in strength for 10% replacement (30.8% increment compared to the control mix), and up to 20% of cement could be valuably replaced with RHA without adversely affecting the strength. Increasing RHA fineness enhanced the strength of blended concrete compared to coarser RHA and control OPC mixtures.

2.Gritsada Sua-iam, Natt Makul: Investigated the properties of self-compacting concrete (SCC) mixtures comprising ternary combinations of Type 1 Portland cement (OPC), untreated rice husk ash (RHA), and pulverized fuel ash (FA). The SCC mixtures were produced with a controlled slump flow in the range between 67.5 to 72.5 cm diameter with a constant total powder materials content of 550 kg/m^3. RHA and/or FA were used to replace in powder materials with 20 or 40 wt%. The fresh and hardened properties including water requirement, workability, density, compressive strength development and ultrasonic pulse velocity were determined. Self-compacting concrete mixtures formulated using ternary blends exhibited significant improvements in physical properties compared to SCC mixtures containing only RHA or FA.

3.Farid Debib and Said Kenai2:Studied the effect by partially replacing the fine and coarse aggregate with crushed clay brick in concrete. The compressive, flexure and split tensile tests were conducted on concrete at the replacement levels of 25, 50, 75 and 100%. The authors reported a relatively low density for crushed brick concrete than normal concrete. The substitution levels of 25% for coarse aggregate and 50% for fine aggregate were reported from the test results.

4.Cachim.P: Investigated the mechanical properties of fresh and hardened concrete made with crushed bricks at replacement levels of 15 and 30%with the water cement ratios of 0.45 and 0.5. The author concluded that the crushed brick can be replaced upto 15% without any strength reduction and upto 30% with a strength reduction.

5.Yang. Jet al. Investigated the physical and mechanical properties of concrete after replacing the natural aggregate with recycled concrete aggregate and crushed clay brick. The authors observed that with the increased Crushed Clay Brick substitution levels the compressive strength decreased. The reduction in compressive strength was observed more significantly in recycled concrete made with 50% CCB replacement. The author concluded that the compressive strength and cylindrical splitting strength were crucially affected when the replacement levels of CCB was varying between 0 to 50% and no predominant change was observed in flexural strength.

6. Khalaf. F .M and DeVenny. A.S: carried out a study to evaluate the physical and mechanical properties of new and recycled crushed clay brick as aggregate for use in Portland cement concrete. The author stated that the impact value of brick aggregate increases as the compressive strength of the parent brick decreases. The results showed that the crushed clay brick aggregates can be used for producing concrete for low level civil engineering applications.

III. MATERIALS& MIX PROPORTIONS

Cement: Cement is the most important material in concrete and it acts as a binding material. Ordinary Portland cement 53 grade manufactured by Zuari Cement Company confirming to IS 12269-1987 is used in this investigation

Coarse Aggregate: In the present investigation, crushed granite aggregate of 20mm size was used. The specific gravity of coarse aggregate is 2.64.

Rice Husk Ash:RHA is greyish-black in colour due to unburned carbon. At burning temperatures of 550–800 °C, amorphous silica is formed, while crystalline silica is produced at higher temperatures. The specific gravity of RHA varies from 2.11 to 2.27; it is highly porous and light weight, with a very high specific surface area.

Brick: In this study, well-burnt bricks of irregular and reddish colour known as picket manufactured by a local company were collected. The standard test method was followed to find out the crushing strength and water absorption values of brick.

Fine aggregate:

The amount of the fine aggregate usage is important to fill the voids present in coarse aggregate. In this investigation, natural sand was used as fine aggregate. Sand was obtained from Kundu River near Nandyal in Kurnool district.

Mix Proportions:

In the present investigation M30 grade concrete is used with a constant W/C ratio of 0.5. Concrete mixes were prepared by varying the percentage of replacement of Coarse aggregate with Brick Aggregate as constant 10% and cement replaced with Rice Husk Ash (0%, 10%, 15%, 20%, and 25%).

Mix Proportions

Mix Designation	Proportions of Binding Materials
A1	Normal Mix
A2	10% Brick Aggregate + 0% RHA
A3	10% Brick Aggregate + 10% RHA
A4	10% Brick Aggregate + 15% RHA
A5	10% Brick Aggregate + 20% RHA
A6	10% Brick Aggregate + 25% RHA

IV. RESULTS & DISCUSSION

Compressive Strength:

The Compressive strength of concrete is measured to be the most valuable and significant mechanical property of concrete since it gives the overall picture of the concrete quality.

Effect of Brick Aggregate and Rice Husk Ash on Compressive Strength of Concrete:

The compressive strength of M30 grade concrete mixture by replacing CA with Brick Aggregate as constant 10% and RHA as replaced with cement as 10%, 15%, 20% and 25% is investigated. The results of compressive strength of A1, A2 A3 and A4 concrete mixtures tested at 7 days, 14 days, 28 days, 56 days and 90 days are presented in table no – 4.1. Graphical representation between compressive strength versus curing time of concrete is represented in Fig. given below.

Table 5.1– Compressive strength test results for BAC and RHA

Mix Design	Mix Proportion	Compressive strength N/mm^2				
		7-days	14-days	28-days	56-days	90-days
A1	Normal Concrete	31.85	32.08	38.56	39.54	40.17
A2	10% Brick Aggregate	33.70	35.96	37.98	38.34	39.81
A3	10% Brick Aggregate + 10% Rice Husk Ash	33.86	37.80	39.67	39.15	40.23
A4	10% Brick Aggregate + 15% Rice Husk Ash	35.62	38.12	41.37	42.63	43.76
A5	10% Brick Aggregate + 20% Rice Husk Ash	35.41	38.04	41.12	42.30	42.52
A6	10% Brick Aggregate + 25% Rice Husk Ash	34.91	36.80	39.17	40.18	41.07

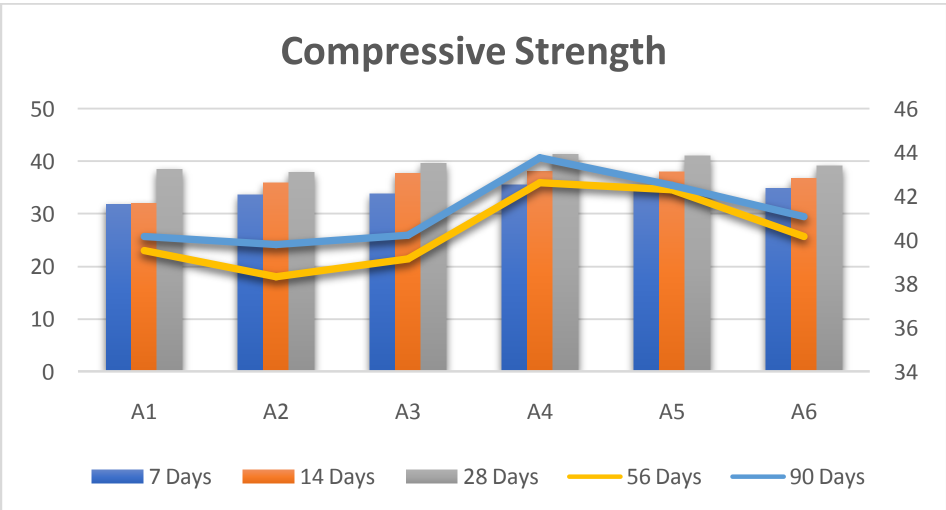


Fig. 5 Compressive Strength of Concrete

Split Tensile Strength:

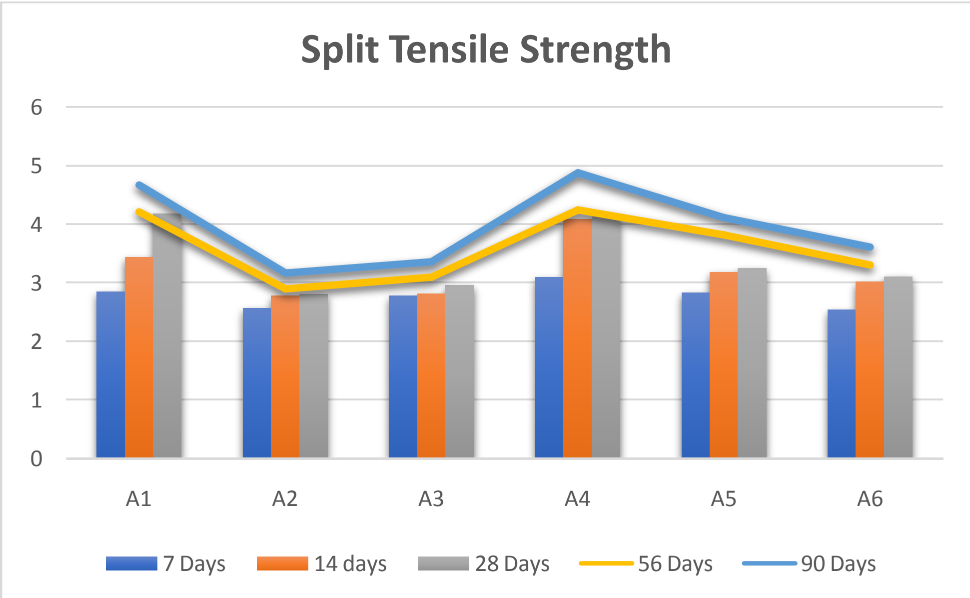
The Split Tensile strength of concrete is measured to be the most valuable and significant mechanical property of concrete since it gives the overall picture of the concrete quality.

Effect of Brick Aggregate and Rice Husk Ash on Split Tensile Strength of Concrete:

The Split Tensile strength of M30 grade concrete mixture by replacing CA with Brick Aggregate as constant 10% and RHA as replaced in cement as 10%, 15%, 20% and 25% is investigated. The results of compressive strength of A1, A2 A3 and A4 concrete mixtures tested at 7 days, 14 days, 28 days, 56 days and 90 days are presented in table given below. Graphical representation between compressive strength versus curing time of concrete is represented in Fig. given below

Table 5.2– Tensile strength test results for BAC and RHA

Mix Design	Proportions of coarse aggregate	Split Tensile strength N/mm^2				
		7-days	14-days	28-days	56-days	90-days
A1	Normal Concrete	2.85	3.44	4.18	4.22	4.67
A2	10% Brick Aggregate	2.57	2.78	2.81	2.90	3.17
A3	10% Brick Aggregate + 10% Rice Husk Ash	2.78	2.82	2.96	3.10	3.36
A4	10% Brick Aggregate + 15% Rice Husk Ash	3.10	4.09	4.13	4.25	4.88
A5	10% Brick Aggregate + 20% Rice Husk Ash	2.83	3.18	3.25	3.82	4.12
A6	10% Brick Aggregate + 25% Rice Husk Ash	2.54	3.02	3.11	3.31	3.61



5.3 Flexural Strength:

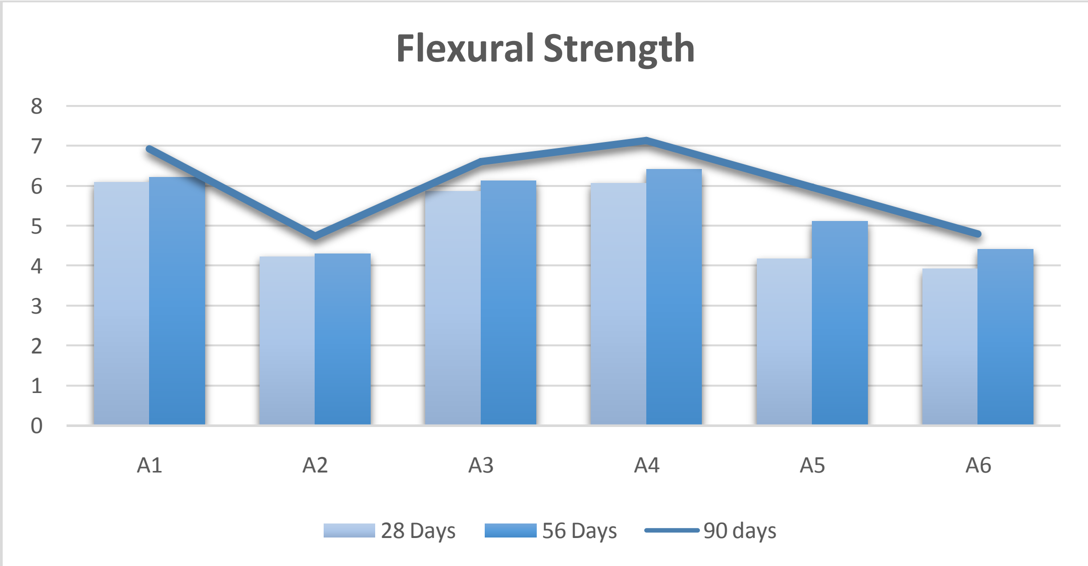
The Flexural Strength of concrete is measured to be the most valuable and significant mechanical property of concrete since it gives the overall picture of the concrete quality.

5.2.1 Effect of Brick Aggregate and Rice Husk Ash on flexural Strength of Concrete:

The Flexural strength of M30 grade concrete mixture by replacing CA with Brick Aggregate as constant 10% and RHA as replaced in cement as 10%, 15%, 20% and 25% is investigated. The results of compressive strength of A1, A2 A3 and A4 concrete mixtures tested at 28 days, 56 days and 90 days are presented in table as given below. Graphical representation between compressive strength versus curing time of concrete is represented in fig. below

Mix Design	Proportions of coarse aggregate	Flexural strength N/mm^2		
		28 days	56 days	90 days
A1	Normal Concrete	6.10	6.23	6.94
A2	10% Brick Aggregate	4.24	4.31	4.75

A3	10% Brick Aggregate + 10% Rice Husk Ash	5.87	6.14	6.61
A4	10% Brick Aggregate + 15% Rice Husk Ash	6.08	6.42	7.14
A5	10% Brick Aggregate + 20% Rice Husk Ash	4.18	5.12	5.97
A6	10% Brick Aggregate + 25% Rice Husk Ash	3.93	4.42	4.81



6 CONCLUSION

- Based on Research for the study of behavior of conventional by partial replacement of Brick Aggregate and Rice Husk Ash
- The compressive strength of M_{30} concrete increases with increase in the replacement of Coarse Aggregate with Brick Aggregate 10% as constant and Rice Husk Ash as proportions as 10%, 15%, 20% and 25%. Maximum compressive strength is obtained as 10% and BAC and 15% of RHA when compared with conventional concrete.
- The Split Tensile strength of M_{30} concrete increases with increase in the replacement of Coarse Aggregate with Brick Aggregate 10% as constant and Rice Husk Ash as proportions as 10%, 15%, 20% and 25%. Maximum Split Tensile strength is obtained as 10% and BAC and 15% of RHA when compared with conventional concrete.
- The Flexural strength of M_{30} concrete increases with increase in the replacement of Coarse Aggregate with Brick Aggregate 10% as constant and Rice Husk Ash as proportions as 10%, 15%, 20% and 25%. Maximum Flexural strength is obtained as 10% and BAC and 15% of RHA when compared with conventional concrete.
- As I concluded that comparing with normal concrete the proportion 10% BAC and 15% RHA is to be optimum where the strength is proportionally increased.

FUTURE SCOPE

Future use can Research on Durability Properties of partial replacement of Brick Aggregate and Rice Husk Ash such as Alkalinity, Acidity, Sulphate Chloride, Freeze and Thawing Actions.

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