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# SUITABILITY OF ALKALINE ACTIVATED RICE HUSK ASH AS PARTIAL REPLACEMENT FOR CEMENT IN CONCRETE

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## ABSTRACT
This study suitability of alkaline activated rice husk ash as partial replacement for cement in concrete has been investigated. The activated rice husk ash was partially replace as cement by percentage of 5%, 10%, 15% and 20% respectively. 60 number of grade 20 concrete cubes and 60 numbers of grade 25 concrete cubes were cast in laboratory and cured for 7, 14, 21, and 28 days respectively in accordance to BS1881: part 116: 1983. The study uses water/cement ratio of 0.55; with the hope that its usage would reduce accumulation of rice husk wastes which is harmful to human health. The rice husk was carbonized, sieved after carbonization using sieve size 150µm and was activated in the chemical laboratory using sodium hydroxide (NaOH) as the alkaline medium. However despite the observed loss in strengths of the concrete, it can still be used for various applications requiring medium and low strength in accordance to concrete grade 5, a strength which is achieved with these replacements of activated rice husk ash concrete: such as non-load bearing concrete wall, sidewalks, road barrier, concrete block, kerbs. The amount of concrete produce worldwide for this application could ensure the viability of this study.
**Keywords:** Cementious material, Compressive strength, Rice husk ash, Pozzolana, filler,

## INTRODUCTION
Rice husk ash is an agro waste material. Rice husk ash (RHA) is obtained by burning of rice husk in a controlled manner. When properly burnt, it has high silica content and can be used as an admixture in mortar and concrete. India produces about 122 million tons of paddy every year. About 20-22% rice husk is generated from paddy and 20- 25% of the total husk becomes as "RICE HUSK ASH" after burning. Each ton of paddy produces about 40 Kg of rice husk ash. Therefore it is a good potential to make the use of rice husk ash as pozzolanic material for making mortar and concrete. (Sumit Bansal, 2014). Rice husk is an agricultural residue widely available in major rice processing countries. The husk surrounds the paddy grain. During milling process the paddy grains about 78% of weight is obtained as husk. This husk is used as fuel in the various mills to generate steam for the parboiling process. This husk contains about 75% organic volatile matter and the rest 25% of the weight of this husk is converted into ash during the firing process. This ash is known as rice husk ash. This RHA contains around 85% -90% amorphous silica. Rice husk is generated from the rice processing industries as a major agricultural by product in many parts of the world especially in developing countries. About 500 million tons of paddies are produced in the world annually after incineration only about 20% of rice

husk is transformed to RHA. Still now there is no useful application of RHA and is usually dumped into water streams or as landfills causing environmental pollution of air, water and soil. RHA consists of non-crystalline silicon dioxide with high specific surface area and reactivity, thus due to growing environmental concern and the need to conserve energy and resources, utilization of industrial and biogenic waste as supplementary cementing material has become an integral part of concrete construction. Pozzolonas improve strength because they are smaller than the cement particles and can pack in between the cement particles and provide a finer pore structure. RHA has two roles in concrete manufacture, as a substitute for Portland cement, reducing the cost of concrete in the production of low cost building blocks and as an admixture in the production of high strength concrete.

Alkaline activation is a chemical process in which a powdering alumino silicate such as fly ash is mixed with an alkaline activator to produce a paste capable of setting and hardening within a reasonably short period of time. The alkaline activation of aluminum silicates is a research line that has achieved remarkable results by comparing their properties with those of materials made of Portland cement. Alkaline-activated cements, such as those made from ceramic tile wastes (CTW), are characterized as having a high content of alkalis and a low content of calcium. For this reason, the development of the mechanical strength and durability is attributed to the reaction product or N-A-S-H gel, an alkaline aluminum silicate that presents a three-dimensional structure, quite different to C-S-H gel, calcium-silicate-hydrate, obtained from the OPC hydration. However, this gel can incorporate a small aluminum content, forming a C-(A)-S-H gel. Nowadays, the cement industry works together with the scientific community in order to minimize the negative environmental impact by using materials such as pozzolana (fly ash, silica fume, construction wastes, and ceramic tiles among others). However, they are focusing on geopolymers due to their high strength, durability, and reduction of environmental impact.
The term "geopolymer" was given to inorganic synthetic polymers of alumino silicates derived from a chemical reaction known as geopolymerization where silica and aluminum are bound tetrahedronically by exchanging oxygen atoms, forming the basic unit, a sialate monomer (O-Si-O-Al-O). It carries a negative charge excess due to the replacement of Si for Al. The charge balance in the polysiate structure is achieved by alkaline metallic cations (K or Na).

## MATERIAL AND METHOD

### Rice Husk Ash

Rice husk ash is the ash that is obtained by the process carbonizing unit it get reduced by 25%. The rice husk for the research was obtained locally. These ashes were deliberated until fine ash is being produced. These ashes were sieved by the 600micron where further impurities are being minimized. After the process of sieving, the rice husk ash was activated so as to increase it reactivity properties before been used.

### Materials

Rice husk ash is the ash that is obtained by burning the rice husk until it gets reduced by 25%. The rice husk for the research was obtained locally. These husk then were deliberated until fine ash is being produced. These ashes were sieved by the 600 micron where further impurities are being minimized (Rahmat et al. 2011). Ordinary Portland cement (BUA), fine aggregate (sand) and coarse aggregate (gravel) was used for casting the concrete.

### Compressive Strength Test

Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not.

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc.

For cube test, casting was done using 150mm X 150mm X 150mm concrete mould. The concrete is poured in the mould and tempered 35 times in three (3) layers properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen is made even and smooth. These specimens are tested by compression testing machine (digital display) after 7 days 14 days 21 days and 28 days curing. Load are applied gradually until the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

## RESULTS AND DISCUSSION

Table 1: Compressive Strength of Control, 5%, 10%, 15% and 20% (Grade 20)

| Age (Days) | Crushing strength (N/mm$^2$) | | | | |
|---|---|---|---|---|---|
| | Control | 5% Repl. | 10% Repl. | 15% Repl. | 20% Repl. |
| 7 | 13.11 | 11.20 | 9.80 | 7.85 | 6.45 |
| 14 | 16.84 | 14.82 | 12.63 | 10.45 | 8.26 |

| | | | | | |
|---|---|---|---|---|---|
| 21 | 19.00 | 17.81 | 15.15 | 12.24 | 10.82 |
| 28 | 23.67 | 20.34 | 17.33 | 14.62 | 11.38 |

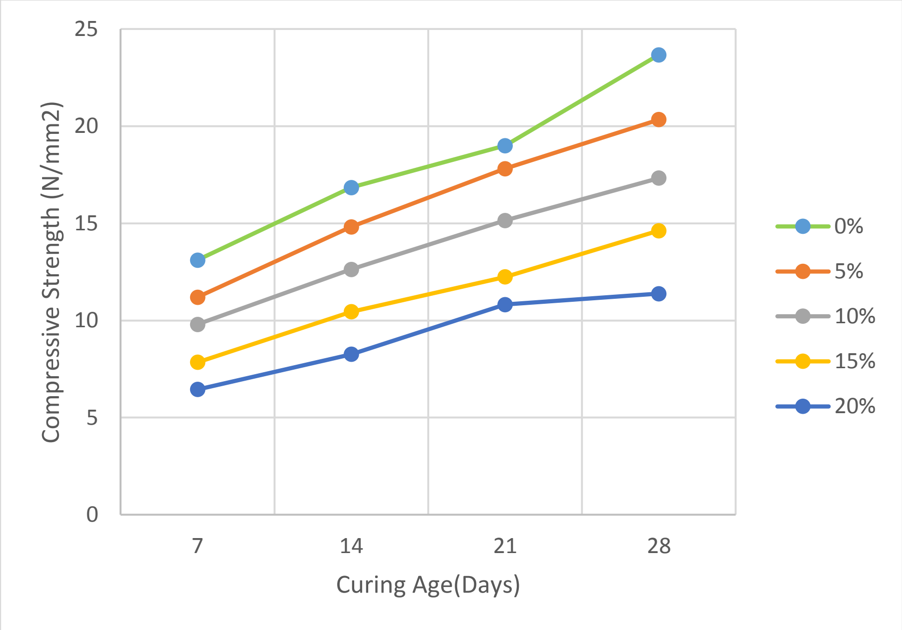


Fig. 1: A graph of compressive strength (N/mm²) against Age (Days) for Grade 20

Table 2: Compressive Strength of Control, 5%, 10%, 15%, and 20% (Grade 25)

| Age (Days) | Crushing strength (N/mm²) | | | | |
|---|---|---|---|---|---|
| | Control | 5% Repl. | 10% Repl. | 15% Repl. | 20% Repl. |
| 7 | 16.81 | 14.3 | 11.5 | 8.65 | 5.85 |
| 14 | 18.81 | 16.64 | 14.1 | 11.52 | 8.35 |
| 21 | 22.5 | 18.92 | 16.4 | 12.82 | 10.3 |
| 28 | 27.3 | 22.5 | 18.74 | 14.92 | 11.98 |

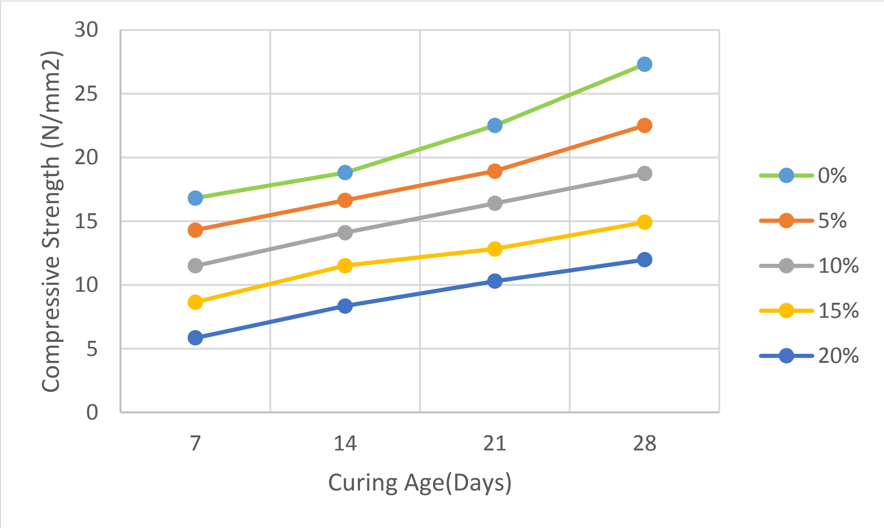


Fig. 2: A graph of compressive strength (N/mm$^2$) against Age (Days) for Grade 25

## DISCUSSION OF RESULT

The result obtained from the entire test carried out on the sample of concrete is as follows:

The compressive strength grade 20 and 25 for 0%, 5%, 10%, 15% and 20% were obtained as follows:

**Concrete grade 20**

7 days = 13.11N/mm$^2$, 11.2 N/mm$^2$, 9.8 N/mm$^2$, 7.85 N/mm$^2$, 6.45 N/mm$^2$
14 days = 16.84 N/mm$^2$, 14.82 N/mm$^2$ 12.63 N/mm$^2$ 10.45 N/mm2, and 8.25 N/mm$^2$
21 days = 19. 0 N/mm$^2$, 17.81 N/mm$^2$, 15.15 N/mm$^2$ 12.24 N/mm$^2$, and 10.82 N/mm$^2$
28 days = 23.67 N/mm$^2$, 20.34 N/mm$^2$, **17.33 N/mm$^2$, 14.62 N/mm$^2$ and 11.38 N/mm$^2$.**

**Concrete grade 25**

7 days = 16.81N/mm$^2$, 14.3 N/mm$^2$, 11.5 N/mm$^2$
14 days = 18.82 N/mm$^2$, 16.64 N/mm$^2$ and 14.1 N/mm$^2$
21 days = 22. 5 N/mm$^2$, 18.92 N/mm$^2$, 16.4 N/mm$^2$, 12.82 N/mm$^2$, and 10.3 N/mm$^2$
28 days = 27.3 N/mm$^2$, 22.5 N/mm$^2$, 18.74 N/mm$^2$, 14.92 N/mm$^2$ and 11.98 N/mm$^2$ respectively.

Therefore, the result above shows that increases in percentage of replacement decreases the strength of concrete for both grade 20 and 25 and increases in strength with increase in curing days.

The results of this trend may be due to a drop in workability with increase RHA. Test to assess the workability of fresh concrete indicates that incorporation of RHA in concrete leads to a decrease in slump value, which depends on the RHA content. This reduction in slump was due to the absorption of some quantity of mixing water by RHA particles.

Because of the large surface area of RHA, more water molecules were attracted towards the surface of these particles. Thus, the quantity of the free water available for the concrete mix which helps in improving the fluidity of the mixture was decreased and there was an increase in the viscosity of the concrete mix. This in turn reduces the workability of the concrete and the effect was the same for other two tests also. If density were to be considered according to BS877, the concrete using RHA would have been considered a light-weight concrete.

## CONCLUSION

Despite the observed lower values of the compressive strength of the partial replace concrete, there is a potential large market for this concrete products in which inclusion of activated rice husk ash would be feasible. Because the lower strength values of the partial replace concrete would still be acceptable for low strength requirement structures as specified by BS 1881: part 116: 1983.

## RECOMMENDATIONS

Although, the results of this research study have shown a considerable reduction in the compressive strength of concrete with high activated rice husk ash content percentage than normal concrete, it could be recommended to use in low strengths requirements structures such as non-load bearing walls, road kerb, precast units for partition walls, some cases of slabs on soil, culverts, sidewalks, concrete blocks for architectural applications and concrete blocks. Although, these research works was carried out within a specific time frame and considering the financial challenges, further study can be carried out on activated rice husk ash concrete by the additive of admixture such as silica fume of different percentage or by the use of different cement type in order to overcome the significant reduction of the concrete strength due to activated rice husk ash.

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