International Journal of Engineering, Management and Humanities (IJEMH)
Volume 3, Issue 5, pp: 102-106 www.ijemh.com

Production of Concrete Kerbs Using Rice Husk Ash as Partial Replacement with Cement.

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Date of Submission: 01-10-2022 Date of Acceptance: 13-10-2022

Abstract

In this research, agro waste RHA was used as a partial replacement of cement in concrete, and the resultant was studied and compared with the normal (0% of RHA). The results obtained have established that RHA can serve as a partial replacement of cementatious material in concrete for the production of concrete kerbs. The results from the study showed an average compressive strength at 10% of RHA has the higher compressive strength of 28.8 N/mm^{2,} than that of 0% of RHA 27.73N/mm^2 at 28 days of curing. Conclusions are drawn based on the results obtained from this study and the test demonstrates that concrete containing 10% of RHA exhibits higher compressive strength development than that of 0% of RHA. The use of RHA in concrete can prove to be economical as a useful waste and cost effective material for production of concrete elements for the construction industry. This also goes to show that the use of RHA in concrete will eradicate the disposal problem of waste materials and prove to be environment friendly and bring about sustainability in the construction industry.

Keywords: Rice Husk Ash, Concrete, Agro waste

I. Introduction

Based on building and construction industry, the use of cement is unavoidable and is one of the most widely used building and construction materials. The most commonly used cement is Ordinary Portland Cement (OPC) which is produced from limestone resulting in many challenges including: total dependency on limited raw materials, increased demand for cement in concretes, environmental challenges, high energy use and high cost of production (Nnamdi O.P.(2011). Fapohunda*et al*., 2017 in their paper showed that 30% of the cementused globally is replaced by supplementary cementitous materials during production or by direct substitution on the building site, the amount of carbon dioxide in the atmosphere would be reduced by about 60%. According to Bawarlftikhar*et al*., 2022, one possible remedy to mitigate the effect of these environmental issues is the use of waste and recycled material in concrete.To ensure sustainability, the use of substitute natural materials is constantly being researched in order to address the challenges posed by conventional OPC. These natural materials are thus to be used as either partial or full replacements of OPC.

The kerb (British English) or curb (American English) is the raised edge of the road where the footpath or median is separated from the street or roadway. The use of kerbs was first discovered in the city of Pompeii, Italy, which was buried under volcanic ash and pumice in the eruption of Mount Vesuvius in AD 79. The main functions of kerb are to provide structural support to the edges of the roads and channel away rainwater. The failure of kerbs often leads to excessive moisture ingress into the pavement structure, leading to the softening of the pavement materials, which can significantly affect the structural performance of the road and increase the repair and maintenance cost. Kerbs also improve the aesthetic aspects of roads and can be used as road markings.

Rice Husk is an agro waste by-product from rice paddy milling industries. Rice husk ash (RHA) is derived from rice husks, which are usually regarded as agricultural waste and an environmental hazard. Rice husk, when burnt in open air outside the rice mill, yields the ash that can serve as fillers or as supplementary materials in concrete. The usage of Rice Husk Ash is due to the increasing rate of environmental pollution and the consideration of sustainability factor, whereby rice husk is used as an alternative for cement in concrete manufacturing.

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Rice husk ash (RHA) possesses high pozzolanic activities and very suitable as partial replacement of cement in concrete (Ayesha Siddika*et al*., 2018). Studies have shown the increase in the compressive strength of concrete incorporated with RHA (Ayesha Siddika*et al*., 2018; SeyedAlirezaZareei*et al*., 2017, Hwang C.L. and Chandra S., 1996). F. LópezGayarre*et al*., 2013 utilized the use of recycled aggregates from the construction and demolition wastes to manufacture concrete kerbs and floor blocks which are used in pavements and floor slabs respectively.Maurice E. et. al. (2012) in their study showed the effect of RHA on the compressive strength of concrete.

In this paper, concrete kerbs are produced with 10% partial replacement of cement with corresponding investigation of their compressive strength. Thus the possibility of using Rice Husk ash (RHA) as partial replacement with cement for the production of concrete kerbs, to reduce or eliminate environmental waste and constructions cost.

II. Materials And Methods

2.1 Materials collection and preparation

A total of 40 concrete kerbs were casted having a dimension 450mmx300mmx100mm, while a total30Cube mould of 150mmx150mmx150mm in dimension were casted to obtain the compressive strength of the concrete.

The concrete constituents consisted of DangoteOrdinary Portland cement, fine aggregate which was collected from a river after Nasarawa market, in Nasarawa LGA of Nasarawa State, and coarse aggregate were collected from Tamma, in Nasarawa LGA of Nasarawa State. The Rice Husk used for this study was obtained from Tamma, in Nasarawa LGA ofNasarawa state, and was burnt to ashes using the open burning method. The burning of the husk can result in the ash product, with silica mainly in an amorphous form (Habeeb& Mahmud, 2010). The ashobtained was ground to the required level of fineness and sieved through 90µm sieve in order to remove impurities and larger particle sizes.The constituent materials were measured properly and then water was added carefully till all constituents were mixed thoroughly until a uniform consistency was achieved, using mix ratio 1: 2: 4.

III. Experimental Programe

In the production, casting was done according to BS 1881 – 108:1993 for 0% and 10% RHA replaced with cement. According to the mix proportion materials required for our concrete was collected and mixed. Then, the mixture was filled into the specified moulds. The moulds were tamped to eliminate entrapped air. The moulds were kept in the laboratory condition for one day and then placed into curing tanks. The temperature of water in the curing tanks was the normal temperature of water available in the laboratory. The cubes were taken out from the tanks before the testing date. Tests on hardened concrete were carried out at 7, 14, 21 and 28 days. The kerb and cubespecimens produced in this study were shown in Fig. 1to 3.

Figure 1: Casting of Kerbs cubes

Figure 2: Concrete Kerb.

Figure 3: Concrete Cubes

3.1Compaction of cubes

Three (3) test specimens each of 0% RHA and 10% of RHA cubes were made, for 7, 14, 21 and 28 days. In the molding of the specimen compaction was done by hand. 30 strokes of the compaction rod were used for the 150mmx150mmx150mm cubes.

3.2Compressive strength test

The test was carried out on specified cubes using a compression test machine. Curing for a reasonable period of time of 7, 14, 21 and 28 days. to achieve its potential strength and durability (British Standard 1881 Part 116, (1983). The compressive strength test result is shown in table1. Figure 4 shows the weighing and crushing of the concrete cubes after the curing process and days. Figure 5 shows installed kerbs.

Fig. 4 Weighing and crushing of concrete Cubes.

Fig. Installation of kerbs

IV. Analysis of Results

4.1 Compressive Strength Test

The result for the compressive strength test on concrete is shown in table 1. It was observed that the compressive strength increased with age at curing, for all the ages at curing, the highest strength was obtained from concrete made with 10% of RHA in partial replacement with cement at 28 days of curing. The Average compressive strength of 0% RHA and 10% RHA varied according to their different curing days. On curing at 7 days the result obtained showed that the average compressive strength of 0% RHA is 21.20 N/mm^2 while average compressive strength of 10% RHA is 21.39N/mm^2. At 14 days, the average compressive strength of 0% RHA increased to 26.35N/mm^2 that of 10% RHA also increased to 26.58N/mm^2. At 21 days, the average compressive strength of 0% RHA increased to 26.84N/mm^2 that of 10% RHA also increased to 27.26N/mm^2. Prior to aging of the concrete cubes on the 28th day 0% RHA increased to 27.73N/mm^2. At of 10% RHA also increased to 28.81N/mm^2. It is observe that the compressive strength of the concrete cube of 0% RHA and 10% RHA are dependent on their different masses, density and crushed load level. It is clearly seen that 10% RHA has the higher compressive strength 28.8 $N/mm^{2,}$ than that of the 0% RHA 27.73N/mm^2. Figure 6 shows a graphical representation of the compressive strength against the curing days of the concrete cubes.

Table 1 Compressive strength of concrete for 0% and 10% replacement with RHA

Cubes Age	Compressive Strength (N/Mm^2) 0% RHA REPLACEMENT	Compressive Strength (N/Mm^2) 10% RHA REPLACEMENT
7	21.20	21.39
14	26.35	26.58
21	26.84	27.26
28	27.73	28.81

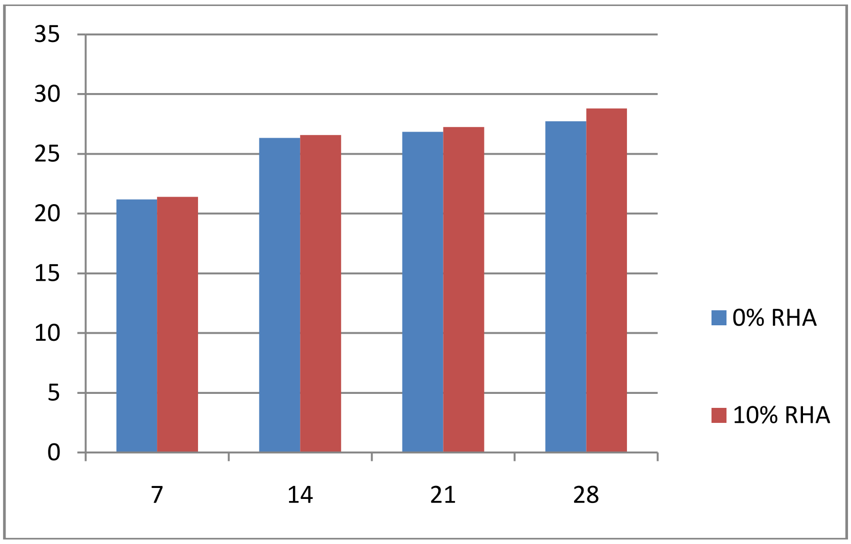

Figure 6.Graph showing compressive strength of concrete for 0% RHA and 10% RHA against curing dates.

V. Conclusion

This study has established that RHA can serve as a partial replacement of cementatious material.Since the average compressive strength at 10% of RHA has the higher compressive strength of 28.8 $N/mm^{2,}$ than that of 0% of RHA 27.73N/mm^2 at 28 days of curing. Based on the result of the experiment carried out, the following conclusions may be drawn;

1. From the result of the average compressive strength of concrete for seven (7) days of curing, with 1:2:4 mix ratio for both concrete made of 0% RHA (21.20N/mm^2) and for 10% of RHA (21.39N/mm^2).
2. From the result of the average compressive strength of concrete for twenty one (21) days of curing, with 1:2:4 mix ratio for both concrete made of 0% RHA (26.84N/mm^2) and for 10% of RHA (27.26N/mm^2).
3. From the result of the average compressive strength of concrete for twenty eight (28) days of curing, with 1:2:4 mix ratio for both concrete made of 0% RHA (27.73N/mm^2) and for 10% of RHA (28.81N/mm^2).
4. Concrete incorporated with 10% partial replacement of RHA can be used in the production of concrete kerbs based on the result of the compressive strength test.

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