International Journal of
Science and Engineering Investigations vol. 8, issue 95, December 2019
Received on December 3, 2019 ISSN: 2251-8843

Melon Husk Ash as a Sustainable Alternative to Cement in Concrete

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Abstract-In this paper, Portland Limestone Cement was partially replaced by Melon Husk Ash at 5%, 10%, 15% and 20% by weight of cement. The melon Husk was milled and burnt under a controlled temperature of 600°C to produced ash. Twelve (12) standard concrete cubes (150 x 150 x 150 mm) were produced for each percentage (0, 5, 10, 15 and 20%) replacement of melon husk ash by weight of cement The cube samples were cured for 7, 14, 21 and 28 days and were investigated on their respective days to determine the compressive strength. The results achieved were compared with results of conventional C-23.85 concrete mix (0%) and it was realized that the maximum increase in strength occurred at 5% level of replacement at 28days. With an increase in Melon Husk Ash content, water absorption decreased signifying the increase in walkability. Based on the study results, it is recommended that the Melon Husk Ash as partial replacement of cement by weight should be encouraged in the concrete industry. The Melon husk Ash could be utilized in concrete production as cement with 5% to 15% replacement for 600^0C Burnt temperature.

Keywords- *Sustainable, Melon Husk Ash, Alternative, Cement Calcined*

I. INTRODUCTION

Concrete is the most universally utilized construction material and demand for it is increasing steadily. For the concrete industry to be sustainable, the practice of agricultural wastes alternative for cement in concrete is one of the preferred approaches. A huge amount of agricultural by-product is produced all around the Northern part of Nigeria. There is enormous potential for utilizing agricultural wastes in the construction industry. When agricultural by-products are reprocessed and used in concrete production, the cost of concrete products will eventually reduce. This approach will assist in keeping the environment-friendly and waste replacing valuable and comparatively costlier materials. Sundry nations are facing challenges of traditional pozzolanic materials. In recent times, there are significant attempts of employing reprocessed agricultural wastes in the concrete sector. Agricultural waste is specifically caused by agricultural produce. A good example of such materials is the melon husk if effectively milled and calcined, the ash produced can be utilized as a cement substitute in concrete. A large amount of cement content emits significant heat release in the concrete because of the reaction between cement and water and can lead to cracking [10]. The advantages of Melon Husk Ash Concrete could probably consume less quantity of cement with environmental benefits and lower emission of $CO_{2.}$

[16] Studied the supplement of 10% in mass of cement using fly ash in concrete. Results showed that it is possible to add fly ash into the concrete. Fracture occurs in concrete as a result of rupture of the interface paste and aggregate, and the existence of pores. [15] Studied to identify the most possible technique for field production of reactive pozzolans from rice husk. The ash generated was blended with Portland cement to produce concrete which would be appropriate for low-strength structure application. The purpose was to recommend a reasonably priced construction possibility for rural housing. [1] revealed that the supplement of Rice Husk Ash at 25% reduces the compressive strength and addition of 0.5% polypropylene fibres into concrete mixes increases compressive strength. [13] first presented researches on dual mixes with the replacement of cement by Rice Husk Ash in America, concentrated on vital parameters possibly influence rice husk burning process and improving the end product". [7] pointed out that Rice Husk Ash as a reactive pozzolan influence noticeably on optimization of microscopic construction of the transition interface zone amongst paste and both fine and coarse aggregates surface in high strength concretes.[12] showed that greater the percentages of Rice Husk Ash replacement the lesser the compressive strength. Nevertheless, 10% replacement of cement with Rice Husk Ash achieved the targeted compressive strength. The addition of Rice Husk Ash instead of cement not only improves compressive strength but also make the normal concrete more durable.

[17] Explored fresh and hardened properties of fly ash in concrete and reveals that fly ash has a significant effect on the hardened and fresh concrete properties. The fly ash concretes workability was better, and the water requirement also lower, bleeding of fly ash concretes was about the same, the setting was reduced, dependent on the category and properties of the fly ash and on the mix ratio.

[18] Revealed that physical, chemical, mineralogical and technical properties of fly ash show excellent pozzolanic properties and this fly ash can give higher quality raw material.

The fly ash acts as excellent pozzolan in the addition of cement in large construction of dams, ports etc. This has special importance in reference to the current "Peace Process", in the Middle East. Fly ash is replaced for cement, fine aggregates, coarse aggregates, as a constituent of raw materials for light weight and light weight aerated concrete in Israel.

In this paper, we aimed to study the effects of Melon Husk Ash replaced by cement partially based on existing experimental findings of what influence these materials may have on concrete strength. We performed various levels of Melon Husk Ash replacement ranging from 0 to 20%, supported by some tests to evaluate the basic properties of concrete.

II. MATERIALS AND METHODS

A. *Materials*

1) *Concrete materials*

Concrete samples to be investigated were cast in the civil laboratory using the following materials: Portland limestone cement, fine aggregate and coarse aggregate and melon husk ash.

2) *Cement*

Portland Limestone Cement of 42.5 grade was used throughout the work.

3) *Melon husk ash (MHA)*

Melon Husk generally described as an agricultural waste was sourced from Kano, Nigeria. The melon Husk was milled and burnt under a controlled temperature of 600°C to produce ash and was used to replace cement at different percentage levels (5%, 10%, 15%, 20%). It was reported by [14] that melon husk ash contained aluminum oxide (Al_2O_3 = 18.5 %), Iron oxide (Fe2O3 = 2.82 %) and silicon dioxide (SiO2 = 51.24 %) was found to be 72.56 % which is more than the minimum requirement for pozzolan [2].

4) *Fine Aggregate*

Fine aggregate used was river sand at Tombia, an outskirt of Yenagoa. The maximum particle size was 4.75mm. It conformed to [3].

5) *Coarse Aggregate*

Coarse aggregate with particle size greater than 4.75mm and maximum size of 12.5mm is used. It conformed to [3].

6) *Water*

Clean was used in the mixing of concrete specimen as specified by [4]

B. *Methods*

1) *Mixture proportions*

Twelve (12) standard concrete cubes (150 x 150 x 150 mm) in conformation to [5], were produced for each percentage (0, 5, 10, 15 and 20%) replacement of melon husk ash by weight of cement with mix and water-cement ratio of 1:2:4 and 0.45 respectively. The cube samples were cured for 7, 14, 21 and 28 days and were investigated on their respective days to determine the compressive strength.

III. RESULTS AND DISCUSSION

A. *Results*

TABLE I. MIX PROPORTION ADOPTED FOR THE COMPRESSIVE STRENGTH

Percentage Replacement	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Melon Husk Ash (kg)	Mixing Water (kg)
0%	14.5	29.0	58.0	-	7.0
5%	13.77	29.0	58.0	0.73	7.0
10%	13.05	29.0	58.0	1.45	7.0
15%	12.33	29.0	58.0	2.18	7.0
20%	11.6	29.0	58.0	2.9	7.0

TABLE II. COMPRESSIVE STRENGTH OF CONCRETE AT 7, 14, 21 AND 28 DAYS FOR DIFFERENT PERCENTAGE REPLACEMENT OF MELON HUSK ASH

Percentage Replacement	7 Days (N/mm^2)	14 Days (N/mm^2)	21 Days (N/mm^2)	28 Days (N/mm^2)
(0%)	16.00	18.89	20.44	23.85
5%	23.11	33.78	30.07	27.56
10%	28.89	27.85	29.63	26.96
15%	24.59	21.93	24.52	22.07
20%	20.15	19.70	20.59	16.44

TABLE III. SLUMP VALUES FOR MELON HUSK ASH PARTIAL REPLACEMENT

Replacement	W/C Ratio	Slum (mm)
0%	0.45	15
5%	0.45	9
10%	0.45	2
15%	0.45	3
20%	0.45	5

TABLE IV. % INCREMENT IN COMPRESSIVE STRENGTH OF CONCRETE FOR CALCINED MELON HUSK ASH DOSE

Days	5%	10%	15%	20%
7 Days (N/mm^2)	30.76	44.6	35	20.6
14 Days (N/mm^2)	44	32.2	13.86	4.1
21 Days (N/mm^2)	32	31	16.64	0.73
28 Days (N/mm^2)	13.46	11.53	-8.07	-45.07

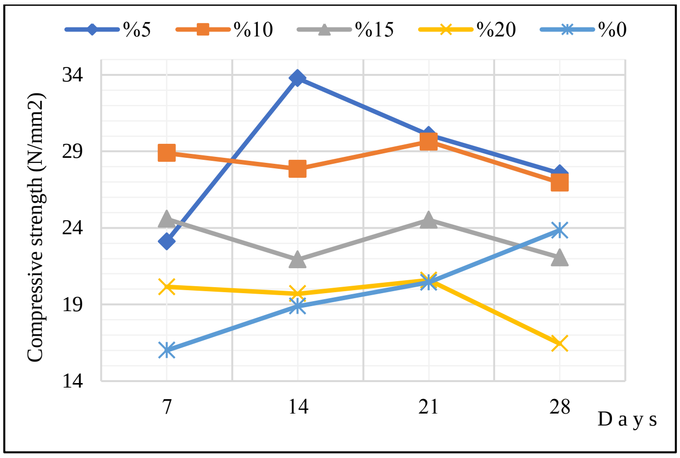

Figure 1. Compressive Strength against Days for 0%, 5%, 10%, 15% and 20% Replacement

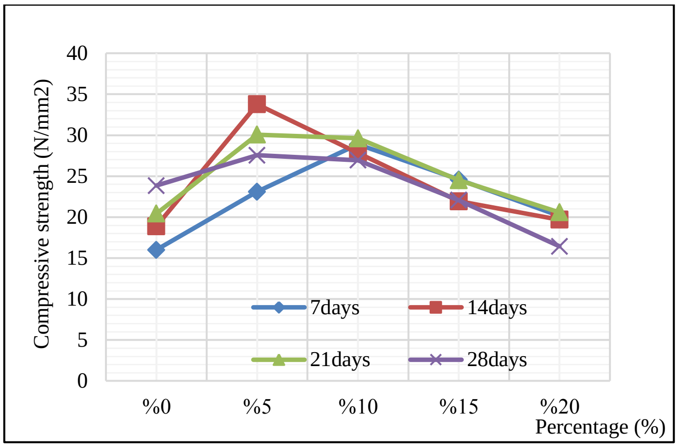

Figure 2. Compressive Strength against Percentage replacement for 0%, 5%, 10%, 15% and 20% Replacement

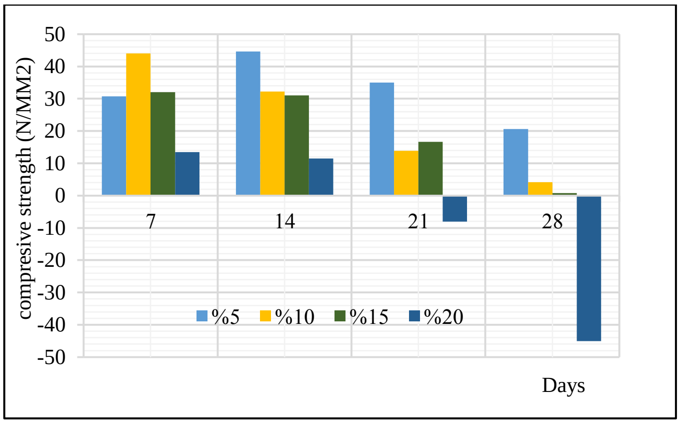

Figure 3. % Increment in Compressive Strength of Concrete for Calcined Melon husk ash Dose

B. *Discussion*

The results obtained from this experimental study of compressive strength of concrete samples at different percentage replacement of Melon Husk Ash showed in Table 2.o. The results revealed that the compressive strength of concrete increases with age and tends to decrease as the percentage of melon husk ash increases.

From figure 1.0 and 2.0, the highest compressive strength was obtained at 5% Melon Husk Ash replacement at 14days followed by 10% Melon Husk Ash replacement at 21 days.

This accurately implies that MHA relative to cement as a partial replacement at 5% and 10% can be adopted since its compressive strength when compared to the controlled results at 0% replacement showed a tremendous increase.

Applying least square regression method, as given in (1), where $f_{c,ex}$ and x are dependent and independent variables, respectively; Rj is the residual; β is a vector in the predicted function f (x, β)

$$R_j = f_{c,ex} - f(x, \beta) \quad (1)$$

minimizing the sum of the squared residual, *Rj*, in (2), we arrived at the relationships in (3) and (4) respectively;

$$S = \Sigma R_j^2 \quad (2)$$

$$f_{c,pr} = -0.0672x^2 + 2.4913x + 9.745 \quad (3)$$

$$f_{c,pr} = -0.0189x^2 + 0.5144x + 17.155 \quad (4)$$

Equation (3) represents the connection among strength improvement and period for a 5 % partial alternative of calcined melon husk ash (CMHA). $f_{c,pr}$ signifies the predicted concrete strength and x implies duration in days. While (4) shows the relationship between strength development and period when 20% cement is replaced by calcined melon husk ash (CMHA).

Above equations predicts the compressive strength development between minimum curing days to 90 days.

IV. CONCLUSION AND RECOMMENDATION

A. *Conclusion*

The following conclusions were drawn:

i. Calcined Melon Husk Ash has (Al2O3 = 18.5 %), Iron oxide (Fe2O3 = 2.82 %) and silicon dioxide (SiO2 = 51.24 %), as in cement, is considerable as a cement replacement

ii. Calcined Melon Husk Ash can be effectively replaced cement in concrete production

iii. 5% replacement of Calcined Melon Husk Ash at 600^0C gave about 13% increase in concrete strength at 28days.

iv. 10% replacement of Calcined Melon Husk Ash at 600^0C gave about 11.5% increase in concrete strength at 28days

v. The best replacement dosage of Melon Husk Ash at $600^{\circ}C$ is 5% followed by 10% at 28days.

B. Recommendation

The following recommendations are drawn:

i. Melon Husk Ash can be used to replace cement in concrete sector of 5% -15% at $600^{0}C$ burnt temperature

ii. Other agricultural waste containing higher Al_2O_3, Fe_2O_3 and SiO_2 could be recycled to improve the used of Melon Husk Ash as cement replacement.

V. ACKNOWLEDGEMENTS

The authors express special thanks to Niger Delta University and Department of Civil Engineering making available the laboratory for this research.

REFERENCES

[1] A. Pradhan Kumar, P. Padma Rao, B. Bhaskar Singh., (2014) "A Study on Use of Rice Husk Ash in Concrete", IJEAR Vol. 4, Issue Spl-2, ISSN: 2348-0033.

[2] ASTM C618-94, (1994). Standard Specification for coal fly ash and raw or calcined natural pozzolan for use as a mineral admixture in Portland cement concrete.

[3] BS 882: (1982); Specification for aggregate from natural sources for concrete.

[4] BS 3148: (1980); Test of water for making concrete.

[5] British Standard Institution (2000). Testing hardened concrete, BS EN 12390: Parts 1-8, BSI, London.

[6] BS 882: (1983); Specification for aggregate from natural sources for concrete.

[7] Bui D.D., Hu J., Stroeve P. (2005) Particle size effect on the strength of rice husk ash blended.

[8] Deepa G Nair, K. Sivaraman, and Job Thomas (2013), "Mechanical Properties of Rice Husk Ash (RHA) – High strength concrete", American Journal of Engineering Research AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936. Volume-3, 14-19 Int. J. Appl. Sci. Technol., 1 (6) pp. 1-16

[9] J. Eng. Sci. Technol. School Eng. Taylor's Univ. Coll., 5 (1).

[10] Kartini K. (2012) Effects of Silica in Rice Husk Ash (RHA) in producing High Strength Concrete, … of Engineering and vol. 2, no. 12, pp. 1951–1956.

[11] Kartini K. (2011) Rice husk ash- pozzolanic material for sustainability

[12] Kartini M., Mahmud K., Hamidah H.B. (2010) Absorption and permeability performance of Selangor rice husk ash blended grade 30 concrete

[13] Mehta P.K. (1977) "Rice husk ash – a unique supplementary cementing material", Proceedings of the CANMET/ACI International Symposium on Advances in concrete Technology, V.M. Malhotra, ed. Athens, Greece, 1992, pp. 407-430

[14] Mohammed, I. S., Balami, A. A., Abdullahi, M., Dauda, S. M. and Aliyu, M. (2014) Stabilization of clay soil with lime and melon husk ash for use in farm structures. Arid Zone Journal of Engineering, Technology and Environment. Vol. 10: 56-66

[15] Nair, D.G., Jagadish, K.S. and Fraaij, A. (2006). Reactive Pozzolans from Rice Husk Ash: An Alternative to Cement for Rural Housing. Cement and Concrete Research, 36(6): 1062-1071.

[16] P. Padma Rao and A. Pradhan Kumar, (2014) "A Study on Use of Rice Husk Ash in Concrete", IJEAR Vol. 4, Issue Spl-2, ISSN: 2348-0033.

[17] Philleo R.E. (2008) "Compressive Strength of Low Cement/High Fly Ash Concrete", Cement and Concrete Research. Vol. 18, pp. 571-58.

[18] Henry A. Foner, Thomas L. Robl, James C. Hower, Uschi M. Graham (2012) "Characterization of fly ash from Israel with reference to its possible utilization", Fuel 78 215-223.

How to Cite this Article:

TrustGod, J. A. & Geofrey, B. (2019) Melon Husk Ash as a Sustainable Alternative to Cement in Concrete. International Journal of Science and Engineering Investigations (IJSEI), 8(95), 9-12. http://www.ijsei.com/papers/ijsei-89519-02.pdf