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UTILISATION OF ORGANIC LEAF WASTE ASH IN THE PREPARATION OF CONCRETE

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ABSTRACT
With increasing industrialization, the industrial by products (wastes) are being accumulated to a large extent, leading to environmental and economic concerns related to their disposal (land filling). Leaf ash is the residue produced from the incineration of plant leaves and it is one kind of solid waste ash. The use of leaf ash in cement concrete mix will make it cost effective and environment friendly disposal of the product. Cement is an energy extensive industrial commodity and leads to the emission of a vast amount of greenhouse gases. By reducing the demand of cement, natural reserves of limestone can be preserved, energy can be saved and pollution due to CO_2 can be reduced. In this project, concrete will be casted for M25 grade and the partial replacement of cement with leaf ash in the range of 0%, 5%, 10%, 15% and 20% by weight of cement. The workability, compressive strength were conducted and results were analysed.

Keywords: Organic leaf ash, concrete, M25 grade.

1. INTRODUCTION

1.1 General

Excess demand of natural resources on account of expeditious urbanization and the scrapping problem of agricultural waste have paved the way for research in usage of organic waste in the construction industry. Scores of organic waste materials have found their usage in concrete as substitute alternatives for cement, fine aggregate, coarse aggregate and reinforcing materials. This paper highlights and examines some of the organic waste material used as partial replacement of fine aggregate in concrete which is being defined and termed as organic waste concrete in present context. The project aims at evaluating the strength characteristics of organic waste concrete by using different organic wastes and thus understanding the feasibility of using each organic waste. Distinct properties of fresh and hardened concrete, their reliability when admixed with organic wastes are examined. It has been observed that the organic waste concrete containing groundnut shell, rice husk ash, saw dust ash, leaves demonstrated more desirable workability than their other substitutes did.

1.2 Organic waste ash

Various research works has been carried out for the cost reduction in construction with some of the locally available materials as the partial or full replacement material for cement. Over the last few decades supplementary materials like fly ash, rice husk, silica fume, egg shell, groundnut shell, etc. are used as a replacing material. These supplementary materials have proven to be successful in meeting the needs of the concrete in construction.

Organic leaf waste ash is generated as a combustion of dried plant leaves. As a result the quantity of ash generated will also increased and concurrently raising the issues of disposal. Incorporation of organic leaf waste ash as a partial replacement of cement material in blended

cement and concrete will be beneficial from both the environmental and economic point of views. This will give a solution to the waste management problem while minimizing the consumption of energy intensive hydraulic cement.
Accordingly, this study presents the possibility of using OLWA as a part of raw materials in cement manufacturing without adjusting the proportion of raw meal. For real applications, if OLWA is replaced in raw materials, it may be necessary to adjust the proportion of raw meal. This new type of cement is expected to improve energy efficiency, to conserve raw materials and to reduce air pollution of the cement manufacturing, while the cement quality is expected to be the same as that of OPC.

2. LITERATURE REVIEW

Organic waste ash (OWA) used in this study is the residue generated due to combustion of about 80% waste wood (from oak, almond, milk vetch, etc.) and 20% animal waste with total density of 890 kg/m3 which is used in a common WTE program in rural regions of Iran for many years. The generated OWA in rural regions mostly is used as compost, the remaining is landfilled or used to reduce the PH of the soil. On the other hand, for WA, approximately 70% of it is land filled, 20% is applied on land as a soil supplement, and remaining 10% is used for miscellaneous applications [5, 6, 7, 8 and 9] including construction materials, and pollution control. It should be noted that due to high carbon content in WA and OWA, their use criteria should be limited to low and medium strength concrete needs [2], therefore there are not many reports about the applications of WA or OWA as a construction material, in cement-based materials especially. Several studies around the performance of concrete using fly ash, wood ash, and waste wood ash (WWA) have been done [2 to 15] but none of them investigated the effects of adding animal waste ash to WA on the mechanical properties of manufactured concrete. Naik et al. investigated on the economic benefits of using WA as a part of the total cementitious materials in concrete and concluded that only in Wisconsin city, approximately 120,000 to 500,000 US dollars annually could be saved by using only 5 to 12% wood ash [10]. Sashidhar investigated the influence of adding different percentages of wood ash (0 to 30%) to concrete on its resistance in acid attack with concentrated acids such as H_2SO_4 and HCL and concluded that 10% of wood ash is the optimum rate to confront acid threats [15]. Oye reported that wood bottom ashes have no components which would be harmful to cement [4]. Olokode et al. reported that the best ratio of WA to get the desired mechanical properties from concrete is about 5 to 10% [14].

3. OBJECTIVE AND METHODOLOGY

3.1 Objective

The objectives of the work are stated below:

i) To develop mix design methodology for mix 25 MPa
ii) To study the effect of adding different percentages (0% - 20%) of OLW ash by the weight of cement in the preparation of concrete mix.
iii) To determine the workability of freshly prepared concrete by Slump test.
iv) To determine the compressive strength of cubes at 7, 14, 28 days.

3.2 Methodology

1. Collect the organic leaf waste, by manual incinerate process the ash will uptained.

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2. The organic leaf waste ash and sieve the ash with 75microns IS sieve.
3. Find out the fineness modulus and specific gravity tests for organic leaf ash.
4. Find out the physical properties of Coarse aggregate, Fine aggregate, cement.
5. Design mix design of M25 grade concrete. And calculate the mix proportions for individual mix.
6. Partial replacement of cement with leaf ash with varying percentages (0% - 20%) in the preparation of concrete.
7. Perform the workability, compressive strength tests on conventional and leaf ash-based concrete. Compare the values and find out the optimum percentage of organic leaf ash replacing by cement.
8. Conclusions and future scope of the study.

4. EXPERIMENTAL WORK

4.1.1 Organic leaf waste ash

The OLWA prepared in the month of February 2022 in a manual incineration process at College Solid waste dampage area. The incinerator ash has been sieved and coarser pieces has been removed manually. The generated ash from manual incineration involves a wide range of particles size; only the fraction less than 75 microns has been used in this work. The ash has been dried before experiments. The content of major components (in form of oxides) which are found in OLWA is presented in Table. 1.

Table. 1: Content of major oxides found in OLWA.

Compound	Percentage in OLWA	Percentage in Cement
Silica (SiO_2)	55.7	20.7
Alumina (Al_2O_3)	14.1	6.3
Iron oxide (Fe_2O_3)	8.8	3.6
Lime (CaO)	11.9	63.6
Magnesia (MgO)	2.7	2.4
Sulphur Trioxide (SO_3)	0.7	1.4
Sodium oxide (Na_2O)	1.4	0.1
Potassium oxide (K_2O)	1.2	0,1
Copper oxide (CuO)	0.5	-
Zinc oxide (ZnO)	0.3	-

4.2 Mix Design

Adopted Grade of concrete used-M_{25}

Table. 2: Design proportions of materials for M25 grade concrete.

Item name	As per mixed Design (kg/m^3)
Cement	438.13

Fine aggregates	612.58
Coarse aggregates	1109.27
water	197.16

Volume of the cube = 1.1 X (0.003375) = 0.0037125 m^3

4.2.1 Mixed design proportions for OLWA Concrete

- In this research work 15 Standard cubic specimens of size 150mm (nine sample for each percentage of OLWA) were casted for the compressive strength of concrete and it was kept under curing for 7, 14 days & 28 days of age. Total cubes for compressive strength testing was 45 (9 cubes * 5 proportions).
- Mass of ingredients required will be calculated for 9 no's cubes for each mix proportion, assuming 10% wastage

Table. 3: For single cube material weights

Mix	CA (Kg)	FA (Kg)	Cement (Kg)	OLWA (Kg)	Water (lit)
0%	4.118	2.274	1.626	0	0.7319
5%			1.544	0.0813	
10%			1.4634	0.1626	
15%			1.3821	0.2439	
20%			1.3	0.3252	

4.2.2 Sample Production

The cement, fine and coarse aggregates were weighted according to mix proportion of M_{25}. All are mixed together in a bay until mixed properly and water was added at a ratio of 0.45. The water was added gradually and mixed until homogeneity is achieved. Any lumping or balling found at any stage was taken out, loosened and again added to the mix.

For the second series of the mixture, the OLWA was added at 5%, 10%, 15% and 20% by weight of Cement. Immediately after mixing, slump test was carried out for all the concrete series mixture. A standard 150×150×150mm cube specimen were casted.

The samples were then stripped after 24hours of casting and are then be ponded in a water curing. As casted, a total of (45) 150×150×150mm cubes were produced.

Fig. 1: Cubes with OLWA.

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4.2.3 Curing

The method of curing adopted was the ponding method of curing and produced samples were cured cubes for 7, 14, 28 days.

4.3 Test For Fresh Properties of Concrete (Workability Test)

4.3.1 Slump Test

which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete. It is not a suitable method for very wet or very dry concrete. It does not measure all factor contributing to workability. The slump test was carried in accordance with B.S:1882 PART2:1970.

4.4 Test For Harden Properties of Concrete

4.4.1 Compressive Strength of Concrete

The compression test was conducted according to IS 516-1959. This test helps us in determining the compressive strength of the concrete cubes. The obtained value of compressive strength can then be used to assess whether the given batch of that concrete cube will meet the required compressive strength requirements or not. For the compression test, the specimen's cubes of 15 cm x 15 cm x 15 cm were prepared by using OLWA concrete as explained earlier. These specimens were tested under universal testing machine after 7 days, 14 days and 28 days of curing. Load was applied gradually at the rate of 140kg/cm^2 per minute till the specimens failed. Load at the failure was divided by area of specimen and this gave us the compressive strength of concrete for the given sample.

5. RESULTS AND DISCUSSIONS

As per experimental programme results for different experiments were obtained. They are shown in table format and graph format, which is to be presented in this chapter.

5.1 Harden properties of concrete (Workability Test)

5.1.1 Slump Test

The Slump test was performed on the OLWA concrete to check the workability of it at different replacements viz. 5 %, 10 %, 15%, 20% and the following results were obtained, according to which it can be concluded that with the increase in % of OLWA from 0 to 20 % , workability decreases. The results obtained for Slump test are shown below in Table. 4.

Table. 4: Results of slump test.

S.No	% of OLWA	Slump value (cm)
1	0%	69
2	5%	64
3	10%	58
5	15%	54
6	20%	47

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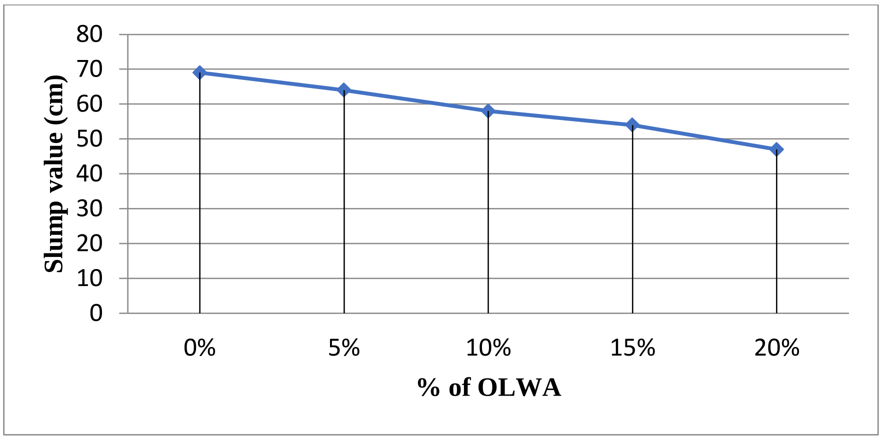

Fig. 2: Slump test results.

The above fig. 2 shows the slump results. It was observed that, the slumps decreased as the OLWA content were increased in the mix. It was suitable for Low Workability mixes used for foundations with light reinforcement. Roads vibrated by hand operated machines.

5.2 Harden properties of concrete

5.2.1 Compressive Strength Test

The compressive strength test was performed on the cubes of size 15 cm x 15 cm x 15 cm to check the compressive strength of OLWA concrete and the results obtained are given in Table. 5.

Table. 5: Results of compressive strength test.

S. No.	% OLWA	Compressive strength of cubes (N/mm^2)		
		7 days	14 days	28 days
1	0	14.7	22.05	24.5
2	5	16.1	24.4	27.2
3	10	15.2	22.9	26
4	15	12.9	19.54	21.9
5	20	11.13	17.82	19.8

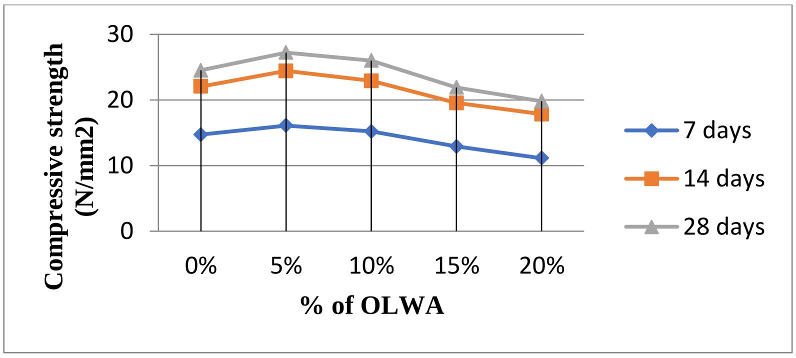

Fig. 3: Compressive strength v/s % of OLWA.

From the above results it was observed that with the increase in percentage of OLWA from 0% to 5% in concrete the compressive strength increases after that decreases.

6. CONCLUSION

1. Based on the result that have carried out here as part of this project, we concluded that the replacement of ash obtained from organic leaf waste ash can be used for the preparation of concrete. The best advantage of this partial replacement is reducing the over dumping of solid waste to public.
2. The compressive test results on the cement replaced Organic leaf waste ash cubes did show improvement while adding 5% and 10% in the 28 days strength in comparison to the control mix, but it fall increasing the percentage of OLWA above 10%.
3. Replacement of Organic leaf waste ash up to 10% is good for using construction purposes. And also solid waste incineration powder replacing mixes are also used as base course for pavement constructions.
4. While increasing the percentage of OLWA in cement then $CaCO_3$ will reduces in it. As we maintain the more percentage of OLWA then add suitable amount of $CaCO_3$.
5. The untreated OLWA was used as partial cement replacement in concrete. This ash, by its chemical composition, does not fulfill the standard requirements on concrete admixtures but the prepared concrete had acceptable properties. The frost resistance of OLWA containing concrete was very good. The prepared concrete contained relatively low content of OLWA; this approach represents a compromise between the ecological request on a practical utilization of OLWA and properties of the acquired product.
6. Higher ash dosage without any accompanied loss of concrete properties would be possible only when the ash would be treated in some way (e.g. by verification) but in such case there would arise additional costs suppressing the OLWA utilization attractiveness for building industry.

REFERENCES

[1] Lee, M., Legg, R., Maxwell, S., Rees, W., (2013). Closing the Loop: Reducing greenhouse gas emissions and creating green jobs through zero waste in BC. Wilderness committee.

[2] Siddique, R., (2012). Utilization of wood ash in concrete manufacturing. Resources, Conservation and Recycling 67, 27-33.

[3] Naik, T. R., (1999). Tests of wood ash as a potential source for construction materials. Report no. CBU-1999-09. UWM Centre for By-Products Utilization. Department of Civil Engineering and Mechanics, university of Wisconsin-Milwaukee, Milwaukee, p. 61.

[4] Bjarte O., (2012). Ash Utilisation, Wood ash as raw material for Portland cement. SINTEF.

[5] Campbell, A., (1990). Recycling and disposing of wood ash. TAPPI Journal, 73(9), 141–143.

[6] Etiegni, L., (1990). Wood ash recycling and land disposal. Ph.D. thesis. Department of Forest Products, University of Idaho at Moscow, Idaho, USA.

[7] Etiegni, L., Campbell, A. G. (1991). Physical and chemical characteristics of wood ash. Bio-resource Technology, 37(2), 173–184.

[8] National Council for Air and Stream Improvement, Inc. (NCASI), (1993). Alternative management of pulp and paper industry solid wastes. New York, NY: Technical Bulletin No. 655, NCASI.

[9] Tarun, R., Naik, R., Kraus, N., Siddique, R., (2003). Use of wood ash in cement-based materials, CBU-2003-19.

[10] Tarun, R., Naik, R., Kraus, N., Siddique, R., (2003). Demonstration of manufacturing technology for concrete and CLSM utilizing wood ash from Wisconsin, Report No. CBU-2003-20, Interim Report for Year 2 Activities Submitted to the Wisconsin Department of Natural Resources, Madison, WI, for Project # 01-06, Department of Civil Engineering and Mechanics, University of Wisconsin-Milwaukee, Milwaukee

[11] Udoeyo, F. F., Inyang, H., Young, D. T., Oparadu, E. E., (2006). Potential of wood waste ash as an additive in concrete. Journal of Materials in Civil Engineering, 18(4), 605–611.

[12] Abdullahi, M., (006). Characteristics of wood ash/OPC concrete. Leonardo Electronic Journal of Practices and Technologies, 8, 9–16.

[13] Tarun, R., Naik, R., Kraus, N., Siddique, R., (2002). Demonstration of manufacturing technology for concrete and CLSM utilizing wood ash from Wisconsin, Report No. CBU-2002-30, Report for year 1 activities submitted to the Wisconsin Department of Natural Resources, Madison, WI, for Project # 01-06 UWM Center for By-Products Utilization, Department of Civil Engineering and Mechanics, University of Wisconsin-Milwaukee, Milwaukee

[14] Olokode, O. S, Aiyedun, P. O., Kuye, S. I. Anyanwu, B. U., Owoeye, F. T., Adekoya, T. A., Nwonah, J. N., (2013). Optimization of the Quantity of Wood Ash Addition on Kaolinitic Clay Performance in Porcelain Stoneware Tiles. The Pacific Journal of Science and Technology, 14(1), 21-30.

[15] Sashidhar, C., Sudarsana, Rao H., (2010). Durability studies on concrete with wood ash additive. CI□Premier PTE LTD, 35th Conference on Our World in Concrete and Structures, August 2010, Singapore

[16] Karthik H. Obla, What is Green Concrete? The Indian Concrete Journal, April 2009, 26-28.

[17] Nurdeen M. Altwair and Shahid Kabir, Green Concrete Structures by Replacing Cement with Pozzolanic Materials to reduce Greenhouse Gas Emissions for Sustainable Environment, American Society of Civil Engineers, June-2010, 269-277.

[18] C. Meyer, The greening of the concrete industry, January- 2009, Cement & Concrete Composites 31 601-605

[19] S. P. Mukherjee And Dr Gaurang Vesmawala "Literature Review on Technical Aspect of Sustainable Concrete" , International Journal of Engineering Science Invention ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 www.ijesi.org Volume 2 Issue 8ǁ August. 2013 ǁ PP.01-09.

[20] SULYMAN OLAMILEKAN IBRAHIM, “Bamboo Leaf Ash as a Partial Replacement of Cement in Concrete”, https://afribary.com/

[21] Gashaw Abebaw, Bahiru Bewket, and Shumet Getahun, “Experimental Investigation on Effect of Partial Replacement of Cement with Bamboo Leaf Ash on Concrete Property” Hindawi Advances in Civil Engineering Volume 2021, Article ID 6468444, 9 pages https://doi.org/10.1155/2021/6468444.

[22] M.R. Karim, M.F.M. Zain, M. Jamil, F.C. Lai,Fabrication of a non-cement binder using slag, palm oil fuel ash and ricehusk ash with sodium hydroxide,Construction and Building Materials 49 (2013) 894–902.

[23] Dhiraj R.Naxine[1], Swapnil Bagmare[2] , Pramendra Katre[3], Divya Parteke□, Rina Bansod□ , Priya Washnik□ ,Prathna Bawangade□, “PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH BANANA LEAVES ASH: A REVIEW” © 2021 IJCRT | Volume 9, Issue 5 May 2021 | ISSN: 2320-2882.