IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 48-52

Partial Replacement of Cement with Textile Industry Wood Ash Waste

Faizan Ahmed[1], Mohammed Junaid[2], Naveed Akhtar[3], Saud Mahevi[4]
[1](Civil Engineering Department, Maulana Mukhtar Ahmad Nadvi Technical Campus, SavitribaiPhule Pune University, India)
[2](Civil Engineering Department, Maulana Mukhtar Ahmad Nadvi Technical Campus, SavitribaiPhule Pune University, India)
[3](Civil Engineering Department, Maulana Mukhtar Ahmad Nadvi Technical Campus, SavitribaiPhule Pune University, India)
[4](Civil Engineering Department, Maulana Mukhtar Ahmad Nadvi Technical Campus, SavitribaiPhule Pune University, India)

Abstract: *Due to increasing rate of industrialization, there are large amount of by products which are producing from various industries, disposal of these by products through safe way is a major concern nowadays. The wood ash is a waste produced after the incineration of wood in any industry. This may include wood chips, dust and bark etc. Utilization of such wood ash waste in making concrete will greatly help to prevent environment from the disposal problems and also it is cost effective. Numbers of cubes were casted and tested for various grades of concrete mix for the 5%, 10%, and 15% of cement by wood ash waste and parameters for the strength of the concrete are evaluated.*

Keywords: *Wood ash waste, partial replacement of cement, 5-15% replacement, strength parameters.*

I. Introduction

As we all know concrete is basic material for construction of any reinforced concrete structure due to its high strength and long life also it can safely withstand with all the loads which are likely to come on a R.C.C. structure. In modern era concrete is used at everywhere in the construction of buildings, bridges and roads also in making railway sleepers and pavement blocks. As industrialization increases it results in generation of a large quantity of waste materials which creates problems for environment and for disposal due to which greenhouse effect is taking place at very extent. Cement is a raw material to prepare concrete of any type. Production of 1 tonnes of cement results in the production of a huge quantity of CO_2 gas which is a major concern of greenhouse effect.

To solve these all environmental problems there big need to utilize waste materials in a proper way such that it should also help in economy. Wood ash waste is a byproduct of wood incineration industries. At this time the disposal of these wood ashes waste is of major concern. Utilization of wood ash waste as a partial replacement of cement in concrete results in achieving the strength of concrete and will reduce the consumption of cement which saves the cost of construction and results in economy.

II. Literature Review

Experiment study is done by Rafat Siddique (2003) [3] on the effect of wood ash replacement with cement in concrete. Testing is done for various compositions and found: 5-30% carbon, 7- 33% calcium, 3- 4% potassium, 1- 2% magnesium, 0.3-1.4% phosphorous, and 0.2- 0.5% sodium. The significant variations in the chemical composition of tested wood ash were:SiO_2 (4 to 60%), Al_2O_3 (5 to 20%), Fe_2O_3 (10 to 90%), CaO (2 to 37%), MgO (0.7 to 5%), TiO_2 (0 to 1.5%), K_2O (0.4 to 14%), SO_3 (0.1 to 15%), LOI (0.1 to 33%), moisture content (0.1 to 22%), and available alkali (0.4 to 20%).

C. Sashidhar and H. Sudarsana Rao (2010) [4]Fine and coarse both the aggregates are bounded togather artificially to form concrete mix in addition with water. Due to huge application in various fields, concrete becomes very popular material. Modification is needed for properties of concrete to make it suitable for situations with advancement of technology and increases fields. To achieve this it is necessary to use some admixtures which results in low cost and increasing strength. Hence 0-30% wood ash is used to check the properties of concrete. Wood ash concrete is tested for compressive strength, acid attack with concentrated acids like H2SO4 and HCL and water absorption.

Wood ash which obtained from bakeries after burning is used as the partial replacement of cement in concrete mortar by Akeem Ayinde Raheem and Olumide A. Adenuga (2012) [7]. Various tests were carried out on the strength, workability and chemical composition of concrete. 5-25% replacement of cement is used to

obtain test results and is compared with concrete with no replacement. 1:2:4 proportion and 0.5 w/c ratio was used. The Compressive strength was determined for 3, 7, 28, 56, 90 and 120 days. It is observed that wood ash is of Class F type fly ash since the sum of (SiO2 +Al2O3 +Fe2O3) is greater than 70%. Strength increases with increase in curing period and decreases with increase in wood as percentage. Maximum 10% replacement of wood ash can be used as above 10% replacement decrease in strength is observed.

III. Objective

This experimental investigation is specially done by keeping in mind the industrialization of Malegaon city located in Maharashtra. Since 1935 Malegaon is h major hub for cloth weaving industry. Starching the yarn, transferring it over the tubes, preparing tana-bana was done by the women initially as this is the traditional for Maharashtra state. Even after power looms were introduced, women continued to help their men folk in the weaving procedure. The increased productivity flourished the Malegaon as the power looms introduced.

In the Malegaon, 10 tones wood ash is produced per month from textile industries. For utilization of this wood ash, we conducted this project.

IV. Properties And Test Results Of Raw Materials

Cement

Table 1 Physical properties

Sr. No.	Property	Value
1	Specific Gravity	3.1
2	Mean size	23 lm
3	Initial setting time	46
4	Final setting time	300

Table 2 Chemical properties

Sr. No.	Chemical Name	Formula	Value
1	Silica Oxide	SiO_2 (%)	20.025
2	Aluminium Oxide	Al_2O_3 (%)	5.04
3	Iron Oxide	Fe_2O_3 (%)	3.61
4	Calcium Oxide	CaO (%)	63.61
5	Magnesium Oxide	MgO (%)	4.56
6	Sodium Oxide	Na_2O (%)	0.08
7	Potassium	K_2O (%)	0.5
8	Loss	Loss on Ignition	3.12

Aggregate

Table 3 Fineness Modulus

IS SIEVE SIZE IN (MM)	WEIGHT RETAINED(g)	CUMULATIVE WEIGHT RETAINED(g)	CUMULATIVE % RETAINED(g)
4.75	46.5	46.5	9.3
2.36	30	76.5	15.3
1.18	90	166.5	38.3
600 µ	50	216.5	47.3
400 µ	60	276.5	57.3
300 µ	10	286.5	69.3
150 µ	5	291.5	71.3
90 µ	2	293.5	72.3

$$FM = \frac{380.4}{100} = 3.804$$

V. Mix Design

Mix design is defined as quantity of material (cement, fine aggregate, course aggregate) required per cubic meter of concrete. Indian standard method of mix design (as per IS: 10262-2009, IS 456-2000, IS 10262 – 1982 and SP-23) the mix design of plain concrete is carried out.

Sample Mix design for M20 grade concrete

1. Determination of target means strength

$F_{ck} = f_{ck} + (t \times s)$

f_{ck} = 20 N/mm^2

t = 1.65 (From IS: 10262- 1982, Table - 2)

S = 5.0 N/mm^2 (Std. Deviation as per IS: 456-2000 clause 9.2.4.2)

F_{ck} = 20 + (1.65 x 5)

F_{ck} = 28.25 N / mm^2

2. Selection of water cement - ratio

From IS: 10262-1982 figure - 1 the water cement ratio required for target mean strength of 28.25 N/mm^2 is 0.39. Mild exposure value i.e. 0.55 is higher than this.

Adopt water cement ration of 0.55

3. Selection of water and sand content

From IS: 10262-1982 table - 4 for 20 mm maximum size, aggregate sand confirming to grading zone II water content per cubic meter of concrete = 186 kg. And sand content as percentage of total aggregate = 35%

Sr. No.	Change in Conditions	Adjustment required in water content	% sand in total aggregate
01	For decrease in water – cement ratio by (0.6 – 0.39) i.e.0.21	0	-4.2%
02	For increase in compacting factor (0.9 – 0.8) i.e.0.10	+3%	0
Total		3%	-4.2%

For change in value in water cement ratio and compacting factor above adjustment is required by using table - 6 of IS:10262-1982.

Therefore required sand content as percentage of total aggregate by volume = 35 - 4.2 = 30.8%

Required water content = 186 + 3% of total water content

= 186 + 5.58 = 191.58 say

= 191.6 litre / m^3

Water / cement = 0.55

Cement = 191.6 / 0.55 = 348.36 kg/m^3

It satisfying mild exposure condition.

4. Determination of coarse and fine aggregate content

From IS: 10262-1982 table - 3 for the specified maximum size of aggregate of 20 mm the amount of entrapped air in the wet condition is 2%

$$V = \left[W + \frac{C}{S_c} + \frac{f_a}{P * S_{fa}}\right] * \frac{1}{1000}$$

Where,

V = 1 - 2 / 100

V = 0.98

0.98 = [191.6 + 491.30 / 3.15 + 1 / 0.308 x f_a / 2.65] x 1 / 1000

Fine aggregate f_a = 516 kg / m^3

$Coarse\ aggregate = [\frac{(1-P)}{P} * f_a * \frac{S_{ca}}{S_{fa}}]$

= [(1-0.308) / 0.308] x 491 x 2.70/ 2.65

Coarse aggregate = 1181 kg/m^3

Table 4 mix proportion per cubic meter of concrete

Water	Cement	Fine aggregate	Coarse aggregate
191.6 liters	491.30 kg	516 kg	1181 kg
0.50 :	1 :	1.05 :	2.40

Table 5 Quantities of materials for one cube

Particulars	0%	5%	10%	15%
Cement	1.410 kg	1.352 kg	1.293 kg	1.234 kg
Wood ash	0 kg	0.058 kg	0.117 kg	0.176 kg
Fine aggregate	2.140 kg	2.140 kg	2.140 kg	2.140 kg
Coarse aggregate	4.681 kg	4.681 kg	4.681 kg	4.681 kg
Water	0.775 lit.	0.775 lit.	0.775 lit.	0.775 lit.
Water cement ratio	0.50	0.50	0.50	0.50

VI. Result And Discussion

Different mixes were considered for compressive strength test at the age of 7, 21, and 28 days. For each mix nine cubes of 150 x 150 x150 mm were casted for curing period 7, 21, 28 days. At the end of each curing period three cubes where tested and average compressive strength was noted as shown below.

Table 6 Compressive strength result for M15 grade concrete

Water to cement ratio	Replacement percentage	Compressive strength (N/mm²)		
		7 days	21 days	28 days
0.55	0 %	9.75	14.1	14.85
	5 %	8.95	14.25	15.15
	10 %	10.15	14.21	15.35
	15 %	8.91	12.55	13.25

Column Graph 1 Compressive strength result for M15 grade concrete

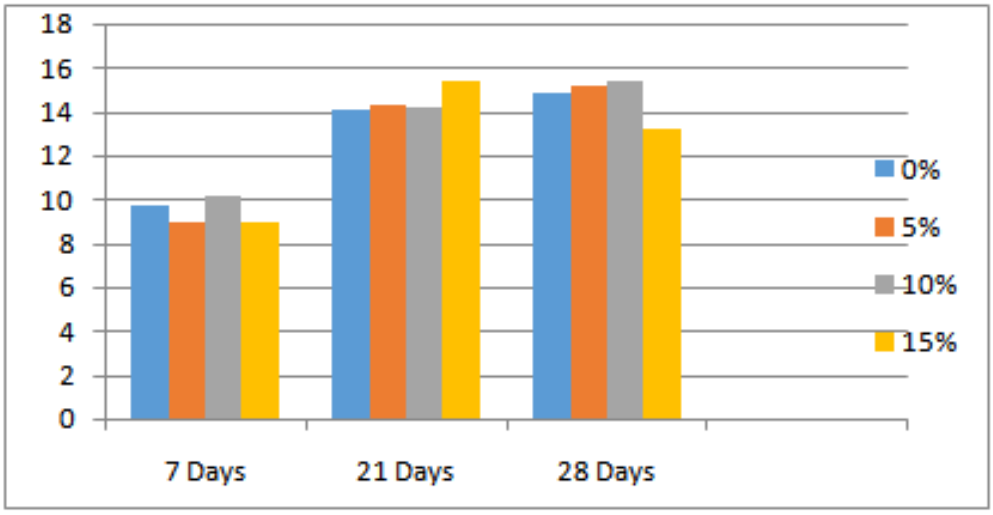
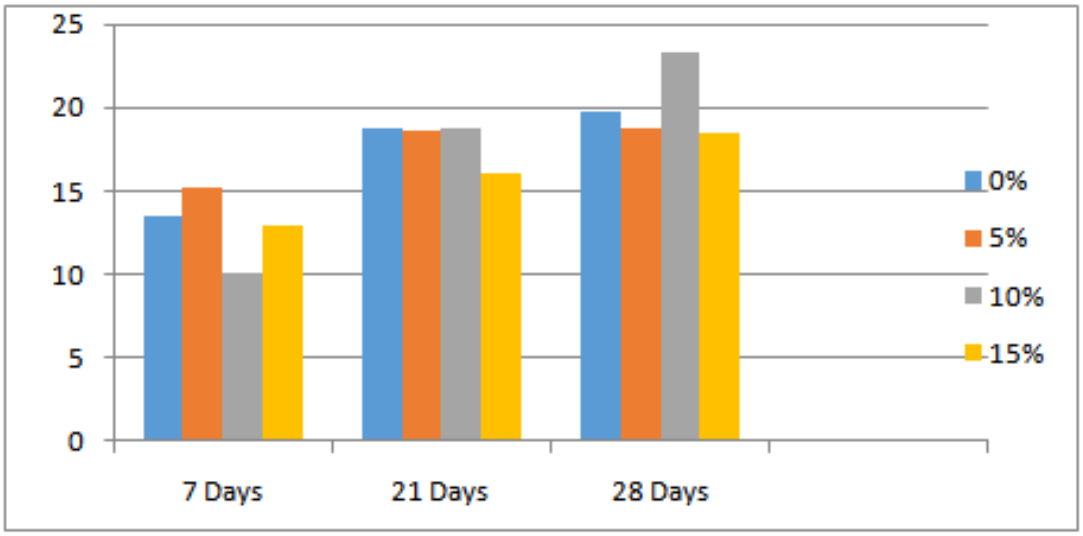


Table 7 Compressive strength result for M20 grade concrete

Water to cement ratio	Replacement percentage	Compressive strength (N/mm²)		
		7 days	21 days	28 days
0.55	0 %	13.5	18.8	19.8
	5 %	15.15	18.54	18.82
	10 %	10.15	18.76	23.33
	15 %	12.89	16.11	18.45

Column Graph 2 Compressive strength result for M20 grade concrete



VII. Conclusions

- Wood ash at replacement percentage up to 5% to 10% of the weight of cement can be successfully used as additive in place of cement to produce structure grade concrete.
- Slump of concrete is affected by replacement with wood ash.
- Replacement by wood ash increases water absorption capacity.
- Decrease in strength of concrete is mainly due to higher porosity and higher water demand on use of wood ash in concrete.
- Before the application of wood ash in concrete, it is important to analyse it due its different combustion temperature and technology and type of wood.
- Wood ash chemical characteristics differ with species of wood but chiefly contain lime and silica.

References

[1]. Campbell AG. Recycling and disposing of wood ash. Tappi J1990;73(9):141–3.
[2]. Etiegni L, Campbell AG. Physical and chemical characteristics of wood ash. Bioresour Technol 1991;37(2):173–8.
[3]. Duchsene J, Berubet MA. Effect of supplementary cementing material on the composition of cement hydration products. AdvCem Based Mater 1995;2:43–52.
[4]. Cortes C, Vapnik V. Support vector networks. Mach Learn1995;20:273–97.
[5]. Lee IM, Lee JH. Prediction of pile bearing capacity using artificial neural network. Comput Geotechnics 1996;18(3):189–200.
[6]. Obernberger I, Biedermann F, Widmann W, Riedel R.Concentration of inorganic elements in biomass fuels and recovery in different ash fractions. Biomass Bioenergy 1997;12:211–24.
[7]. Smola AJ, Scholkopf B. A tutorial on support vector regression. Neuro COLT 2 Technical Report Series. Nc2-Tr-1998-030; 1998.
[8]. Haykin S. Neural networks: a comprehensive foundation. NewJersey: Prentice Hall Inc.; 1999.
[9]. Freitas ND, Milo M, Clarkson P. Sequential Support Vector machine. In: Proceedings of 1999 IEEE signal processing society workshop; 1999. p. 31–40.
[10]. Elinwa AU, Mahmood YA. Ash from timber waste as cement replacement material. Cem Concr Compos 2002;24:219–22.
[11]. Udoeyo FF, Dashibil PU. Sawdust ash as concrete material. JMater Civ Eng 2002;14(2):173–6.
[12]. Loo SV, Koppejan J. Handbook of biomass combustion and cofiring.The Netherlands: Twente University Press; 2003.
[13]. Cao LJ, Tay FEH. Support vector machine with adaptive parameters in financial time series forecasting. IEEE T NeuralNetwor 2003;14(6):1506–18.
[14]. Naik TR, Kraus RN, Siddique R. CLSM containing mixture of coal ash and a new pozzoloanic material. Aci Mater J 2003;100(3):208–15.
[15]. Lin KL. The influence of municipal solid waste incinerator flyash slag blended in cement pastes. Cem Concr Res 2005;35:979–86.
[16]. Udoeyo FF, Inyang H, Young DT, Oparadu EE. Potential of wood ash waste as an additive in concrete. J Mater Civ Eng2006;18(4):605–11.
[17]. Abdullahi M. Characteristics of wood ash/OPC concrete. Leonardo 2006;8:9–16.
[18]. Malek B, Iqbal M, Ibrahim A. Use of selected waste materials inconcrete mixes. Waste Manage 2007;27:1870–6.
[19]. Monteiro MA, Pereira F, Ferreira VM, Doondi M, LabrinchaJA. Light weight aggregate based industrial wastes. Ind Ceram2007;25:71–7.
[20]. Yin C, La Rosendahl, Kaer SK. Grate firing of biomass for heat and power production. Prog Energy Combust 2008;34:725–54.
[21]. Rajamma R, Ball RJ, Luis AC, Tarelho, Allen GC, LabrinchaJA, et al. Characteristics and use of biomass fly ash in cement based materials. J Hazard Mater 2009;172:1049–60.
[22]. Chee Ban Cheah, Ramli M. Mechanical strength. Durability and drying shrinkage of structural mortar containing HCWA as partial replacement of cement. Constr Build Mater 2012;30:320–9.
[23]. Siddique R. Utilization of wood ash in concrete manufacturing. Resour Conserv Recy 2012;67:27–33.
[24]. S. BARATHAN*1 and B. GOBINATH2, volume 2,10 October 2013
[25]. Amrutha Sebastian, Anju SambathManapurath, Devika Balachandran, Dona Maria Sebastian, Dona Philipm, IJSCTE, Volume 2 | Issue 11 | May 2016
[26]. AnamAyoob K P,Hariprasad K J, Dr. Chandrashekhar A, Mithuna C A, (ICETSE–May 2017)
[27]. J.O. AKINYELE, A.A. ADEKUNLE, O. OGUNDAINI, 4 November, 2016
[28]. Akeem Ayinde Raheem, Olumide A. Adenuga, Received 27 December 2012; Revised 27 February 2013; Accepted 30 March 2013
[29]. S. Chowdhury, A. Maniar, O.M. Suganya, Received 5 May 2014, Received in revised form 1 August 2014, Accepted 18 August 2014
[30]. Swaptik Chowdhury, Mihir Mishra, Om Suganya, Received 3 June 2014; accepted 8 November 2014
[31]. Maria da Luz Garcia, Joana Sousa-Coutinho, Received 18 November 2011, Received in revised form 9 November 2012, Accepted 22 November 2012
[32]. Cheah Chee Ban, MahyuddinRamli, Received 7 September 2010, Received in revised form 3 February 2011, Accepted 10 February 2011