Utilization of Mesquite Wood Ash in Construction Industry

Krubha Shree. C[1] Pavithra. B[2] Shebaani. G. V[3] Yashika. A. K[4] Molykuty. M. V[5]
[1,2,3,4]Student [5]Professor
[1,2,3,4,5]Sri Sai Ram Engineering College, Chennai, India

Abstract— The construction industry is one of the bedrocks of our economy which has made impressive progress since reinforced concrete was introduced as a structural material. In today's world the main emphasis is on green and sustainable development. Cement industry is one of the major contributors to pollution by releasing carbon-di-oxide. Mesquite plant (locally known as karuvelam maram) whose binomial name is Prosopis juliflora provides approximately 75% of fuel wood needs of rural people in arid and semi-arid regions of India. It is fast growing, nitrogen-fixing and tolerant to arid conditions & saline soils. It has spread over the greater part of north-west, central, west and south India there by becoming an aggressive invader species. It replaces native vegetation and takes over several acres of land. But its major disadvantage is that with deep penetrating roots, it draws water from deeper layers which lower the ground water table. To overcome this problem, the removal of the plant has become indispensable which is done by uprooting and is then burnt. The construction industry is one of the areas where the safe use of this waste ash (mesquite ash) is possible. So, by partially replacing cement with ash of mesquite, it can serve the demands of construction industry and at the same time save the scarcity of water resources. This project involves the study of performance of concrete having mesquite ash partially replaced with cement. M25 grade of concrete is selected and IS method is used for mix design. The replacement of cement is done in various proportions such as 5%, 7.5%, 10%. The strength characteristics of concrete after 7 and 28 days of curing are studied and found to give better performance compared to conventional mix with 7.5% replacement showing optimal performance.

Key words: Mesquite Wood Ash, Prosopis Juliflora, Wood Ash, Construction Industry, Green and Sustainable Development, Concrete Mix

I. INTRODUCTION

Prosopis juliflora is used as a fuel in biomass waste power plants. The wood ash is a waste material obtained from these power plants. Though this plant helps to tackle the energy poverty of India, it has got some drawbacks. This plant turns the land dry by sucking too much of ground water[1,2]. Thus the large scaled growth and spread of this species is one of the major concerns of any municipality. Recently there is even a court order issued in Tamilnadu (Southern state of India) to deracinate/uproot most of these trees due to drought situation prevailing in Tamilnadu (In August 2015, the Madurai bench of the Madras High Court also asked the state government to form a committee including the Chief Secretary, Forest Department and Public Works Department secretaries, to structure a plan for the eradication of Karuvelam trees grown on river beds and other areas in the southern districts of Tamil Nadu) **[**3].Though these trees are cut, they have the tendency to grow back faster to its original size within 1-2 years. The permanent solution to overcome this problem is by uprooting the mesquite plant and burning it. Investigations are on for finding innovative methods for uprooting the plant. One possible solution lies in using this waste ash for economical uses is in construction industry as substitute for binding material in concrete. This work is carried out to investigate the suitability of this wood ash as a substitute for cement by designing M25 concrete mix and conducting strength tests. The use of wood ash as partial cement replacement in concrete reduces the requirement of cement to a large extent and subsequently it reduces the related pollution. Thus incorporating usage of wood ash as replacement for cement in concrete is beneficial for the environment leading to sustainable development along with saving the precious water resources.

S. Barathan et al [4] evaluated the suitability of replacement of cement with wood ash. They have analysed the hydration mechanism and found that wood ash exhibits pozzolanic properties. Hence cement can be replaced with wood ash. From their study they found that 20% would be optimum replacement.

Zhifu Yang et al [5] investigated the use of wood ash to partially replace cement or sand in conventional concrete, roller compacted concrete (RCC), and flowable fill. The main focus was to determine how the wood ash addition affected the main fresh and hardened properties of these materials. It was found that the wood ash could be successfully incorporated into the conventional concrete as it not only accelerated the setting, but also improved the early and the 28-day compressive strength of concrete that contained the blast furnace slag. It was also observed that the wood ash could be positively added into RCC to facilitate the compaction and reduce the risk of segregation.

Amrutha Sebastian et al [6] reported that by reducing the demand of cement, natural reserves of limestone can be preserved, energy can be saved and pollution due to CO2 can be reduced. Utilization of wood ash (WA)as a partial substitution for cement is one of the promising method to increase the strength and thermal insulation for cement blocks. The strength parameters (compressive strength, split tensile strength and flexural strength) of concrete with blended WA cement are evaluated.

Raghu. K et al [7] conducted an experimental investigation on partial replacement of cement by mesquite (Prosopis Juliflora(PJ)) wood ash in M30 concrete and found that 15% replacement is optimum.

K.V.Boobala Krishnan et al [8] conducted an experimental study on the behaviour and strength of concrete by replacing cement with wood ash and fine aggregate with wood powder. Cement is partially replaced by 5% of wood ash and fine aggregate is partially replaced by 5%,10% and 15% of wood powder for the study.

II. MATERIALS AND METHODS

A. Cement

Ordinary Portland Cement (OPC) of 53 grade was selected and tested conforming to IS:12269-2013 **[**9]

B. Coarse aggregate and fine aggregate

Coarse and fine aggregate are selected and tested based on IS:383-1970 [10] and found that they conform to the requirements.

C. Mesquite Ash

Mesquite tree is located, their branches were cut, dried under sun for five days, fired in a furnace, ground and sieved to obtain the ash. The tested physical properties of wood ash is given in table (1). The physical properties of wood ash and cement are found to be similar, which confirms the fact that cement can be replaced with wood ash.

D. Water

Water conforming to IS 456-2005**,[**11] is added based at a water cement ratio of 0.4.

E. Mix design

Concrete mix M25 is designed based on the guide lines of IS10262-2009 [12**]**and the material proportion, cement : fine aggregate : coarse aggregate was designed as 1:1.373:2.257. Concrete mix is prepared based on the design proportion using standard procedure. Cement is replaced with wood ash at the rate of 5%, 7.5%, and 10% and tests are conducted on fresh & hardened concrete**[**13],[14],[5],[16].

III. RESULTS AND DISCUSSIONS

The slump obtained was found to be within the permissible limits. Average compressive strength of concrete cube after 7 days and 28 days are shown in figures (3.1), (3.2) and fig.(3.3) shows their comparison. Result of split tensile strength tests done on standard cylinder is shown in figure (3.4). Compressive strength of concrete with all ash proportions are found to be better than that of control concrete. A reasonably good tensile strength is also obtained. The 7.5% replaced P. juliflora concrete showed optimal performance. This optimal mix gave 43.2% increase in terms of compressive strength and 32.3% increase in terms of tensile strength compared to controlled concrete(CC)test results. This confirms that mosquito wood ash can be replaced with cement and can be used in construction activities. The measured slump values are given in table (2). Based on the obtained slump value, the mix is classified as medium workability mix which can be used for normal reinforced concrete works like beams, columns, walls with vibration.

physical properties	values
Specific gravity	2.92
Particles retained on 90 microns	7.2%

Table 1: Test Results of Mesquite Ash

Mix type	Slump test, cm	
M25	Measured value	Slump value
CC	28.5	1.5
5% PJ	29.2	0.8
7.5% PJ	29.5	0.5
10% PJ	29	1

Table 2: Measured Slump Values

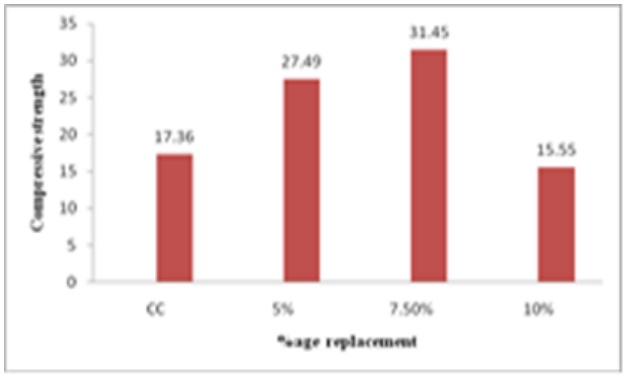

Fig. 1: Average compressive strength in N/mm^2 after 7days curing

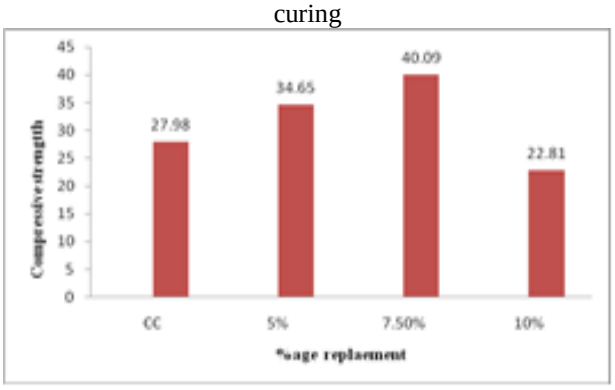

Fig. 2: Average compressive strength in N/mm2 after 28 days curing

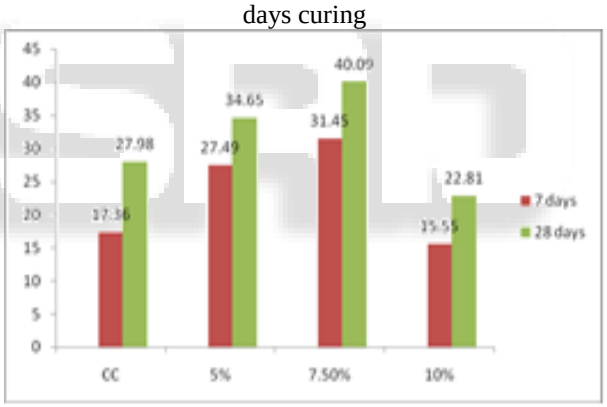

Fig. 3: Comparison of compressive strength test after 7days and 28days curing

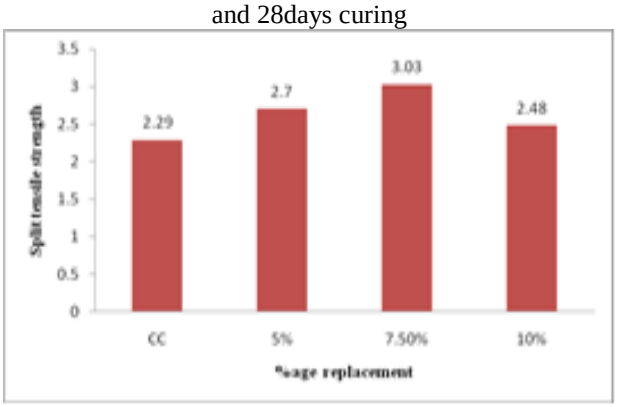

Fig. 4: Average split tensile strength after 28 days curing

IV. CONCLUSION

Cement is replaced with P. juliflora ash at 5 %, 7.5%, 10 % in M25 concrete. The fresh and hardened concrete tests were conducted to study its strength behaviour and compared with

the conventional concrete. The 7.5% replaced P. juliflora concrete showed optimal performance as against 20% obtained in the case of M30 mix.[6]This optimal mix gave 43.2% increase in terms of compressive strength and 32.3% increase in terms of tensile strength compared to control concrete(CC)test results.

The seemai karuvelam maram which is the local name of mesquite plant causes drying up of water bodies in this water starved state. So the government has ordered to uproot thousands of these trees to be burnt and destroyed. Therefore it is suggested that cement can be partially replaced with mesquite ash not only for its better strength but for sustainability aspect as well.

REFERENCES

[1] Herrera Arreola, G., M. S.Vasquez- Murrieta, C. Cruz Mondragon, O. Van Cleemput & Dendooven,"Nitrous oxide emissions from soils of the semi-arid highlands of Durango, Mexico: a laboratory study", Arid Land Research and Management vol. 22, pp.179–194,2008.
[2] Pratiksha Patnaik, Tasneem abbasi & s. A. Abbasi, "Prosopis (Prosopis juliflora): blessing and bane", Tropical Ecology 58(3): 455–483,2017.
[3] http://vinsonias.com/DynImg/4a229942-ead2-49bb-b27b94a6f898c5a5.pdf,(2017)
[4] Barathan.S and. Gobinath. B, "Evaluation of wood ash as a partial replacement to cement", International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 10, pp.2009-2013.
[5] Zhifu Yang, Jon Huddleston, Heather Brown,",Effects of wood ash on properties of concrete and flowable fill"Journal of Materials Science and Chemical E ngineering, vol. 4, pp. 101-114, 2016.
[6] Amrutha Sebastian, Anju Sambath Manapurath,Devika Balachandran, Dona Maria Sebastian, and Dona Philip,"Partial Replacement of Cement with Wood Ash", International Journal of Science Technology & Engineering,Volume 2, Issue 11,pp. 666-670,2016.
[7] Raghu K Sharath V. T Naveen Y Bharath Kumar and Yogesha B.S, "Experimental Investigation on Partial Replacement of Cement by Mesquite (Prosopis Juliflora) Wood Ash in Concrete", International Journal for Scientific Research & Development, Vol. 5, Issue 06, pp 284-287,2017.
[8] Boobala Krishnan, K.V., Vignesh, N., Kulandhai Antony, S., Mandira Adhikari, C. and Paguthariv u, N, "Experimental investigation on partial replacement of cement by wood ash and fine aggregate by wood powder" South Asian Journal of Engineering and Technology, Vol.3, No.7,pp 46-52,2017.
[9] IS:12269-2013.,"IndianStandard ordinary portland cement, 53 Grade — specification", b u r e a u of Ind ian s t a n d a r d s manak bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002, 2013
[10] IS:383-1970, "Indian Standard Specification for coarse and fine aggregates from natural sources for concrete," Bureau of Indian standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi,1970.
[11] IS: 456-2000, "Plain and reinforced concrete - code of practice", Bureau of Indian standards Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi,2000.
[12] IS: 1199- 195, "Methods of sampling and analysis of concrete", Bureau of Indian standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi,1991.
[13] IS: 1199- 195, "Methods of sampling and analysis of concrete", Bureau of Indian standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi,1991.
[14] IS: 516-1959, "Indian Standard methods of tests for strength of concrete", Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi,1959.
[15] IS: 5816 (1999), "Indian Standard Splitting tensile strength of concrete - method of test", Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi,1999
[16] M.S.Shetty, "Concrete Technology",S. Chand & company Ltd.,Ram Nagar, New Delhi – 110.,1987.

