

Biomedical Waste Ash in Concrete: An Experimental Investigation

Amit Kumar Singh¹, Vikas Srivastav², Udit Kumar³

P.G Students, Department of Civil Engg., Sam Higginbottom Institute of Agriculture, Technology and Science,
Allahabad, India^{1,3}

Associate Professor and Associate Head, Department of Civil Engg., Sam Higginbottom Institute Of Agriculture
Technology and Science, Allahabad, India²

ABSTRACT: Biomedical waste generated from hospitals, medical research activities and the other medical sources are causing a major problem in India. The waste generated affects adversely environment as well as the human world. Some studies revealed scope of utilization of biomedical waste ash as partial replacement of cement in concrete. This paper describes the result of an experimental investigation carried out to study the effect of partial replacement of cement with biomedical waste ash.

I. INTRODUCTION

Biomedical waste ash produced from various medical resources such as hospitals, medical institutes and research centers caused great threat to the environment. Biomedical waste can be classified as hazardous and non hazardous. As per ministry of environment and forest of India, total biomedical waste produced is 4,05,702 kg per day, about 72% of the waste generated is treated where as the rest is left out untreated. Most common process for treatment of biomedical waste is incinerating in this process biomedical waste is incinerated in incinerators specifically made for biomedical waste. The ash produced in these incinerators are the disposal as landfills. For the landfills large area of land is required. This requirement of land can be reduced by partial replacement of cement in concrete.

II. REVIEW OF LITERATURE

(Genazzini *et al.*, 2003) presented the scope of incorporating hospital waste ashes in Portland cement-based materials. Al-Mutairi *et al.*, (2004) determined the compressive strength of mixtures made with bottom and fly hospital ash in order to evaluate the effectiveness of reusing hospital incinerator ash. Results showed that when 5% micro silica and fly ash were incorporated, the compressive strength of cubes was further increased.. Aubert *et al.*, (2004) evaluated the use of biomedical waste ash on the compressive strength and the durability of hardened concrete and suggest the use of waste in concrete constitutes a potential means of adding value. (Genazzini *et al.*, 2005) The new cement–ash composite systems have been tested for future applications in building materials. The additions of hospital ash in cement matrices to be potentially used as construction elements. This involved the assessment of the effect of the additions on the physio mechanical properties of the building materials. Anastasiadou *et al.*, (2011) evaluated the mechanical properties of the medical waste incineration bottom ash using different amounts of ordinary Portland cement (OPC) as a binder. Result showed that strength decreased as the percentage of cement loading was reduced. Al-Rawas *et al.*, (2005) investigated the use of incinerator ash as a replacement for sand and cement in cement mortars. The cement, sand and water mixing proportions were 1:3:0.7 respectively. Results showed that incinerator ash caused a reduction in slump values when it was used as a replacement for sand while an opposite trend was observed when it was used as a replacement for cement. Filipponi *et al.*, (2003) prepared the different mixes by blending hospital waste incinerator bottom ash with ordinary Portland cement in different proportions and at different water dosages. Results at curing times longer than 28 days and for waste dosages higher than 50% suggested that bottom ash exhibited weak pozzolanic property. Anastasiadou *et al.*, (2011) studied the cement based stabilization/solidification of fly and bottom ash generated from incinerated hospital

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waste to reduce the leachability of the heavy metals present in these materials. . Azni *et al.*, 2005) In Germany 50% of the ash produced from incinerated waste is used for the manufacturing of sound insulation walls at National roads, as well as, sub layers on the streets. 60% of the bottom ash is used for the construction of asphalt and as a sub layer of roads in Netherlands

III. MATERIALS AND METHODS

In the present investigation and experimental program was carried out to investigate the suitability of use of biomedical waste ash as partial replacement of cement in concrete and effect of replacement of cement of biomedical waste ash on workability of concrete in general and on compressive strength in particular.

(i) CEMENT

In the present study, Portland pozzolana cement (fly ash based) of single lot. The cement was used confirming to IS 1489(part I):1991 specification. The physical properties of cement were specific gravity 3.1, mean grain size (μm) 22.5, specific area (cm^2/gm) 3250.

(ii) FINE AGGREGATE

Fine aggregate used in this investigation was the natural river sand passing completely through 4.75 mm aperture size sieve and confirming to the gradation zone II as per IS:383-1970 specification. Its fineness modulus and specific gravity were 2.75 and 2.3 respectively.

(iii) COARSE AGGREGATE

Owing to the local unavailability of 20 mm Nominal size Graded Aggregate as per IS:383-1970 specification, A Combined grading of the two individual 20 mm and 10 mm Nominal size coarse aggregate (20mm CA & 10mm CA) grading was used with the ratio of these coarse aggregates as 60:40 respectively.

(iv) BIOMEDICAL WASTE ASH

Biomedical waste ash which was used throughout this experiment was collected from Naini, Allahabad incinerator plant which was grey in colour and lighter in weight and coarser than cement.

(v) SUPER PLASTICIZER (WATER REDUCER)

Sulphonated naphthalene formaldehyde (SNF) based Superplasticizer (KEM SUPLAST 101 S)of Chembond chemicals was used which conforms to IS:9103-1999 specifications. It was in liquid form compatible with the used Cement, brown in colour having specific gravity 1.2 and It showed good deflocculation and dispersion with cement particles to fluidly the concrete mix results with enhancement in workability of concrete mix.

(vi) CONCRETE

The concrete mix design is done in accordance with IS 10262(2009). The cement content used in the mix design is taken as 380 kg/m^3 which satisfies minimum requirement of 300 kg/m^3 in order to avoid the balling affect.

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(vii) WORKABILITY AS SLUMP TEST

The present study was carried out to study of workability and density of fresh concrete and compressive strength of hardened concrete after 7 days and 28 days. The study was carried out for referral conventional concrete and concrete with biomedical waste ash as partial replacement of cement.

IV. RESULTS AND DISCUSSION

The result of experimental program carried out to determine workability, density and compressive strength are discussed here in after.

(i) WORKABILITY

Workability is the property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product.

Workability which was measured by slump test of referral as well as concrete made using biomedical waste ash as partial replacement of cement is shown in figure for visual observation. It is evident from figure 1 that workability of concrete decreased with increase in replacement level. Reason of this trend may be that being lighter than cement. Biomedical waste ash occupies more volume than cement on equal weight basis resulting which more water is needed for lubrication.

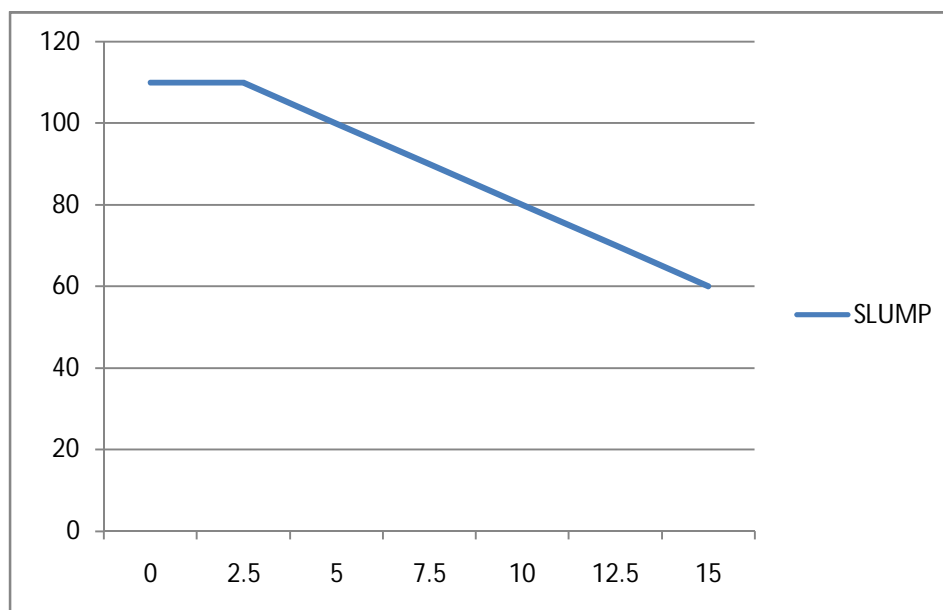


Figure 1 Workability Of Concrete at Different Replacement Level of Cement

(ii) DENSITY

The density of concrete is a measurement of concrete's solidity. The process of mixing concrete can be modified to form a higher or lower density of concrete end product.

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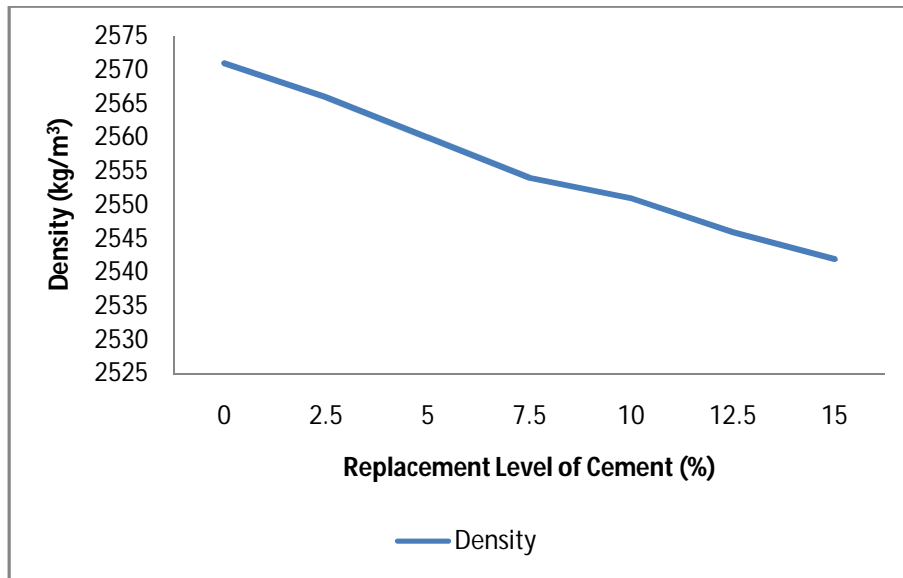


Figure 2 Density Of Concrete at Different Replacement Level of Cement

It is evident from figure 2 that density of concrete that workability of concrete decreased with increase in replacement level which may be due to biomedical waste ash being lighter than cement.

(iii) COMPRESSIVE STRENGTH

From this experiment it is clearly observed that the Compressive strength of concrete made by using biomedical waste ash with replacement of cement by weight at 7 days and 28 days are increased with replacement level up to 5 and at more than 5% compressive strength of concrete made by using biomedical waste ash is approximate equal to referral concrete upto 10% as shown in figure 3 and table 1.

Table 1– Variation of compressive strength with biomedical waste ash % .

Cube Concrete Designation	Replacement Level of cement with biomedical waste ash (%)	7 Days Average Compressive Strength (MPa)	28 Days Average Compressive Strength (MPa)
C1	0	21.39	34.67
C2	2.5	21.42	35.40
C3	5	21.51	36.44
C4	7.5	20.54	35.62
C5	10	21.09	33.62
C6	12.5	19.58	30.07
C7	15	18.69	29.18

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Table 1 shows 7 days & 28 days compressive strength achieved by concrete with different replacement level of cement with biomedical waste ash. This experimental study shows that 5% is the optimum level for replacement of cement with biomedical waste ash.

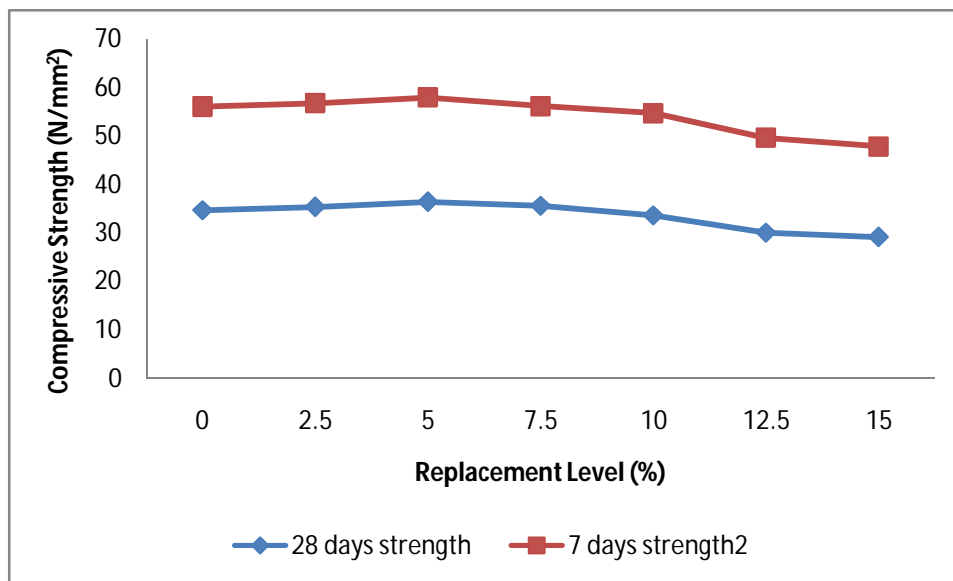


figure 3 variation of compressive strength with replacement level of cement

Figure 3 is the graphical representation of table 1 showing optimum level for replacement of cement with biomedical waste ash. It is evident from the figure that the optimum level is 5%.

V. CONCLUSION

On the basis of results obtained during the experimental investigation, following conclusions are drawn

- (i) It is observed that workability decreased with increase in replacement level at constant dose (0.6%) of superplasticizer.
- (ii) It is observed that density of fresh concrete decreased marginally with increase in replacement level.
- (iii) Compressive strength of concrete made using biomedical waste ash is more than that of conventional concrete upto 7.5% replacement level.
- (iv) Upto 10% replacement level compressive strength of concrete with biomedical waste ash is comparable to the conventional concrete.

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