International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 03
March 2017

Effect on Compressive Strength of Concrete with Partial Replacement of Cement by Municipal Solid Waste Incineratoror Ash

Amit Kumar Gupta[1], Dr. Rajeev Chandak[2]

[1]M.E.-scholar (Structural Engineering), Department of civil engineering, Jabalpur engineering college, Jabalpur, Madhya Pradesh, India.

[2]Head of the department, Department of Civil Engineering, Jabalpur engineering College, Jabalpur, Madhya Pradesh, India.

ABSTRACT: *This paper presents the use of Municipal Solid Waste Incinerator Bottom Ash as partial replacement of cement in concrete. The municipal solid waste incinerator ash is a waste material that is taken from WTE plant (waste to energy), Jabalpur, M.P. The aim of the study is to investigate the feasibility of Incinerator bottom ash as a partial replacement of cement in concrete. The compressive strength of newly form concrete with 10% incinerator ash (WBA) replacement by weight of Cement is found to be an optimum usage in concrete in order to get a favourable strength and good strength development pattern over the increment ages.*

Keywords: *Incinerator ash,* Municipal Solid Waste Incinerator Bottom Ash*, MSWI, Cement Replacement, Concrete*

INTRODUCTION:

Concrete is the homogeneous mixture of cement, sand, coarse aggregate and water. The cost of making concrete by conventional methods are increasing day by day due to the diminishing of the natural resources used in making concrete as it for cement or sand. Therefore the properties of other materials like fly ash, blast furnace slag, silica fumes are being examined for the partial replacement of cement in concrete.

Municipal solid waste ash is also one such material which is the by-product produced from the combustion of municipal solid waste and can be used to replace cement and sand in the concrete partially. The amount and properties of municipal solid waste ash vary from plant to plant depending upon the type of incinerator and air pollution control technology and waste. A number of studies have been carried out to evaluate the feasibility of using MSWI bottom ash as a replacement for aggregates in the production of concrete.

Incineration ash is one of the major by-products of the mass-burn industry. These ashes can be potentially used in concrete, road pavements, embankment, ceramics, and glass. This paper discusses the possibility of disposing of the incinerator ash by adding it to concrete. Increase in strength can be observed by replacing 10% of municipal solid waste incinerator ash with cement.

MATERIALS :

Concrete may be defined as a mixture of water, cement or binder, sand and aggregate, where water and cement or binder from the paste and the aggregate forms the inert filler. In absolute volume terms, the aggregate volume amounts to 60-80% of the volume of concrete and influences the properties of concrete, its mix proportion and its costs. In this research, ordinary Portland cement (OPC), granite and MSWI bottom ash are used as raw materials.

Cement: Ordinary Portland Cement (43 Grades) which is available in market is used. Ordinary Portland Cement (OPC) was used as binding material to solidify and stabilize the hazardous components in MSWI bottom ash.

Fine Aggregate: The natural river sand available in local market which passes through 4.75mm sieve with specific gravity of 2.65 (Conforming to Zone II) has been used.

Coarse Aggregate: Crushed granite conforming to IS 383:1987 and having specific gravity 2.80 has been used.

Water: Water is an important ingredient of concrete as it actively participated in the chemical reaction with cement, clean portable water which is available in college campus is used.

MSWI bottom ash: Bottom ash is basically a heterogeneous mixture of large pieces of incombustible materials and residual pieces of combustible material from incineration. The ash is a light weight material from the specific gravity compared to natural sand and gravel. It is a pervious material quite comparable to sand. It is well graded and compactable material. It is a fairly stable and durable material comparable to natural sand as obtained from the shear strength parameters.

The subject of study was MSWI ash (Figure-1) collected in the month of September 2016 in a modern incineration facility at WTE Plant, Essel MSW Pvt Ltd. Jabalpur. The incinerator ash has been sieved and metal pieces were removed manually. The generated ash from incinerator involves a wide range of particles size; only the fraction 0-4 mm was used in the present work. The ash was dried before experiments. The content of major components (in form of oxides) which are found in MSWI ash is presented in Table-1.

Table-1

Compound	Percentage in MSWI ash	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	-

Figure - 1

METHODOLOGY:

Municipal solid waste incineration ash can be collected from WTE (waste to energy) plant, Jabalpur, M.P. The ash is then sieved and the metal particles are separated manually. Various Physical and Chemical tests are conducted on the ash to test the suitability and composition of the ash. Mix design of M20 is chosen as standard and design for the same. We made a number of batch of sample cubes, each batch has certain number of sample cubes which have certain amount of MSWI ash contents. We named each batch after the percentage of cement replaced by MSWI bottom ash. For example, the batch in which 5% of cement is replaced by ash is named as Five Percent batch. We made 0% batch, 5% batch, 10% batch, 15% batch, 20% batch, 25% batch and 30% batch. The cubes of each batch are tested at the seventh and 28^{th} day. The compressive strength of the cubes in each batch is averaged out and noted down in a table.

COMPRESSIVE TEST:

There are many test applied to the concrete, but compressive strength is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm are used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen.

These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

RESULTS AND DISCUSSION:

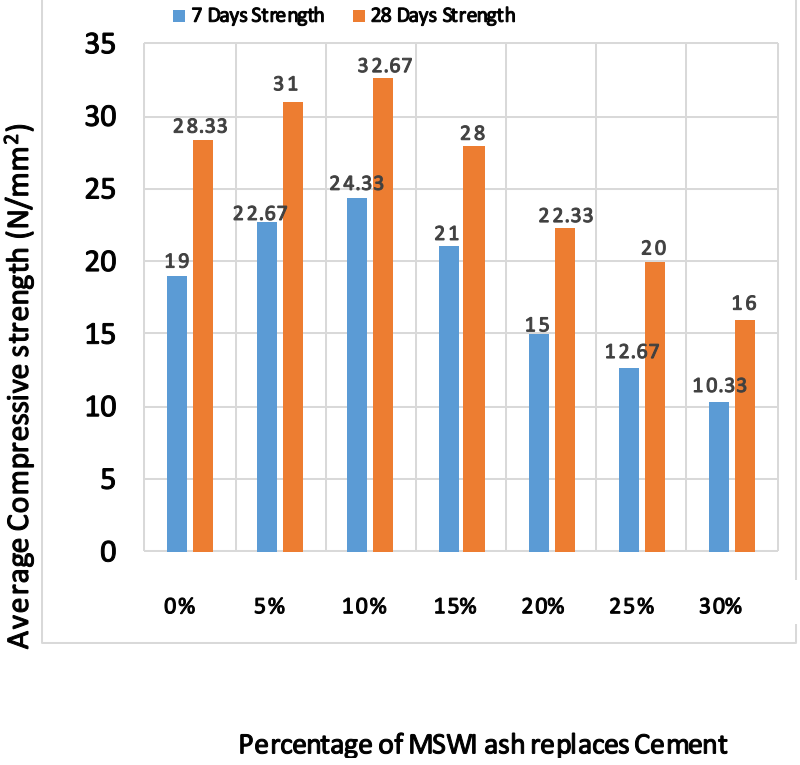
The compressive strength first increases with increase in percent of MSWI ash content upto 10% but start decreasing sharply on further adding ash content. The results of compressive strength cubes for 7 days curing and 28 days curing are given as in Table-2 and their corresponding graphs are shown in Figure-2.

TABLE-2

S.No.	Designation of the mix	Average compressive strength at 7 days (N/mm^2)	Average compressive strength at 28 days (N/mm^2)
1.	0% batch	19	28.33
2.	5% batch	22.67	31
3.	10% batch	24.33	32.67
4.	15% batch	21	28
5.	20% batch	15	22.33
6.	25% batch	12.67	20
7.	30% batch	10.33	16

FIGURE-2

Graphical Representation of Compressive Strength



CONCLUSION:

The main mechanism affecting the concrete properties made with MSWI bottom ash as a partial replacement of cement is the reaction of aluminium with the cement paste to form aluminium hydroxide, aluminates and hydrogen. If moisture is present, the reaction is able to proceed long after hardening of the concrete. If the reaction occurs in the near surface region in conjunction with a high reaction rate, spalling will take place.

The untreated MSWI bottom ash was used as partial cement replacement in concrete after sieving. This MSWI ash, by its chemical composition, does not fulfill the standard requirements on concrete admixtures but the prepared concrete had acceptable properties. The 28-days compressive strength of material with 10 % cement replacement was comparable with the reference concrete. The prepared concrete contained relatively low content of MSWI ash. Higher ash dosage without any accompanied loss of concrete properties would be possible only when the MSWI bottom ash should be given proper chemical treatment to avoid hydrogen gas evolution when used in concrete, which can eventually lead to a significant reduction of the concrete strength, but in such case there would arise additional costs suppressing the MSWI ashes utilization attractiveness for building industry.

However, the compressive strength test shows that the 10% batch has the highest compressive strength. As we move to the higher percent batch (for e.g. Fifteen percent batch, Twenty Percent batch etc.) the compressive strength keeps on decreasing. The compressive test is conducted at the 7^{th} days and the 28^{th} day after the cubes were moulded. Thus 10% percent of cement is found to be optimum to be replaced by municipal solid waste incineration ash.

REFERENCE:

1. A. Ananthi and J. Karthikeyan. A review on the effect of industrial waste in concrete. The Indian Concrete Journal November 2015

2. M.R. Lavanya, M. Ibrahim Bathusha and B. Sugumaran. A review on use of municipal solid waste ash in concrete. The Indian Concrete Journal December 2014

3. Rubner, K., Haamkens, F., & Linde, O. (2008). Use of Municipal Solid Waste Incinerator Bottom Ash as Aggregate in Concrete. Quarterly Journal of Engineering Geology and Hydrogeology, 41(4), 459-464.

4. K. S. Rebeiz, and K. L. Mielich. Construction Use Of Municipal-Solid-Waste Ash. American Society of Civil Engineers, 21/05/2015.

5. Hashim Mohammed Alhassan, Ahmed Musa Tanko, Characterization of Solid Waste Incinerator Bottom Ash and the Potential for its Use. International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue 4, July-August 2012, Page no.516-522

6. S.Deepak, Dr V.Ramesh. Properties of municipal solid waste incinerator ash in concrete. International Journal Of Engineering And

Computer Science ISSN:2319-7242 Volume 4 Issue 6 June 2015, Page No. 12322-12326

7. Charles H. K. Lam, Alvin W. M. Ip. John Patrick Barford and Gordon McKay. Use of incineration MSWI ash: A review. Department of Chemical Engineering, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong.

8. Martin Keppert, Zbysek Pavlik, Robert Cernyand Pavel Reiterman, Properties of concrete with municipal solid waste incinerator bottom ash, Department of Materials Engineering and Chemistry, Faculty of Civil Engineering, Czech Technical University in Prague, Czech Republic;

9. Jinyoung Kim, Boo Hyun Nam, Baig A. Al Muhit ,Kazi M. Tasneem, Jinwoo An. Effect of chemical treatment of MSWI bottom ash for its use in concrete. Magazine of Concrete Research Volume 67 Issue-4. Institution of Civil Engineers 2014.