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Properties of Municipal Solid Waste Incinerator Ash in Concrete

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Abstract: - **The Municipal Solid Waste Incineration (MSWI) residues are a worldwide studied topic over the last decades. So that to utilize the municipal solid waste is the one of the possibilities is to use MSWI ashes in concrete production, as it is done the bottom ash features the most convenient composition in concrete, and it is available in highest amounts among the MSWI ashes. The bottom ash was used as partial replacement of cement in concrete strength has to find, if the prepared concrete will get sufficient durability or not. The behavior of concrete with the bottom ash is differed from the control material due to presence of sulfates and chlorides in bottom ash.**

Keywords: **municipal solid waste incineration; bottom ash; concrete; compressive strength**

1. INTRODUCTION

Incinerator ash is the ash that is left over after waste is burnt in an incinerator. Municipal energy from waste plants that use incineration burn a wide range of municipal wastes and therefore the term 'ash' is slightly misleading because it is not all powdery but contains glass, brick, rubble, sand, grit, metal, stone, concrete, ceramics and fused clinker as well as combusted products such as ash and slag.

The appropriate utilization of Municipal Solid Waste Incineration (MSWI) residues is a worldwide studied topic over the last decades. One of the possibilities is to use MSWI ashes in concrete production, as it is done with coal combustion products. The bottom ash features the most convenient composition for this purpose, and it is available in highest amounts among the MSWI ashes. Untreated bottom ash was used as partial replacement of sand in concrete; strength was not negatively affected up to 10 % replacement, the prepared concrete had sufficient durability. The longer-time behavior of concrete with bottom ash differed from the control material due to presence of sulfates and chlorides in bottom ash.

Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is generated mainly from residential and commercial complexes. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing.

Waste is a continually growing problem at global and regional as well as at local levels. Solid wastes arise from human and animal activities that are normally discarded as useless or unwanted. In other words, solid wastes may be defined as the organic and inorganic waste materials produced by various activities of the society and which have lost their value to the first user. As the result of rapid increase in production and consumption, urban society rejects and generates solid material regularly which leads to considerable increase in the volume of waste generated from several sources such as, domestic wastes, commercial wastes, institutional wastes and industrial wastes of most diverse categories. Management of solid waste may be defined as that discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations. In its scope, solid waste management includes all administrative, financial, legal, planning, and engineering functions involved in the whole spectrum of solutions to problems of solid wastes thrust upon the community by its inhabitants (Tchobanaglous, G. et al, 1997). Solid wastes have the potential to pollute all the vital components of living environment (i.e., air, land and water) at local and at global levels. The problem is compounded by trends in consumption and production patterns and by continuing urbanization of the world. The problem is more acute in developing nations than in developed nations as the economic growth as well as urbanization is more rapid.

MSW Incinerator ash and environment

Reduce, Reuse, and Recycle – there are often still residual materials left over requiring treatment or disposal. At this point, it is also important to minimize the human health and environmental effects by managing wastes in an environmentally sound manner. In India, collection, diversion (recycling and composting) and disposal operations are the responsibility of municipal governments, while the provinces and territories are responsible for the approval, licensing and monitoring of operations.

Landfills are designed and located in a manner to minimize impacts both to the social and natural environment. To the greatest extent possible, future concerns of landfills are taken into consideration during the design and operation of the landfill.

The history of municipal solid waste (MSW) incineration is linked intimately to the history of landfills and other waste treatment technology. The merits of incineration are inevitably judged in relation to the alternatives available. Since the 1970s, recycling and other prevention measures have changed the context for such judgments. Since the 1990s alternative waste treatment technologies have been maturing and becoming viable.

Incineration is a key process in the treatment of hazardous wastes and clinical wastes. It is often imperative that medical waste be subjected to the high temperatures of incineration to destroy pathogens and toxic contamination it contains.

What is Incinerator Bottom Ash (IBA)?

IBA is the ash that is left over after waste is burnt in an incinerator. Municipal energy from waste plants that use incineration burn a wide range of municipal wastes and therefore the term 'ash' is slightly misleading because it is not all powdery but contains glass, brick, rubble, sand, grit, metal, stone, concrete, ceramics and fused clinker as well as combusted products such as ash and slag.

2. MATERIALS

The materials used in the experiment are:

a. Cement

b. Fine aggregate

c. Coarse aggregate

d. Water

MINERAL ADMIXTURES

The admixtures used in these experiments are:

a. M.S.W incinerator ash

CHEMICAL ADMIXTURES

The chemical admixtures used in this experiment:

a. Super plasticizer-Fosroc (For workability)

3. METHOD OF NEXT INVESTIGATION STEP

A) Collection of burnt MSW Incinerator ash

B) Physical Tests to be conducted on incinerator ash

C) Preparation of mix design for M40 grade

D) Adding of I. Ash from 0, 10, 20, 30, 40% in cement

E) Making number of samples of concrete cubs

F) Testing of cubes is to be done for 7, 28 & 56 days

The following testes are to be conducted on specimens

- Compressive strength
- Flexural strength
- Durability test
- Thermal test

Specific gravity of MSW.I ash

Specific gravity of MSWI.Ash = 2.24

4. Mix Proportions for M40 Grade

Cement = 400 kg/m^3

Water = 160 litre

Fine aggregate = 813.38 kg/m^3

Coarse aggregate = 1099 kg/m^3

Chemical admixture = 0.5 kg/m^3

Water – Cement ratio = 0.40

5. Compression test:

Compression test is the most common test conducted on hardened concrete, partly because it is an easy to perform, and partly because most of the desirable characteristic properties of concrete is related to its compressive strength. The compressive strength of concrete is one of the most important and useful properties of concrete. In most structural applications concrete is employed primarily to resist compressive stresses. In those cases where strength in tension or in shear is of primary importance, the compressive strength is frequently used as a measure of these properties.

Compression test is carried on specimens of cubical in shape. The cube specimen is of the size 150mmX150mmX150mm. The cube moulds were coated with mould oil on their inner surfaces and were placed on Plate. Concrete was poured in to the moulds in three layers each layer being compacted using mechanical vibrator. The top surface was finished using trowel. After 24 hours concrete cubes were de-moulded and the specimens were kept for curing under water.

6. Casting and curing

The Cubes and beam moulds are assembled on the concrete leveled flooring with a paper between the mould and the floor. The inner side of the mould is lubricated properly. Cover blocks of sufficient thickness are placed below the bottom of the case so that the required effective depth is maintained. The materials are mixed in the electronically operated mixer thoroughly to get the uniformity. The concrete is placed in the moulds in two layers and compacted with tamping rod. The moulds are de moulded after 24 hours of casting. After the required period of curing, the specimens are taken out of the curing tank, wiped off the moisture and the surface is made dry.

The physical properties of concrete depend to a large extent on the degree of hydration of the cement and the resultant microstructure of hydrated cement. It is necessary to create conditions of temperature and humidity during a relatively short period immediately after placing and compaction of concrete, favorable to the setting and hardening of concrete. The process of creation of a favorable environment is termed as curing. The cube specimen was kept in water for 28 days and column specimens are kept in water for 28 days of curing before conducting the tests.

Experimental work

The specimens required for compressive strength test (both number of specimens and its size) are cast with established Concrete mix proportion, as per the relevant codal requirement, the details of which are as given below. To study the compressive strength behavior of M40 grade incinerator ash concrete in which cement is partially replaced. The cube specimens of size 150mmx150mmx150mm are prepared. The cubes each tested for 7, 28 & 56 days. Compressive strength of modified concrete is compared with normal concrete.

7. Results and Discussion

- **Compressive Strength**

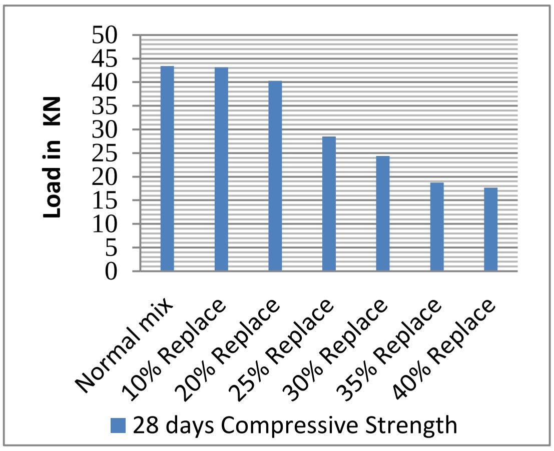

Fig.1 The strength variation is to be shown in graph

After the curing period the test results are carried out for all the specimens and found the optimization where the strength is reducing. The strength is varying in the range of 20 to 25%. The value of M40 is nearer to the 20% replace so that the further value to be fixed to find in between 18, 19, 20 & 21% replacement.

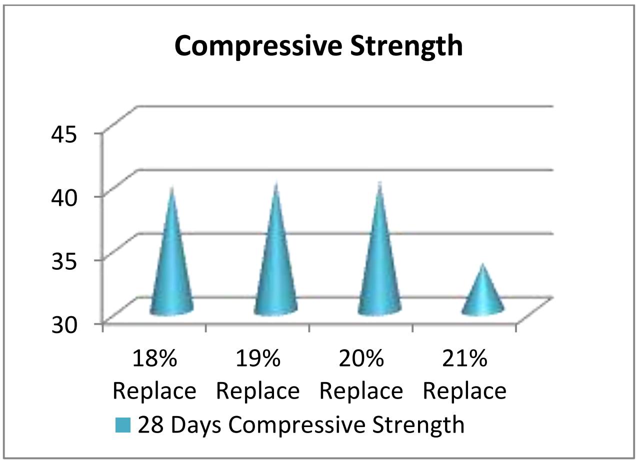

Fig.2 the Graphical representation of compressive strength of concrete cubes after replacing with municipal solid waste incinerator in concrete

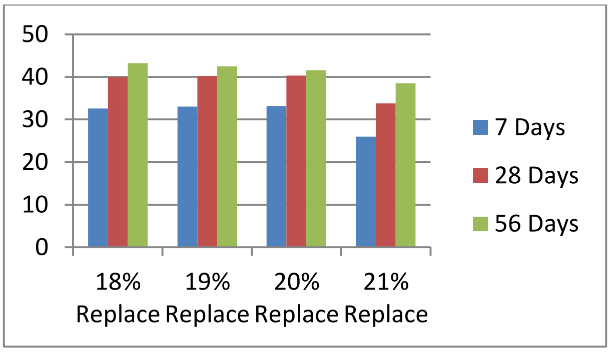

Fig.3 the final compressive strength results of MSW Incinerator Ash

The dependence of concrete compressive strength up to level of cement replacement is plotted in fig. 3. The replacement up to 20 % does not affect the strength negatively.

Flexural Strength

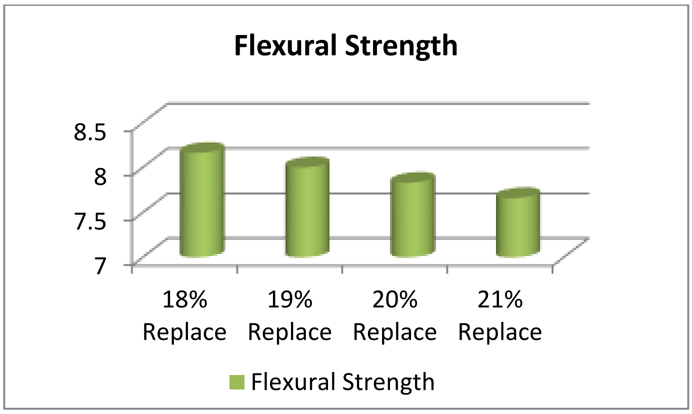

Fig.4 the final flexural strength results of MSW Incinerator Ash

The dependence of concrete flexural strength up to level of cement replacement in plotted in fig. 4. The replacement up to 20 % does not affect the strength negatively.

Durability Test

Acid Test (HCL) of 10%

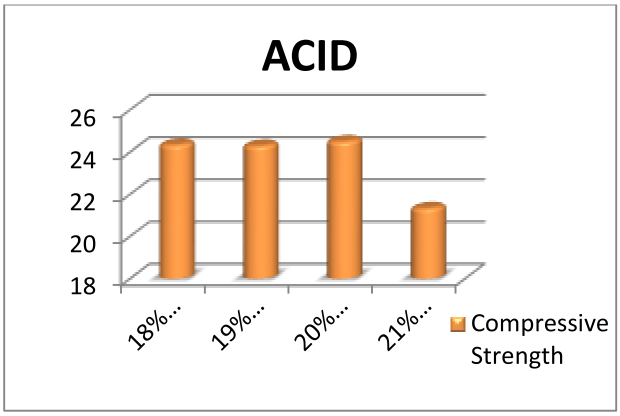

Fig.5 the final compression strength results after acid attack on MSW Incinerator Ash concrete

Base (Na2So4) of 15%

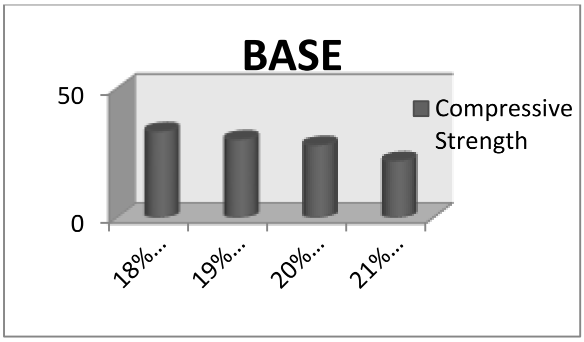

Fig.6 the final compression strength results after base attack on MSW Incinerator Ash concrete

The concrete compression strength after acid and base attack up to level of cement replacement is plotted in fig. 5 & 6. The replacement up to 20 % will negatively affect the strength.

Thermal test

Test results of concrete cubes for 7Days, 7Cycle in Oven

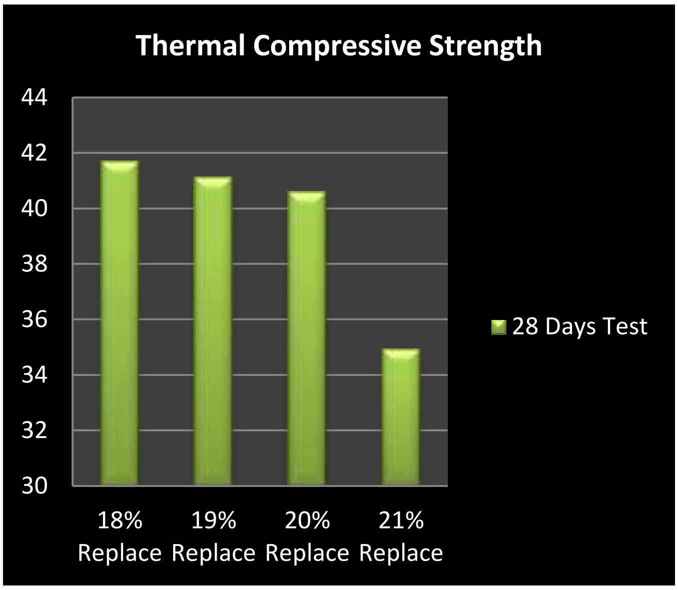

Fig.7 the final compression strength results after thermal treatment on MSW Incinerator Ash concrete

8. Conclusions

The untreated MSWI bottom ash was used as partial cement replacement in concrete after sieving in 90microns. This 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 20 % cement replacement was comparable with the reference concrete; the 56-days strength was also acceptable. The frost resistance of bottom ash containing concrete was very good. The prepared concrete contained relatively low content of MSWI ash; this approach represents a compromise between the ecological request on a practical utilization of MSWI ashes and properties of the acquired product. Higher ash dosage without any accompanied loss of concrete properties would be possible only when the ash would be treated in some way but in such case there would arise additional costs suppressing the MSWI ashes utilization attractiveness for building industry.

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