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EFFECT ON STRENGTH PARAMETERS OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY MUNICIPAL SOLID WASTE INCENATATION ASH

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ABSTRACT:

Huge amounts of waste are being generated, and even though the incineration process reduces the mass and volume of waste to a large extent, massive amounts of residues still remain. On average, out of 1.3 billion tons of municipal solid wastes generated per year, around 130 and 2.1 million tons are incinerated in the world and in India, respectively. Landfilling makes the valuable resources in the residues unavailable and results in more primary raw materials being used, increasing mining and related hazards. Identifying and employing the right pre-treatment technique for the highest value application is the key to attaining a circular economy. We reviewed the present pre-treatment and utilization scenarios in India, and the advancements in research around the world for realization of maximum utilization are reported in this project. With all the research evidence available, there is now a need for combined efforts from incineration and the cement industry for technical and economic optimization of the process flow. The municipal solid waste incineration ash reduces are worldwide studied topic over the last decades, so that utilizethe municipal solid waste is the one of the possibilities is to use MSW ash 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 MSW ashes the bottom ash was used as partial replacement of cement 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 as is differed from the control material due to presence of sulphats and chlorides in bottom ash.This project about the feasibility of using municipal solid waste ash as a replacement of cement in M25 grade concrete. The ash proportion utilized here is 0%, 5%,10%, 15% and 20% by the weight of cement, weight of fine aggregate, coarse aggregate and water cement ratio is kept constant.

Keywords: M25, sulphats, MSW, aggregate, solid waste .

1. INTRODUCTION

The incineration of municipal solid waste has significant benefits as it can reduce the volume and the mass of the waste by about 90% and 70%, respectively. Municipal solid waste is collected and burned in an incinerator; the by-products of the combustion process are collected. Bottom ash typically accounts for 80% of the whole amount of by-products in the MSWI plants. Municipal solid waste incinerator bottom ash is the ash that is left over after waste is burnt in an incinerator. This ash contains glass, brick, rubble,

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sand, grit, metal, stone, concrete, ceramics and fused clinker as well as combustive products such as ash and slag. Cement and aggregate, which are the most important constituents used in concrete production, are the vital materials needed for the construction industry. This necessity led to a continuous and increasing demand for natural materials. Parallel to the need for the utilisation of the natural resources emerges a growing concern for protecting the environment and need to preserve natural resources, by using alternative materials that are either recycled or discarded as a waste. One of the possibilities is to use Municipal Solid Waste ashes in concrete production.

Cement and aggregate, which are the most important constituents used in concrete production, are the vital materialsneeded for the construction industry. This inevitably led to a continuous and increasing demand of natural materials used for their production. Parallel to the need for the utilization of the natural resources emerges a growing concern for protecting the environment and a need to preserve natural resources, such as aggregate, by using alternative materials that are either recycled or discarded as a waste. Concrete has been a major construction material for centuries. Moreover, it would even be of high application with the increase in industrialization and the development of urbanization. Yet concrete construction so far is mainly based on the use of virgin natural resources. Meanwhile the conservation concepts of natural resources are worth remembering and it is very essential to have a look at the different alternatives. Among them lies the recycling mechanism. This is a twofoldadvantage. One is that it can prevent the depletion of the scarce natural resources and the other will be the prevention of different used materials from their severe threats to the environment. The use of Municipal Solid Waste incinerator ash(MSWA) as a part of cement raw material was investigated. The purpose was not only to dispose of the wastes, but also to alleviate some environmental problems, by reducing resources usage, CO2 emissions and energy consumption in cement manufacturing. The replacement of MSWA in raw meal was 5 and 15 percent. Chemical composition and general characteristics, as well as setting times and compressive strength, of the MSWA cements were tested and compared with conventional cement. The chemical compositions of MSWA cements were similar to the control cement, except that the SiO2 component in MSWA cements was higher than that in control cement. Setting times of cement pastes were slightly different when MSWA were used as raw materials in cement. Thelonger setting times of these cement pastes than those of control cement is due to lower c3s and higher c2s levels than in CC. Compressive strength of mortar produced from MSWA cements was rather smaller than the control cement mortar, especially at higher MSWA percentage. Municipal Solid Waste (MSW) generation in India is of critical concern, especially in big cities. Hyderabad city, alone, produced approximately 4200 tons per day and per year 11550000 tons in 2018. The incineration of municipal solid waste, an effective method of volume reduction, is presently receiving wide spread attention as a final disposal method of MSW in Hyderabad. Likewise, MSW incineration process creates two general types of ash; fly ash and bottom ash. MSW ash can be used in concrete; it will not only be able to reduce the consumption of cement raw materials, but also to solve the MSW ash disposal problems simultaneously found that MSW ash has an irregular grain surface and very high specific surface area. Other properties such as high loss on ignition, highly variable in characteristics and low reactivity were also contributing problems in the reuse of MSW ash as a pozzolan. Studied the properties of concrete containing MSW incineration ash and reported that different burning conditions affected the reactivity of MSW fly ash. In addition, samples from different compositions resulted in different chemical and physical properties of the final MSW ash cement studied the use of MSW as cementreplacing material. The results show that the setting time of paste was delayed significantly. Compressive strength of the concrete replaced with MSW was also greatly reduced when compared with the control concrete.

2. LITERATURE SURVEY:

Population growth, booming economy, and rapid urbanization have greatly accelerated the solid waste generation all around the world. The annual global generation of solid waste has recently approached 17 billion tons and is supposed to hit 27 billion tons by 2050 (Laurent et al., 2014). This issue is of stinging concern to the nations, municipalities, and individuals, as it can cause significant damages to human health, natural resources, and ecosystems. Therefore, the concept of adopting green chemistry and technologies for environmental sustainability has been increasingly recognized and included in recent years. Most notably, the traditional concept, in which waste is regarded as pollution, has been progressively shifting towards the new perspective that waste is treated as a resource. This undoubtedly can support societies to become more sustainable. For instance, the energy generated in certain thermal processes of waste materials can trim the energy generation services through conventional technologies. Likewise, the reuse or recycling of certain solid waste materials, such as metal, plastic, and paper can conserve the source of the corresponding virgin materials. Against this scenario, the research of recycling solid waste materials into the production of construction materials has been carried out extensively (De Carvalho Gomes et al., 2019). These endeavors are intended to slim down the volume of solid waste, and also trim down the mounting demand for natural resources in the construction industry. Heretofore, impressive achievements relevant to this field have been attained. For example, Huang et al. (2007) reviewed the successful utilization of solid waste materials (i.e., steel slag, waste glass, tires, and plastics, etc.) for the development of asphalt pavements.

Meng et al. (2018) summarized the existing research work on recycling a range of solid waste materials in the production of concrete blocks, including crushed brick, waste glass, recycled concrete, ceramic waste, and tile waste, etc. Luhar et al. (2019b) outlined the possible use of various kinds of aquacultural and agricultural farming waste as supplementary materials in concrete.
Besides that, some attracting achievements have been made in recycling solid waste materials for the manufacture of geopolymer composites. Geopolymer, namely alkali-activated material, is usually derived from the chemical reaction between aluminosilicateprecursor materials and alkaline activators, being widely regarded as an alternative to ordinary Portland cement (OPC) (Provis, 2013). The past three decades have witnessed the rapid development of geopolymer through academic pursuit because of its excellent performance in various fields.

In general, geopolymer exhibits excellent mechanical properties and other inherent properties such as superior durability, immobilization of toxic contaminants, or even multifunctionality and intelligence (Ji and Pei, 2019; Provis, 2013; Tang et al., 2019b). Furthermore, geopolymeris featured with low greenhouse-gas emissions, less energy consumption, and reuse of waste materials, which is considered critical to the future sustainability of the building and construction industry (Habertet al., 2011; Hassan et al., 2019). Thus, exploiting the potential of using solid waste materials as a component in geopolymer composites will
certainly contribute to a greener and more sustainable construction material. Generally, solid waste is mainly composed of the municipal, industrial, construction, and agriculture solid wastes (Hoornweg and Bhada-Tata, 2012). In literature, the utilization of solid waste such as industrial waste and agricultural waste in the manufacturing of geopolymercomposites has been well documented (Part et al., 2015).

3. PROPOSED SYSTEM:

The objectives of the work are stated below:

i) To develop mix design methodology for mix 25 MPa
ii) To study the effect of adding different percentages (0% - 15%) of MSW ash by the weight of cement in the preparation of concrete mix.
iii) To determine the workability of freshly prepared concrete by Slump test& compaction factor test.
iv) To determine the compressive strength of cubes at 7, 14, 28 days.

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v) To determine the Flexural strength of beams at 28 days.

STANDARD CONSISTENCY OF CEMENT PASTE

Aim :To determine the normal consistency of a given sample of cement

Reference :IS: 4031 (Part 4) - 1988, IS: 5513-1976

Theory :For finding out initial setting time, final setting time of cement, and strength a parameter known as standard consistency has to be used. The standard consistency of a cement paste is defined as that consistency which will permit a Vicat plunger having 10 mm diameter and 50 mm length to penetrate to a depth of 33-35 mm from the top of the mould.

Apparatus: Vicat apparatus conforming to IS: 5513-1976, Balance, Gauging Trowel, Stop Watch.

Procedure:

1. The Standard consistency of a cement paste is defined as that consistency which will permit the Vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicatmould.
2. Initially a cement sample of about 400gms is taken in a tray and is mixed with a known percentage of water by weight of cement, say starting from 25% and then it is increased by every 2% until the normal consistency is achieved.
3. Prepare a paste of 400gms of Cement with a weighed quantity of potable or distilled water, taking care that the time of gauging is not less than 3 minutes, nor more than 5min, and the gauging shall be completed before any sign of setting occurs.
4. Fill the Vicatmould with this paste, the mould resting upon a non-porous plate. After completely filling the mould, smoothen the surface of the paste, making it level with the top of the mould. The mould may be slightly shaken to expel the air.
5. Place the test block in the mould, together with the non-porous resting plate, under the rod bearing the plunger; lower the plunger gently to touch the surface of the test block, and quickly release, allowing it to sink into the paste. This operation shall be carried out immediately after filling the mould.
6. Prepare trial pastes with varying percentages of water and test as described above until the amount of water necessary for making up the standard consistency as defined in Step 1 is found.

4. RESULTS EXPLANATION

As per experimental programme results for different experiments were obtained. They are shown in table format or graph, which is to be presented in this chapter.

4.1 Workability Test

4.1.1 Slump Test

The Slump test was performed on the MSWA concrete to check the workability of it at different replacements viz. 5 %, 10 %, 15%, 20% and the following results were obtained, according to which it can be concluded that with the increase in % of MSWA from 0 to 20 % , workability decreases. The results obtained for Slump test are shown below in Table 5.1.

Table 5.1: Results of Slump test

S.No	% of MSWA	Slump value (cm)
1	0%	11.5
2	5%	11
3	10%	10.5
5	15%	8.5
6	20%	8.2

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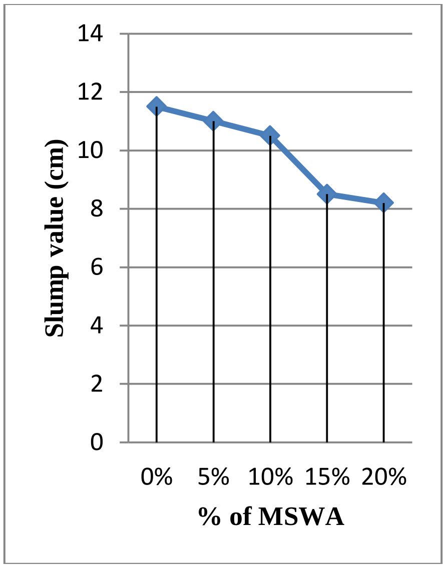

Fig 5.1 : Slump test results

The above figure 5.1 shows the slump results. It was observed that, the slumps decreased as the MSWA content were increased in the mix. It was suitable for Low Workability mixes used for foundations with light reinforcement. Roads vibrated by hand operated machines.

4.1.2 Compacting Factor

The compaction factor test was performed on the MSWA concrete to check the work ability of it at different replacements viz. 5 % , 10 % , 15%, 20% and the following results were obtained, according to which it can be concluded that with the increase in % of MSWA from 0 to 20 % , workability decreases. Theoretical maximum value of compaction factor can be 0.96 to 1.0. The results obtained for compaction factor test are shown below in Table 5.2.

Table 4.2: Results of compaction factor test

S.No	% of rubber	Wt. of partially compacted concrete (kg)	Wt. of fully compacted concrete (kg)	Value of compaction factor (%)
1	0%	9.63	11.83	0.81
2	5%	11	12.17	0.9
3	10%	10.43	12.00	0.87
5	15%	9.52	11.69	0.82
6	20%	8.76	10.92	0.80

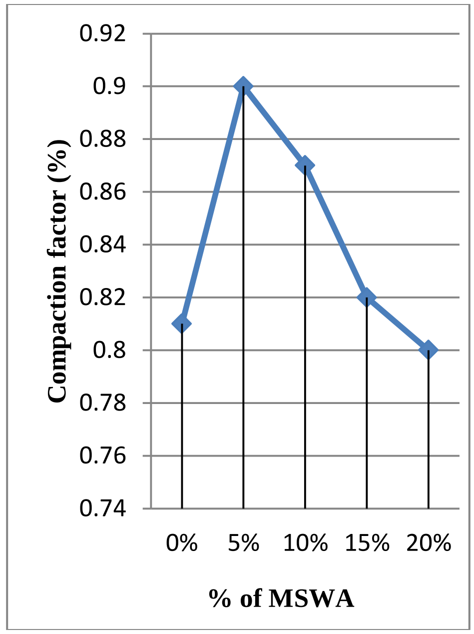

Figure 4.2: Compacting factor test

The above figure 5.2 shows the results of the compacting factor. The results show that, the compacting factor increases upto MSWA 5% after that it was decreased.

5. CONCLUSION:

1. Based on the result that have carried out here as part of this research, we concluded that the replacement of ash obtained from municipal solid wastes can be used for the preparation of concrete. The best advantage of this partial replacement is reducing the over dumping of solid waste to public.
2. The compressive test results on the cement replaced municipal solid waste ash cubes did show improvement while adding 5% and 10% in the 28 days strength in comparison to the control cube, but it fall increasing the percentage of MSWA above 10%.
3. Replacement of municipal solid waste ash up to 10% is good for using construction purposes. And also solid waste incineration powder replacing mixes are also used as base coarse.
4. While increasing the percentage of MSWA in cement then $CaCO_3$ will

reduces in it. As we maintain the more percentage of MSWA then add suitable amount of $CaCO_3$.

5. The untreated MSWA was used as partial cement replacement in concrete. This ash, by its chemical composition, does not fulfill the standard requirements on concrete admixtures but the prepared concrete had acceptable properties. The frost resistance of MSWA containing concrete was very good. Theprepared concrete contained relatively low content of MSWA; this approach represents a compromisebetween the ecological request on a practical utilization of MSWA and properties of the acquired product.
6. Higher ash dosage without any accompanied loss of concrete properties would be possible only when the ash would be treated in some way (e.g. by verification) but in such case there would arise additional costs suppressing the MSWA utilization attractiveness for building industry.

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