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EFFECT ON COMPRESSIVE STRENGTH OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY MUNICIPAL SOLID WASTE INCINERATION ASH

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ABSTRACT

This paper discusses the possibility of disposing the incinerator ash by adding it to concrete. Generally very small change we can observe by replacing 10% of municipal solid waste incineration ash mix with cement concrete. So we can increase the percentage of ash quantities into the concrete mixes and check the strength.

INTRODUCTION

The generation of solid waste has been rapidly increasing due to the growth of production thousands of million tons of municipal solid waste produced every year .Usually the incineration technique for treating MSW reduce 70% by weight and 90% by volume in this process it produces ash. One of the paper presents the greatly improved strength obtained with ash which is has been exposed to a new additive these results show that up to 35% of the concrete can be made up of ash, while still obtaining compressive strength. A Construction block consists of 35-60% combined ash, 25-50% of sand and 15% of OPC is act like a hardest super plasticizer. The environmental friendliness of concrete cannot be fully appreciated without taking into consideration that cement and concrete industries are providing an ideal home for enormous quantities of waste products from other industries. The cement and concrete industries are uniquely positioned to eliminate many wastes from the environment while receiving significant economic and technical benefits at the same time. The use of industrial by-products in replacement of natural materials is widely encouraged in construction thus enabling residual materials to be recycled and valorized, while at the same time saving natural resources and energy.

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 twofold advantage. 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.

SCOPE OF THE WORK:

The use of Municipal Solid Waste incinerator bottom ash (MSWI) 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 MSWI in raw meal was 5 and 10 percent. Chemical composition and general characteristics, as well as setting times and compressive strength, of the MSWI cements were tested and compared with conventional cement. The chemical compositions of MSWI cements were similar to the control cement, except that the SiO2 component in MSWI cements was higher than that in control cement. Setting times of cement pastes were slightly different when MSWI were used as raw materials in cement. The longer setting times of these cement pastes than those of control cement is due to lower c_3s and higher c_2s levels than in CC. Compressive strength of mortar produced from MSWI cements was rather smaller than the control cement mortar, especially at higher MSWI percentage.

OBJECTIVES AND STUDY:

Municipal Solid Waste (MSW) generation in Thailand is of critical concern, especially in big cities. Bangkok, alone, produced approximately 8,000 tons per day in 2002. 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 Bangkok. 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 cement replacing material. The results show that the setting time of paste was delayed significantly. This new type of cement is expected to improve energy efficiency, to conserve raw materials and to reduce air pollution of the cement manufacturing, while the cement quality is expected to be the same as that of OPC.

METHODOLOGY OF THE STUDY:

The different methods utilized in this research include the following:

BACKGROUND STUDY

Literature survey was carried out to review previous studies related to this thesis.

COLLECTION OF RAW MATERIALS

All the required materials were collected and delivered to the laboratory. These are, Cement, fine aggregate, coarse aggregate, used rubber tires and admixture.

MATERIAL TESTS

Tests were conducted on the raw materials to determine their properties and suitability for the experiment.

MIX PROPORTIONING (MIX DESIGN)

Concrete mix designs were prepared using the Department of Environment (DOE) method. A mixture of M20 grade of concrete was prepared with cement replacements by 10, 20, 30, and 40% of the municipal solid waste incineration ash. A control mix with no municipal solid waste incineration ash replacement was produced to make a comparative analysis.

SPECIMEN PREPARATION

The concrete specimens were prepared in bits vizag, Civil Engineering Department Material Testing laboratory. The prepared samples consist of concrete cubes.

TESTING OF SPECIMENS

Laboratory tests were carried out on the prepared concrete samples. The tests conducted were slump, unit weight, and compressive strength tests.

DATA COLLECTION

The data collection was mainly based on the tests conducted on the prepared specimens in the laboratory.

DATA ANALYSIS AND EVALUATION

The test results of the samples were compared with the respective control concrete properties and the results were presented using tables, pictures and graphs. Conclusions and recommendations were finally forwarded based on the findings and observation

TESTS CONDUNTED ON MATERIALS BEFORE ADDING AND AFTER ADDING ASH

CEMENT:

1. Fineness of cement
2. Normal consistency
3. Initial and final setting time
4. Compression test,
5. Specific gravity

COARSE AGGREGATS AND FINE AGGREGATS

RESULTS AND DISCUSSIONS

Concrete Mix Design

The important kept in view while designing the concrete mix are strength durability and workability of concrete the mix proportions were arrived at theoretically, based on IS-recommendations.

Material Used

OPC 53 grade is used throughout the investigation. Locally available river sand as fine aggregate and crushed granite stone with maximum size of 20mm and 10mm is used as coarse is used for mixing the concrete and curing the specimens.

MSWIA:

To study the compatibility of fly ash with the super plasticizer, a number of trial mixes were prepared with different percentages of solid waste ash and their slumps were recorded. Through this test we can study the behavior of the super plasticizer was added. As it can be seen, the slump of concrete increased with the increase in the amount of solid waste ash added.

Preparation of Test Sample

The specimens used for test cubes are of size150x150x150mm. All the materials are brought to a temperature 27+ or -2^{0}c before commencing the tests. The materials are proportioned as per the design calculations by proper weighing. The concrete is mixed using a laboratory batch mixer. After thorough mixing the concrete, workability of the batch is estimated by slump cone test and compaction factor test as per the procedure given in IS code7. The concrete is then filled in the cube moulds of specified size and the compaction carried out by hand as per the procedure given in code6 (clause2.10.1). the prepared specimen is kept under moist condition (27+ or -2^{0}c) for 24 hours from the time of addition of water to the dry ingredients. After this period, the specimens are marked and removed from the moulds till the day of testing.

Tests on Fresh Concrete

Keeping the need in view in the present work, only the workability tests have been conducted on fresh concrete .The following methods give the measure of workability and have found universal acceptance owing to the simplicity of operation with an ability to detect variations in the uniformity of a mix.

1. Slump cone test
2. Compaction factor test

Compaction Factor Test:

Decreased with an increase in the percentage of the ash. The results of compressive strength cubes for 3 days, 7 days and 28 days.

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Quantities for M_{20} Grade Concrete Mix:

Control Specimen

Table 1: Quantities for Control Specimen

S. No	Items	Quantities in kg	
		1 Cube	9 Cubes
1	Cement	1.82	16.38
2	Fine Aggregate	2.73	24.57
3	Coarse Aggregate	5.5	49.5
	20 mm	3.63	32.67
	10 mm	1.87	16.83
4	Water (0.5)	0.91 lt	8.19 lt

10% Replacement of Cement by MSWIA:

Table 2: Quantities for 10% replacement

S. No	Items	Quantities in kg	
		1 Cube	9 Cubes
1	Cement	1.638	14.742
	Ash	0.182	1.638
2	Fine Aggregate	2.73	24.57
3	Coarse Aggregate	5.5	49.5
	20 mm	3.63	32.67
	10 mm	1.87	16.83
4	Water (0.5)	0.91 lt	8.19 lt

20% Replacement of Cement by MSWIA:

Table 3 Quantities for 20% replacement

S. No	Items	Quantities in kg	
		1 Cube	9 Cubes
1	Cement	1.456	13.104
	Ash	0.364	3.276
2	Fine Aggregate	2.73	24.57
3	Coarse Aggregate	5.5	49.5
	20 mm	3.63	32.67
	10 mm	1.87	16.83
4	Water (0.5)	0.91 lt	8.19lt

Compressive Cube Strength at 3 Days:

Table 4: compressive cube strength at 3 days

S.No	Mix Identity	Mean Weight (Kg)	Mean Load at Failure (kN)	Compressive Strength (Mpa)
1.	Mix 0 %	7.980	430.67	19.14
2.	Mix 10 %	7.850	550	24.4
3.	Mix 20 %	7.545	530	23.55
4.	Mix 30 %	7.378	400	17.7
5.	Mix 40 %	7.198	310	13.77

Compressive Cube Strength at 7 Days:

Table 5: compressive cube strength at 7 days

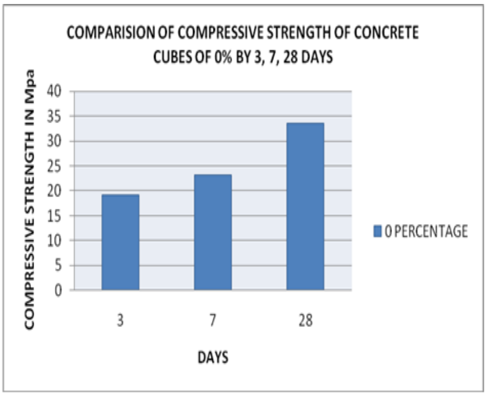
S.No	Mix Identity	Mean Weight (Kg)	Mean Load at Failure (kN)	Compressive Strength (Mpa)
1.	Mix 0 %	8.140	520	23.11
2.	Mix 10 %	7.880	620	27.55
3.	Mix 20 %	7.690	570	25.3
4.	Mix 30 %	7.574	500	22.22
5.	Mix 40 %	7.390	420	18.66

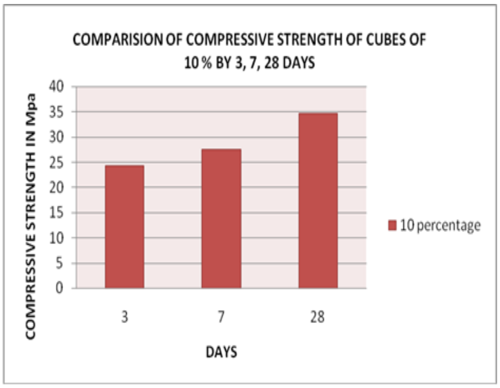
Compressive Cube Strength at 28 Days:

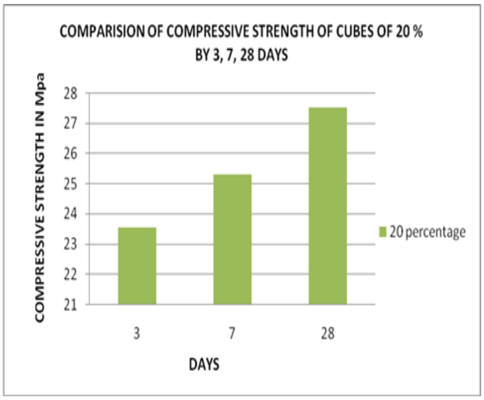
Table 6: compressive cube strength at 28 days

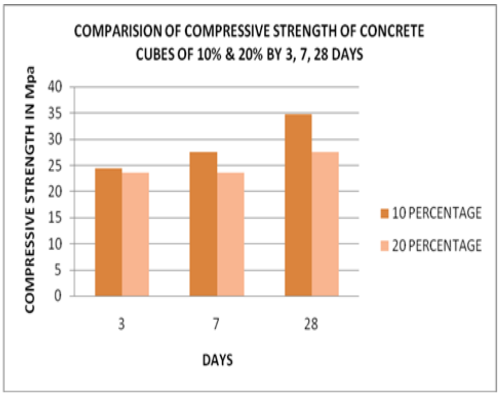
S.No	Mix Identity	Mean Weight (Kg)	Mean Load at Failure (kN)	Compressive Strength (Mpa)
1.	Mix 0 %	8.303	756.5	33.62
2.	Mix 10 %	7.966	780	34.66
3.	Mix 20 %	7.885	620	27.55
4.	Mix 30 %	7.789	540	24
5.	Mix 40 %	7.554	360	16

Compressive Strength









Conclusions:

1. The compressive test results on the cement replaced ash cubes did show improvement while adding 10% and 20% in the 28 days strength in comparison to the control cube, but it fall increasing the percentage above 30% 3 days, 7days. 28days cube strength of M20 grade concrete.
2. Replacement of municipal solid waste ash up to 20% is good for using construction purpose at sea shore buildings and normal buildings. And also solid waste incineration powder replacing mixes are also used as base coarse.
3. While increasing the percentage of MSWI ash in cement then caco3 will reduces in it. As we maintain the more percentage of MSWI ash then add suitable amount of $caco_3$.
4. The untreated MSWI ash 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 3-days compressive strength of material with 10 % cement replacement was

comparable with the control specimen; the 28-days strength was lower which can be explained by different hydration process. The frost resistance of MSWI 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.

5. 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 vitrification) but in such case there would arise additional costs suppressing the MSWI ashes utilization attractiveness for building industry.