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Study of Strength Properties of Concrete Replacing MSWI-Ash for Cement and M-Sand for Fine Aggregates

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***Abstract*: Municipal solid waste incineration ash (MSWA) is the by-product obtained from the incineration of solid waste generated in cities. Incineration is the widely used method to manage the increase in production of municipal solid waste (MSW). To assess the performance of MSWI-ASH during partial replacement with cement the following tests were performed initial setting time, final setting time, consistency, soundness, specific gravity, and strength of cement were carried out along the tests on hardened concrete like compressive, Tensile, and flexural strength up to 56 days of age. Manufacture sand is used to replace the fine aggregate respectively. This work examines the possibility of using the replacements for cement, and fine aggregate for new concrete and tested for its compressive, Tensile and flexural strength up to 56 days of age and were compared with those of conventional concrete to assess effectiveness of partial replacement of sand by its weight with 10%, 20%, 30%, & 40% of M-Sand along with the MSWI-ASH dosages used are 10%, 20%, 30%, & 40%.**

Keywords: Cement, fine aggregates, coarse aggregates, water, and MSWI-ASH, Concrete

I. Introduction

In other words cement concrete comprises of cement, sand and coarse aggregate blended with water and with or without admixture. The cement and water shape an adhesive or gel which coats the sand and coarse aggregate. At the point when the cement has synthetically responded with the water (hydrated), it solidifies and ties the entire. The underlying solidifying response ordinarily happens inside a couple of hours. It takes half a month for concrete to achieve full hardness and quality. Concrete can proceed to solidify and pick up quality over numerous years. The advancement of determining the concrete according to its execution necessities as opposed to the constituents and fixings in concrete has opened incalculable doors to configure based on particular application.

II. MSWI-Ash

Municipal solid waste incineration ash (MSWA) is the by-product obtained from the incineration of solid waste generated in cities. Incineration is the widely used method to manage the increase in production of municipal solid waste (MSW).

Refuse-derived fuel (DRF) and the mass-burning processes are the two processes mostly used to dispose the municipal solid waste (MSW). The fuel deriving process from the refuse consists of separation of recyclable metals and glasses from the MSW, and then the remaining waste is shredded and incinerated, and the heat generated during incineration process is recovered to produce electricity. The mass-burning process of MSW consists of burning the solid waste as it is received in the incineration plant without waste separation or shredding. The bi product of the incineration process is ash. Depending upon the mode and nature of the municipal solid waste incineration plant or waste to energy plant, ash is typically one to thirty percent by wet weight and five to fifteen percent by volume of the wet MSW. Incineration of municipal solid waste produces two types of ashes; whereas the first one is bottom ash and second one is fly ash. MSWI-ASH residues contains of large and heavy metal particles which are removed from the bed of the incinerator whereas the fly ash residues are very fine in size and those are entrained in exhaust gases. Municipal solid waste incinerated bottom ash consists of 75–80% of the total combined ash. Majority of the ash approximately 90% of the bottom ash consists of grate ash, the great ash is the ash which consists of fraction that remains on the stoker or grate at the completion of the incineration process. It is similar in appearance to cement as it is porous, grayish, silty sand with gravel, and it also consists of small amount of unburnt organic matter and pieces of metal. The grate ash stream consists primarily of glass, ceramics, ferrous and nonferrous metals, and minerals.

III. Concrete

MSW fly ash could be used as partial replacement for cement in concrete mixes as a supplementary cementitious material as it contains some quantities of typical cement minerals, although in lesser quantity than cement clinker so that MSWI fly ash is similar to class C pozzolans, as defined in the ASTM standard and could be possibly used as partial replacement of cement even though they failed to comply with one or more criteria of the standard. MSWI fly ash can also be used in concrete as aggregate: MSW fly ash could be processed into pellets and used as lightweight aggregates the researchers have advocated the possible use of MSW ash in construction applications including the innovative use in the production of polymer concrete (PC). Results have shown that good quality PC can be produced with MSW ash.

IV. Manufactured Sand

Manufactured sand is characterized as a reason made smashed fine total created from an appropriate source material. Generation for the most part includes Crushing, Screening and potentially washing, partition into discrete portions, recombining and mixing.

Toward the starting fabricated sand created (by Jaw crusher, cone crusher, move crusher, pound process) contains flaky and prolonged particles. In any case, now made sand created from V.S.I (vertical shaft impactor) is a reasonable and feasible substitute to stream sand and could be viably utilized as a part of making concrete which gives satisfactory quality and solidness to the concrete. Having cubical shape, it adequately gives great holding in concrete. Reviewing of produced sand can be controlled i.e., required zone of sand can be gotten. Fabricated sand can be created with zero fines. As it doesn't contain sediment and dirt, setting properties of concrete are not adjusted. For enormous ventures where extensive amount of total is required, Plants are built up close to the site with the goal that the cost of transportation can be lessened.

V. Manufacturing Process

Vertical Shaft Impactor rule is utilized for pounding greater particles, for forming the pulverized metal (giving better state of the molecule) and for smashing fines totals underneath 4.75 mm. It is best machine Impactor is of cubical shape. Such sand can be utilized for a wide range of development work, Concreting, Plastering and so forth and is better substitute to waterway sand. V.S.I. Crushers is a most prudent machine for Crushing Stone fit as a fiddle and assembling counterfeit sand. In this machine the particles are tossed at a rapid, those particles colloid with each other and break in cubical particles. An Anvil ring, Shelf ring (categorize ring) are given to get the particles edges grounded. The wear cost is a vital criterion in smashing procedure. Wear cost of other smashing machines, for example, Roll crushers, Cone crushers, H.S.I (Horizontal Shaft Impactor) is high contrasted with V.S.I. Crushers. xxIt is around four to five times increasingly that of VSI crusher. Rotopactor is a most temperate machine for assembling fake sand. In this machine the stone are tossed at a rapid, those particles colloid with each other and break in cubical particles. Iron blocks or Shelf ring (categorize ring) are given. A rubbing activity of particles over pigeon ring grounds the sharp edges and make the surface smooth.

In these machine, an uncommonly outlined pigeon ring is given which utilizes the remaining dynamic vitality in the molecule and influences it to rotate and part and rub with each other in a round way. This makes the state of the particles great, and smooth. The sand made can be of fine to course review according to the prerequisite of the work. The sand fabricating process is dry. The procedure requires less water that too just to settle down the lingering dust particles in colloidal state, transmitted from the outlet. This machine can permit, somewhat wet coarseness for squashing. Different machines, Cone crusher, H.S.I. couldn't utilize wet material, as it stops up the machine. V.S.I. crushers and Rotopactors are more productive and more sparing in task. Because of consistent advancement and research our machines are exceptionally solid and requires less upkeep. It is the after effect of our endeavours for consistent advancement the wear cost of our machine is minimum.

VI. Objectives

The objectives of present research work is to obtain the

1) Effect of MSWI-ASH on the physical properties of cement at the time of replacement.
2) Effect of MSWI-ASH on Compressive Strength, Tensile Strength and Flexural Strength of concrete.
3) Effect of Manufacture sand on Compressive Strength, Tensile Strength and Flexural Strength of concrete.
4) Effect of combined application of MSWI-ASH, and Manufacture sand on Compressive Strength, Tensile Strength and Flexural Strength of concrete
5) Comparison of the test results of Conventional Concrete and Compound concrete.
6) Durability properties of concrete were also checked.

VII. Scope

- Dosage of the MSWI-ASH used are 10%, 20%, 30%, & 40% of the total Cement.
- Dosage of the M-Sand used are 10%, 20%, 30% & 30% of the total fine aggregates.
- Combined applications.

VIII. Concrete Mix Preparation

Concrete and MSWI-ASH are blended, to which the fine aggregate and coarse aggregate are included and completely blended. Water and Nano-silica are estimated precisely. At that point it is added to the dry blend and it is completely blended until the point when a blend of uniform shading and consistency is accomplished which is then prepared for throwing. Preceding throwing of examples, workability is estimated as per the code IS 1199-1959 and dictated by drop and compaction factor tests. By the expansion of reasonable measurement of the Super plasticizer, the workability of all blends is kept up pretty much steady.

IX. Tests MSWI-Ash and M-Sand based Concrete

A. Compressive strength

All the concrete specimens that are tested in a 200tones capacity of the compression-testing machine. Concrete cubes of size 150mm × 150mm × 150mm were tested for compressive strength. Compressive strength of concrete is determined by applying load at the rate of 140kg/sq.cm/minute till the specimens failed.

After 3, 7, 28 & 56 days of curing, cube specimens were removed from the curing tank and cleaned to wipe off the surface water. Cubes were tested at the age of 28 days using compression testing machine as shown in Figure. The maximum load to failure at which the specimen breaks and the pointer starts moving back was noted. The test was repeated for the three specimens and the average value was taken as the mean strength.

The cube compressive strength indicates the average of three test results. It is observed that the compressive strength of concrete prepared by replacing 20% MSWI-ASH as Partial replacement of Cement exhibits improved Compressive Strength compared to Control Concrete and also observed that with further increase in content of MSWI-ASH – The

Compressive Strength decreases. However combined application of 20% MSWI-ASH and 20% M-sand proved to be optimum combination of all by resulting increase in Compressive Strength compared to Control Concrete.

B. Split tensile strength

The Test results of Split Tensile Strength of M25 grade Concrete with individual and combined applications of MSWI-ASH (10%, 20%, 30% & 40%), and Manufactured Sand (10%, 20%, 30%, 40%), as partial replacements of Fine Aggregate, and Cement respectively is shown in Table-2.

The Split tensile strength of Control concrete is 3.86 MPa. It is observed that all the replacements MSWI-ASH (10%, 20%, 30%,& 40%), Manufactured Sand (10%, 20%, 30%, 40%), exhibits increase in Split Tensile Strength Characteristics compared to Control Concrete, But the Optimum mix of Concrete with MSWI-ASH (20%), & Manufactured Sand (20%) resulted in significant improvement more than Control Concrete.

C. Flexural strength

The Test results of Flexural Strength of M25 grade Concrete with individual and combined applications of MSWI-ASH (10%, 20%, 30%, & 40%), Manufactured Sand (10%, 20%, 30%, 40%), as partial replacements of Cement, &Fine Aggregate respectively is shown in Table-3.

The Flexural strength of Control concrete is 6.83 MPa. It is observed that all the replacements MSWI-ASH (10%, 20%, 30%, & 40%), Manufactured Sand (10%, 20%, 30%, 40%),exhibits increase in Flexural Strength Characteristics compared to Control Concrete, But the Optimum mix of Concrete with MSWI-ASH 20%, & 20% M-Sand resulted in significant improvement with more than Control Concrete.

TABLE I
COMPRESSIVE STRENGTH OF M25 GRADE CONCRETE

S. No.	Concrete Combination	MSWI-ASH (%)	M.SAND (%)	Compressive Strength (in Mpa)			
				3 Days	7 Days	28 Days	56 Days
1.	CC	0	0	12.83	22.86	35.54	36.52
2.	10%ASH	10	0	13.15	23.92	37.42	39.15
3.	20%ASH	20	0	14.83	25.86	39.54	41.52
4.	30%ASH	30	0	13.03	24.17	37.94	40.35
5.	40%ASH	40	0	11.85	21.97	33.85	34.95
6.	50% ash	50	0	8.75	19.3	28.6	29.15
7.	10%ASH + 10% M-SAND	10	10	14.36	24.17	38.52	39.75
8.	20%ASH + 20% M-SAND	20	20	15.14	26.42	40.82	42.32
9.	30%ASH + 30% M-SAND	30	30	13.57	25.15	38.95	39.15
10.	40%ASH + 40% M-SAND	40	40	12.10	22.15	34.15	35.16

TABLE II
SPLIT TENSILE STRENGTH OF M25 GRADE CONCRETE

S. No.	Concrete Combination	MSWI-ASH (%)	M.SAND (%)	Split tensile strength (in Mpa)
1	CC	0	0	3.86
2	10%ASH	10	0	3.91
3	20%ASH	20	0	4.15
4	30%ASH	30	0	3.87
5	40%ASH	40	0	3.64
6	10%ASH + 10% M-SAND	10	10	4.01
7	20%ASH + 20% M-SAND	20	20	4.18
8	30%ASH + 30% M-SAND	30	30	3.95
9	40%ASH + 40% M-SAND	40	40	3.87

TABLE III
SPLIT TENSILE STRENGTH OF M25 GRADE CONCRETE

S. No.	Concrete Combination	MSWI-ASH (%)	M.SAND (%)	Flexural strength (in Mpa)
1	CC	0	0	6.83
2	10%ASH	10	0	6.94
3	20%ASH	20	0	7.08
4	30%ASH	30	0	6.97
5	40%ASH	40	0	6.79
6	10%ASH + 10% M-SAND	10	10	6.98
7	20%ASH + 20% M-SAND	20	20	7.12
8	30%ASH + 30% M-SAND	30	30	7.04
9	40%ASH + 40% M-SAND	40	40	6.86
10	CC	0	0	6.83

X. Conclusion

A. Compressive strength

1) Individual replacement of MSWI-ASH (10%, 20%, 30%, 40%, & 50%),) for Cement in Concrete exhibited higher compressive Strength at 20% Replacement of ASH and further increase in content of MSWI-ASH the Compressive strength started to decrease gradually.
2) However Combined application of 20% MSWI-ASH, and 20% Manufactured Sand proved to be optimum combination of all by resulting in increase of Compressive Strength compared to Control Concrete.

By replacing more than 50% replacement of cement with MSWI-ASH we can observe that the strength of the concrete is decreased and it don't even attain the characteristic design strength.

B. Split tensile strength

1) Similar trend is observed in Split Tensile Strength for individual replacements for Cement with MSWI-ASH (20%) and Fine Aggregate with Manufactured Sand (20%) exhibited improved Split Tensile strengths i.e higher compared with Control Concrete.

With combined Application of MSWI-ASH (20%), & Manufactured Sand (20%) It is observed that the Split Tensile Strength increased when compared to Conventional Concrete.

C. Flexural strength

1) Similar trend is observed in Flexural Strength for individual replacements for Cement with MSWI-ASH (20%), exhibited improvement in Flexural strengths up to 4.24%, higher compared with Control Concrete.
2) With combined Application of MSWI-ASH (20%), & Manufactured Sand (20%) It is observed that the Flexural Strength increased about 6.54% compared to Conventional Concrete.

These results on strength studies give a clear conclusion that MSWI-ASH, and Manufactured Sand. Can be used as viable replacements for Cement, and Fine Aggregate respectively with Superior properties of Mechanical Properties compared to Control Concrete, saving in cost of concrete and reducing the environmental pollution without affecting the Quality and Strength Properties.

XI. Scope for Further Research

1) To evaluate the durability.
2) To evaluate the mechanical and durability properties of the concrete made with ppc, and geo-polymers.
3) Destructive, semi-destructive, & non-destructive Studies can also be performed on the above combinations.

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