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AN EXPERIMENTAL INVESTIGATION ON SELF-COMPACTING CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH INCINERATED BIOMEDICAL WASTE ASH.

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ABSTRACT

The modern construction technology has been evolving day by day.The savage of environment has become their main aspect in their construction ideology.And many studies has developed more concepts to bring the change in construction field and in that,the usage of Incinerated Biomedical Waste ash as supplement material to the cement is one of that studies.Biomedical waste is combination of medical waste from various sources like hospitals, research centers, clinics etc. and that presently or in the future poses a significant risk to human, plant or animal life. As it is produced in abundance and therefore cannot be treated or disposed of without special precautions. Generally biomedical waste is burned in incineration plant and produce Incinerated Biomedical Waste Ash (IBWA). It is considered as lethal because it may contain toxic substances.

In this experimental investigation, Incinerated Biomedical Waste Ash (IBWA) was employed as a partial substitute element for cement in Self-Compacting Concrete (SCC), designed for M30 grade.

IBWA was partially replaced with cement in proportions of 0%, 5%, 10%, 15% and 20% by cement weight. This experimental work aimed to study the fresh and mechanical characteristics of the SCC mixes incorporating IBWA. And a relevant super plasticizer was used.The results demonstrate that 5% of IBWA substitution for cement in the SCC mix had higher strength compared to all other mixes because IBWA's fine particles filled the voids in the hardened concrete.

Keywords:Self Compacting Concrete(SCC),Incinerated Biomedical waste Ash(IBWA),Flexural strength,Fresh properties.

1.INTRODUCTION

The concrete is the significant constituent in construction field.the evolution of concrete is upgrading day by day by changing the means of ingredients in that.most commonly the usage of cement,fine aggregate and coarse aggregate in the concrete become regular and the present construction department choose an alternative option in substitution for cement due to the increase in demand and also the environment impacts on using the cement.There are types of concretes used for different scope in the construction.In that Self-Compacting Concrete is one of that.Self compacting concrete (SCC) can be defined as fresh concrete that flows under its own weight and does not require external vibration to undergo compaction. It is used in the construction where it is hard to use vibrators for consolidation of concrete. Filling and passing ability, segregation resistance are the properties of self compacting concrete. SCC possess superior flow ability in its fresh state that performs self compaction and material consolidation without segregation issues.

The main elements in Self-Compacting Concrete are Cement,Fine aggregate,coarse aggregate,water and chemical admixtures.the grade of cement is used 43 or 53 grade of cement.fine aggregate is used can be Zone-I or Zone-II and coarse aggregate is 20mm and downward sizes.Water is treated the same way as with regular concrete.Super-plasticizers are commonly used in SSC. Air entraining, intentional creation of air bubbles, agents are used to improve the freezing and thawing resistance. Setting time of concrete is controlled by using Retarders.mineral admixtures are also used based upon the mix design and properties required.Fly Ash improves internal concrete matrix, reduces permeability, and improves structure quality.Ground Granulated Blast Furnace Slag (GGBS) improves the rheological, also known as deformation, properties of concrete.Stone Powder improves powder content of the mixture.Silica Fumes improves mechanical properties of the structure.

Due to the presence of mineral fillers and special admixtures, SCC is resistant to segregation. It is also fluid enough to pass around congested reinforced areas withing structures, while avoiding any honeycombing.SSC having similar water-cement ratio as of the traditional vibrated concrete will result in higher strength, due to lack of vibration. This significantly improves the interface between the aggregate and the hardened paste.

By adopting SSC,there will be fast placement without mechanical consolidation.It improved constructability and reduces permeability in concrete structures.Minimizes voids in highly-reinforced areas.Eliminates problems associated with concrete vibration.Also creates high quality structures with improved structural integrity.It gives high durability, strength and reliability.

Bio-medical waste means any solid and/or liquid waste produced during diagnosis, treatment or vaccination of human beings or animals. Biomedical waste creates hazard due to two principal reasons, infective and toxicity. The source of biomedical waste is the place or the location at which biomedical waste has been generated.the regular generation of biomedical waste in the major source which includes government hospitals, private hospitals, nursing home and dispensaries. Minor source includes physicians and dental clinics. he classification of the biomedical waste is carried out based on its characteristics, source of generation and the level of hazard to the environment. The biomedical waste is classified into two types, Non hazardous waste and Hazardous waste.

Most of the hazardous biomedical wastes was treated by the method of incineration to reduce organic and combustible waste to inorganic incombustible matter. Incineration is a high temperature, dry oxidation process that results in significant reduction of waste volume and weight. Wastes that cannot be reused, recycled or pose problem in disposing in landfills are treated by incineration

An incinerator is a furnace intended for burning dangerous items in a combustion chamber, where incineration is carried out.Burning potentially dangerous materials at temperatures high enough to eliminate pollutants is known as incineration. Incineration is most commonly used where there is a large-scale accumulation of waste and when treating bulky heterogeneous waste needs treatment. It can treat various hazardous pollutants, including soil, sludge, liquids, and gases.

Incinerated Biomedical Waste Ash (IBWA) was used as a partial replacement for cement in this experimental study, as it acts as a mineral admixture. Here, efforts are made to use IBWA in a constructive fashion, which adds to the enhanced performance of concrete at its optimal level and leads to eco-friendly concrete.

2.LITERATURE REVIEW

Aubert et al., (2004) studied the use of biomedical waste ash on the compressive strength and the durability of hardened concrete and suggest the use of waste in concrete constitutes a potential means of adding value.

Al-Mutairi et al., (2004) compared the compressive strength of mixtures made with bottom and fly hospital ash in order to evaluate the effectiveness of reusing hospital incinerator ash. Results showed that when 5% micro silica and fly ash were incorporated, the compressive strength of cubes was further increased.

Genazzini et al., (2003) the chance of incorporating hospital waste ashes in Portland cement- based materials is presented here. Ash characterization was performed by chemical analysis, X-ray diffraction, radioactive material detection, and fineness and density tests.

Al-Rawas et al., (2005) investigated the potential use of incinerator ash as a replacement for sand and cement in cement mortars.The cement, sand and water mixing proportions were 1:3:0.7 respectively. Results showed that incinerator ash caused a reduction in slump values when it was used as a replacement for sand while an opposite trend was observed when it was used as a replacement for cement.

Genazzini et al., 2005) The new cement–ash composite systems have been tested for future applications in building materials. The additions of hospital ash in cement matrices to be potentially used as construction elements.This involved the assessment of the effect of the additions on the physico mechanical properties of the building materials.

Anastasiadou et al., (2011) evaluated the mechanical properties of the medical waste incineration bottom ash using different amounts of ordinary Portland cement (OPC) as a binder. Result showed that strength decreased as the percentage of cement loading was reduced.

Filipponi et al., (2003) prepared the different mixes by blending hospital waste incinerator bottom ash with ordinary Portland cement in different proportions and at different water dosages. Results at curing times longer than 28 days and for waste dosages higher than 50% suggested that bottom ash exhibited weak pozzolana property.

(Azni et al., 2005) In Germany 50% of the ash produced from incinerated waste is used for the manufacturing of sound insulation walls at National roads, as well as, sub layers on the streets. 60% of the bottom ash is used for the construction of asphalt and as a sub layer of roads in Netherlands.

Anastasiadou et al., (2011) studied the cement based stabilization/solidification of fly and bottom ash generated from incinerated hospital waste to reduce the leachability of the heavy metals present in these materials.

Javed Bhat(2021),the main aim of this research is to develop SCC with locally available waste materials i.e. coal ash and wood ash, and to optimize the percentage partial cement replacement to achieve strength similar to normal concrete for a particular water-to-cement (w/c) ratio. The w/c ratios of 0.50, 0.45 and 0.42 have been considered in this study, wherein, all components are kept the same for SCC except the percentage partial cement replacement by coal ash and wood ash with the chemical admixtures adjusted for obtaining the self- compaction in concrete. It was observed that all SCC mixes without any cement replacement by coal ash and wood ash exhibited greater values in both split tensile and compressive strength compared to normal concrete.

Shiren O. Ahmed (2022),The paper focused on the feasibility of substituting the ordinary Portland cement with waste supplementary cementing materials that is, fly ash and silica fume. Four mixes were prepared with proportions of 10% and 15% of fly ash and silica fume by weight of cement in to be compared with a reference mix with 100% Portland cement. Some specimens were cured in water for 7 and 28 days, the other specimens were left in air for 28 days. compressive strength test, splitting tensile strength test and flexural strength test were performed after curing in water and air. The slump flow, V-funnel and segregation resistance test are carried out on the fresh self-compacting concrete.

3.EXPERIMENTAL PROGRAMME

I. MATERIALS:

In concrete, cement acts as binding material, and it is available in different grades based on strength and setting time. In this work, OPC 53 grade cement which satisfied the specifications of IS codes.The test results are presented in Table 1.

Table 1 -Properties of 53 grade cement.

Tests conducted	Results obtained
Normal Consistency (%)	32.5
Specific Gravity	3.12
Initial setting time (min)	48
Final setting time (min)	440

Incinerated biomedical waste ash was collected from Maridi Eco Industries(Andra) Pvt.Ltd. Kapuluppada,Municipal Dumping yard, Paradesipalam, Bheemunipatnam, Visakhapatnam,Andra Pradesh, India.The IBWA sample contained unwanted particles,which are segregated by using 90-µm sieve.

The crushed stone sand (m-sand) was used as fine aggregate in this experimental the study which was procured from the local crusher. These fine aggregates comply with IS standard conforming to zone II. Table 2 shows the basic test results of fine aggregates.Coarse aggregates were collected from the local crushers. The basic tests on coarse aggregate were examined in accordance with IS code standard. The test results are as shown in Table. 3

Table 2-Test results of Fine aggregate characteristics

Tests conducted	Results obtained
Grading Zone	Zone-II
Specific Gravity	2.65
Fineness Modulus	2.71

Table 3-Test results of Coarse aggregate characteristics

Tests conducted	Results obtained
Size	20 mm and 10 mm
Shape	Angular
Specific Gravity	2.79
Fineness Modulus	7.64

Chemical admixtures are necessary to achieve better workability and strength as low water-to-cement ratio is considered in SCC. In this experimental investigation, Cera Hyperplast XR-W40 was used as chemical admixture (super-plasticizer) which was supplied by CERA-Chem Pvt.Lt. (Superior Construction Chemical).The specific gravity of chemical admixture was 1.1.

II. MIX PROPORTIONS

The finished study aimed to investigate the use of IBWA in the production of self compacting concrete of M30 grade (target compressive strength of 30 N/mm2 at 28 days). The SCC mix proportions were determined based on the guidelines in IS: 10262 and IS: 456 .The percentage replacement of IBWA with cement was locked at 5%, 10%, 15% and 20% by weight. The concrete mix calculations for partial replacement of 5% of IBWA were carried out, and similarly for higher percentage, replacements such as 10%, 15% and 20% addition were made. Table 4 presents the designed SCC mix proportions.

Table 4-Mix design

IBWA content (%)	Cement (kg/m3)	Coarse Aggregate (kg/m3)	Fine Aggregate (kg/m3)	Water (kg/m3)	IBWA (kg/m3)	Chemical Admixture (kg/m3)	w/c ratio (%)
0	450	885	881	180	0	6.3	0.4
5	427	894	871	180	23	6.3	0.4
10	405	878	870	180	45	6.3	0.4
15	382	886	868	180	68	6.3	0.4
20	360	871	865	180	90	6.3	0.4

III. A. Determination of Fresh concrete properties

Filling and passing ability, segregation resistance are the properties of self compacting concrete. SCC possess superior flow ability in its fresh state that performs self compaction and material consolidation without segregation issues.Studying the rheological behavior of concrete, especially self-compacting concrete is vital in the design and structural integrity of concrete structures for design, construction, and structural material sustainability.The tests were conducted for assessing flow properties to ensure the better workability of the design mixes.

III.B.Determination of Mechanical properties

Flexural strength of concrete

Beam specimens of SCC mixes were prepared and cured to test the flexural strength.the prepared SCC beam specimens were subjected to 4-point bending test in the UTM.the maximum load at failure was recorded.

Fig 1. Concrete Mix

Casting of specimens:

Place the concrete into the moulds with a trowel. The concreting should be done in layers of 5cm each. For each layer proper compaction is required by tamping bar. After compacting top layer, the moulds are vibrated on the vibrating table for better mixing and bonding.For each trail 3 beams specimens are casted for calculating 14 days and 28 days of strength.

Dimensions of beam: 500 mm x 100 mm x 100 mm

Fig.2 casting of beams

Curing of specimens

The specimens are left in the moulds undisturbed at room temperature for about 24 hours after casting. The specimens are then removed from the moulds and immediately transferred to the curing tank Le. cubes are cured in fresh water. Curing is most important process in concreting Concrete strength increases with age of curing. The specimens should keep in curing tank for better improvement in strength. Generally curing is done by ponding curing tanks. The water used for concrete curing should be free from salinity, scrap, vegetation and chemicals. We need to change the water for every 7 days of curing. The specimens are tested for 14 days and 28 days curing

4.RESULTS AND DISCUSSIONS

A.Fresh Properties

I. Slump Flow test

The stating SCC mix was first tested for slump flow and followed by SCC mixes with IBWA content. After the test, the measured diameter in the flow table of the SCC mix without BMIA i.e., 0% was about 713 mm. The slump flow diameter of IBWA substituted SCC mixes was observed as 706 mm, 698 mm, 681 mm and 659 mm for 5%, 10%, 15% and 20% replacement levels, respectively.The slump flow value decreases with an increase in the IBWA content, which is mainly due to more water absorption by the fine IBWA particles.

Fig.3 Slump flow

II. L-box test

This test was conducted to observe the passing ability of SCC mixes through vertically placed bars in the L-box.The L-box ratios were observed as 0.903, 0.849, 0.831, 0.814 and 0.8 for 0%, 5%, 10%, 15% and 20% IBWA substituted SCC mixes, respectively.

Fig.4 L- box test

III.V-box test

This test was conducted to observe the filling ability of SCC mixes. A flow time of 6.85 s, 7.49 s, 9.1 s, 10.3 s and 11.2 s was achieved by SCC mixes with 0%, 5%, 10%, 15% and 20% IBWA content, respectively.

Fig.5 V-Box test

Table 5-Results of fresh properties

Fresh Properties of SSC	IBWA percentages in SSC mixes				
	0	5	10	15	20
Slump flow (mm)	713	706	698	681	659
L- Box ratio	0.903	0.849	0.831	0.814	0.8
V- box (s)	6.85	7.49	9.1	10.3	11.2

B.Flexural strength results

The flexural strength of all mix proportions of self compacting concrete including 0 % and all other respective proportions i.e.,5%,10 %,15 % and 20 % are tested at 14 and 28 days of curing.The tables below gives the flexural strengths of different combinations for 14 and 28 days.

Table 6- Flexural strength for 14 days

IBWA percentages(%)	Flexural strength obtained (MPa)
0	2.966
5	3.924
10	3.492
15	2.963
20	2.027

Table 7- Flexural strength for 28 days

IBWA percentages(%)	Flexural strength obtained (MPa)
0	3.841
5	4.387
10	4.106
15	3.352
20	2.863

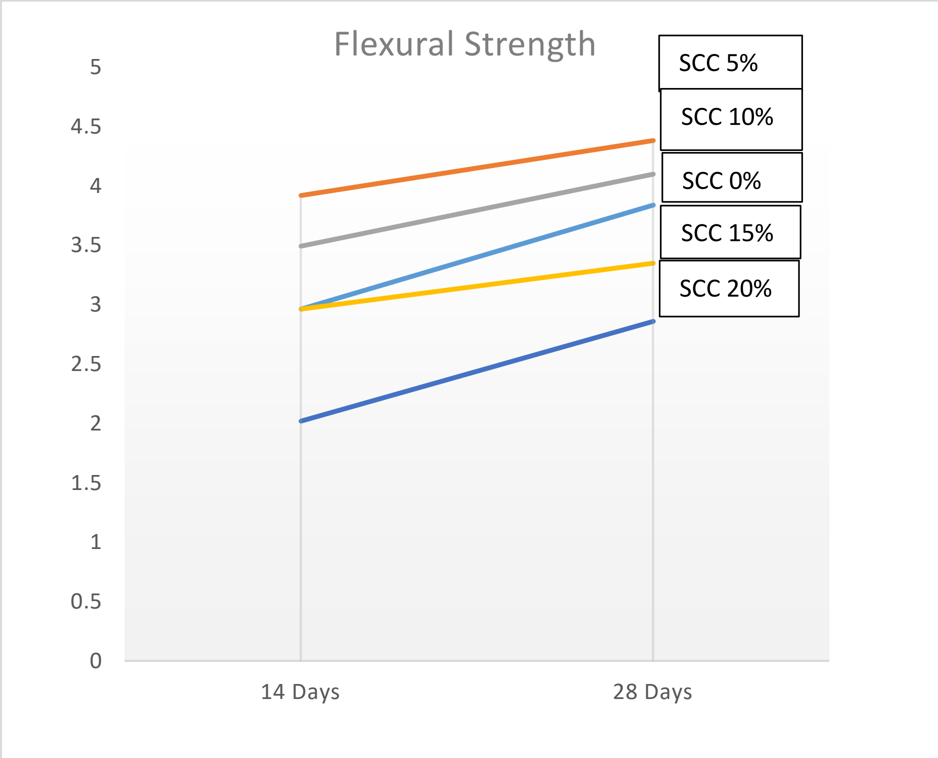

Fig.6 Variation of flexural strength due to addition of BMWA at different mix

5.CONCLUSIONS

Based on the experiments conducted, the following conclusions are drawn:

SSC 20%

1) Biomedical waste ash can effectively be used in concrete making.

2) Workability of concrete made using biomedical waste ash is lower than that of conventional concrete.

3) The workability properties of SCC decrease with the increase in IBWA content due to higher water absorption by the BMIA particles, but it can be compensated by using suitable dosage of super-plasticizer.

4) Based on the mechanical strength results, it was found that the optimum level of substitution of IBWA in SCC was 5%. About 5% increase in compressive strength was observed when compared to that of control SCC mix. Similar trend of variation in flexural strengths was observed.

5) Finally, from the overall observation of the results, it can be concluded that about 5% of IBWA can be easily substituted for cement to produce SCC mixes, which enhance many of the performance characteristics of concrete, leading to an eco-friendly and sustainable solution.

Replacement of IBWA with cement is found to improve the strength of concrete. The optimal dosage of replacement is found to be 5% & 10%. Utilization of IBWA will avoid the disposal problems and related environmental issues. Utilization of BMWA will reduce the hazardous toxic materials.

This research work opens up plenty of possibilities for utilizing harmful toxic Incinerated Bio-Medical Waste Ash (IBWA) replacement in concrete, thereby addressing the environmental and disposal problems of IBWA. It can been used as a building material in the construction field for various applications.

REFERENCES

[1]. Udit Kumar, Väas Srivastava, Amit Kumar Singh (2016). Suitability of Biomedical Waste Ash in Concrete.

[2]. Altin S. Alin A, Elevii B and Cerit O (2003). Determination of hospital waste composition and disposal methods: a case staly.

[3]. Ami I and Katayon 5 (2002). Characteristics of slag produced from incinerated hospital waste.

[4]. CPCB (2008). Hazardous waste management [Online], Chapter 9. Highlights 2008, Central Pollution Control Board,

[5] .Gidarakos E. Petrantonaki M. Anastasiadou K and Schramin KW (2009) Characterization and hazard evaluation of bottom ash produced from incinerated hospital waste.

[6]. Goswami-Giri A (2007). Effect of biomedical waste ash on growth and yield fenugreck and mustard.

[7]. Racho P and Jindal R (2004). Heavy metals in bottom ash from a medical waste incinerator.

[8]. Reijnders L. (2005). Disposal, uses and treatments of combustion ashes: a review,

[9]. Sabiha Javied, Tufail M and Khalid S (2008). Heavy metal pollution from medical waste incineration.

[10]. SOER (2009) State of Environmental Report [Online], India 2009. Ministry of environment and forests, Govt. of India.

[11]. India Today (2011) generation and disposal of biomedical waste throughout the country