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Experimental Investigation on Biomedical Waste Ash and Metakaolin on Ordinary Portland cement as Substitute in Concrete and Its Performance at Elevated Temperature

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ABSTRACT: Cement concrete is the most extensively used construction material. Maintenance and repair of concrete structure is a growing problem involving significant expenditure. As a result, carried out worldwide, it has been made possible to process the material to satisfy more stringent performance requirement, especially long-term durability. Biomedical waste management is a major problem in India. Waste generated from medical activities is a real problem for living nature and human world. In order to minimize its hazardous effect into the environment some studies confirmed the successful utilisation of biomedical using biomedical waste ash as partial replacement in cement. Metakaolin looks to be a promising supplementary cementitious material for high performing concrete. Properties of concrete with a metakaolin is mostly preferred additives in high performance concrete. The substitution proportion of metakaolin and biomedical waste ash are to be used was 5%, 10%, 15%, 20%, 25% and 30% by weight of cement. To make this cubes and cylinders to determine the strength and durability of concrete of it.

I. INTRODUCTION

Concrete is a composite material composed of fine and coarse aggregate both together with a fluid cement that hardens over time. It is the main part of any construction work which is composed of gravels or crushed stones, sand hydrated cement etc. it has been used over a century in all construction works. Now a day's construction sector is expanding rapidly on a large scale involving new techniques. The consumption of natural resources in construction is phenomenal and high cost. To overcome the use of natural resources and by attempting the use waste materials and biomedical waste ash in concrete and also metakaolin as a pozzolanic product which could result in low cost construction and could also help to avoid the problems related to environmental pollution. All recycling and reuse of waste products in order to determine suitable and specific applications.

Wastes are unwanted or unusable materials which includes municipal solid waste, hazardous waste, waste water, water waste, radioactive waste and other waste comes in many different forms that are agricultural waste, commercial waste, biomedical waste, electronic waste etc.

Biomedical waste is any kind of waste containing infectious materials. Biomedical waste is generated from biological and medical sources and activities, it may also package unused bandages, infusion kits and also a research laboratory wastes. Biomedical waste generated from hospitals medical research activities, medical colleges and other medical sources are causing a major problem in India. The waste generated from different sector will adversely affect environment as well human world. Biological waste can be broadly classified as biological wastes and non-biological wastes that may or may not be infectious. According Ministry of environment and forest about 4,05,702kg/day of which only 2,91,983(72%) is disposed which means that almost 28% of the wastes are left untreated.

Metakaolin is a dehydroxylated form of the clay mineral kaolinite. Metakaolin is commonly used in the production of ceramics but now a day's it is also used as cement replacement in concrete. Metakaolin is available in many different varieties and qualities. The purity will define the binding capacity or free lime. Some of them also provide special reactivity. It has a smaller particle size(1-2µm) and higher surface area compared to the Portland cement. When used in concrete metakaolin undergoes a pozzolanic reaction and refines the microstructure of the hydrated cement paste. Due to its smaller size and high surface area metakaolin reacts quickly and reduces the diffusion



co-efficient. Compared with ordinary Portland cement metakaolin is a valuable admixture for concrete and cement applications 8-20% of Portland cement replaced by metakaolin, such a concrete exhibits favourable engineering properties.

II. RELATED WORK

B Prashant, V Ranga Rao the experimental work was carried out on concrete containing biomedical waste ash in the range of 0%, 5%, 10%, 15%, 20% keep metakaolin as constant of 20% by weight for M30 grade concrete. The experimental results shows that there is some increase in compressive strength and split tensile strength for combination of 20% biomedical waste ash and 20% of Metakaolin after replacing the biomedical waste and metakaolin with some percentage. For durability Study Concrete cubes were exposed to chloride attack (NaCl) and the result is compared with that of control concrete.

Sathvik S, Suchith S the biomedical waste ash were used in concrete as a replacement for cement with 5%, 10% and 15% of substitution. The experimental results show that increase in compressive and split tensile strength as compared with conventional concrete. After analysing result the optimum value of biomedical waste ash are to be used within the concrete mix with a water/cement ratio of 0.5w/c with 15% of replacement. The finding revealed that using biomedical waste ash lead to enhancing the property of concrete.

Udit Kumar, Vikas Srivatsa, Amit Kumar Singh biomedical waste ash were used in concrete as a partial replacement for cement with 0%, 2.5%, 5%, 7.5%, 10%, 12.5% and 15% of substitution. After analysing the results the optimum value of biomedical waste ash to be used within the concrete mix with a water/cement ratio of 0.45 determined as about 15% to 20%. The Funding revealed that using biomedical waste ash leads to enhancing the properties of concrete.

M Narmatha, Dr T Felixkola (2017) investigated the cement replacement level were 5%, 10%, 15%, 20% by weight for metakaolin. The strength of all metakaolin admixed concrete mixes over shoot the strength development of concrete. Mix with 15% metakaolin is superior to all other mix. The increase in metakaolin content improves the compressive strength, split strength and flexural strength up to 15% replacement. The result encourages the use of metakaolin.

N Ravi, P Bhavani (2019) the experimental work carried out on concrete containing a metakaolin in the range of 5%, 10%, 15% by weight for M60 grade of concrete. The experimental results shows that increase in compressive strength and durability of concrete with 15% replacement of metakaolin in concrete. The cement can be replaces up to 15% with metakaolin.

J D Chaithanya Kumar, C H Jyoti Nikhila the experiment has been carried out as partial replacement of cement with metakaolin in M70 grade of concrete at 0%, 10%, 15%, 20%, 25% and 30% of replacements. The mix design was made making the use of Emtroy Emperical Shocklocks method. Cubes are tested for durability studies with hydrochloric acid and sulphuric acid of 0.5% and 1% concentration. The experimental result showed that there is some increase in compressive strength of concrete showed better result at 15% replacement of metakaolin for 0.5% and 1% hydrochloric acid at the age of 28 days of strength. The specimen was heated to different temperature of 100°C, 200°C, 300°C, 400°C and 500°C for three different durations of 1, 2 and 3 hours at each temperature. The experimental result showed that some increase in strength at 100°C temperature after it start losing its strength.

III. METHODOLOGY

In this experimental study M30 grade concrete is designed as per the code. The material are collected i.e., cement, fine aggregate, coarse aggregate, biomedical waste ash and metakaolin with the control concrete i.e. 5%, 10%, 15%, 20%, 25%, 30% of concrete is replaced with the biomedical waste ash and metakaolin. The moulds are casted for both conventional concrete and replaced concrete with biomedical waste ash and metakaolin. Casted specimen are cured in water for 7, 14, 28 days respectively. After curing compression strength and split tensile strength test is conducted at 7, 14, 28 days. These specimens are tested for each designation and average of three results will be taken. Also, in other hand the casted specimens are treated under the different °C temperature i.e., 200°C, 300°C and 400°C. Immediately after demoulding the specimens. After the heating, cubes are directly taken to tests i.e., compression strength test and split tensile strength test.

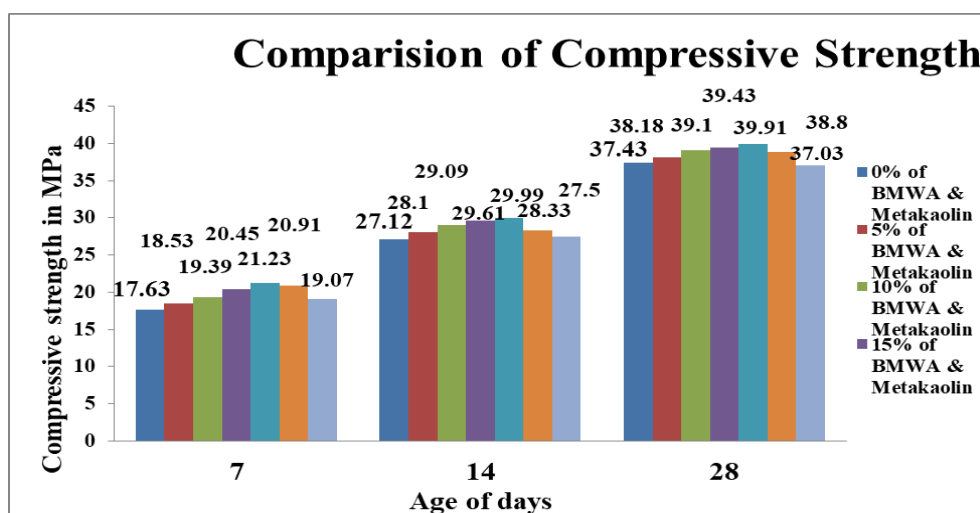
IV. EXPERIMENTAL RESULTS

The properties and the quantity of proportions remain same for all the mixes but the percentage of admixtures changes for every mixes. The strengths of self-curing concrete is compared to the strengths of normal concrete.

1.COMPRESSIVE STENGTH RESULTS FOR DIFFERENT PERCENTAGE OF BOIMEDICAL WASTE ASH AND METAKAOLIN FOR M30 GRADE

Test results of M30 grade concrete for 7, 14 and 28 days

SL.NO	Grade	Percentage Replacement of BMWA and Metakaolin	Age in days	7	14	28
			Compressive strength in Mpa			
1	M ₃₀	0%		17.63	27.12	37.43
2	M ₃₀	5%		18.53	28.10	38.18
3	M ₃₀	10%		19.39	29.09	39.10
4.	M ₃₀	15%		20.45	29.61	39.43
5	M ₃₀	20%		21.23	29.99	39.91
6	M ₃₀	25%		20.91	28.33	38.80
7	M ₃₀	30%		19.07	27.50	37.03



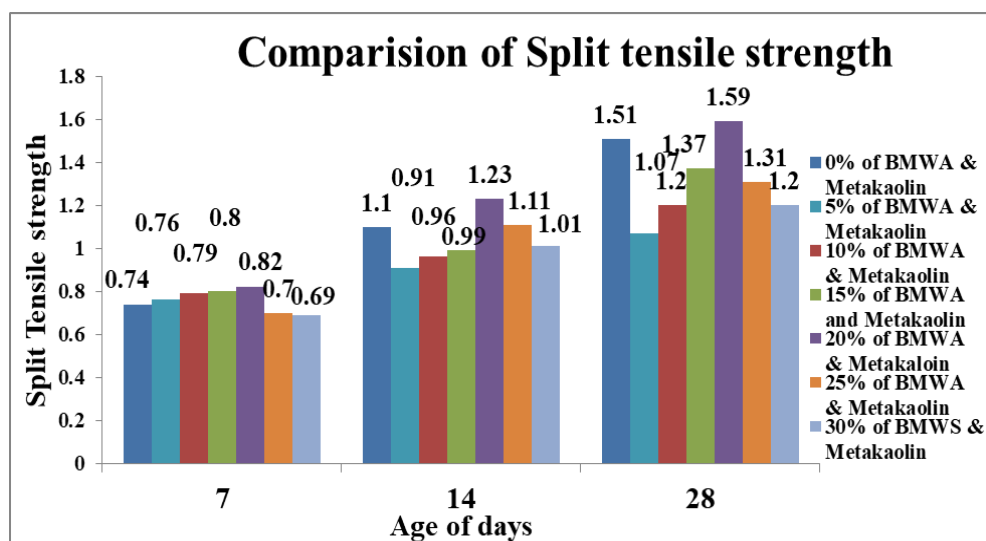
OBSERVATIONS:

The above graph indicates that the compressive strength for 7, 14 and 28 days with 5%, 10%, 15%, 20%, 25% and 30% of biomedical waste ash and metakaolin of the weight of cement. The optimum value is obtained at 20% replacement of biomedical waste ash and metakaolin in compressive strength test.

2. SPLIT TENSILE STRENGTH RESULTS FOR DIFFERENT PERCENTAGE OF BIOMEDICAL WASTE ASH AND METAKAOLIN FOR M30 GRADE

Test results of M30 grade concrete for 7, 14 and 28 days

SL.NO	Grade	Percentage Replacement of BMWA and Metakaolin	Age in days	7	14	28
			Split Tensile Strength in Mpa			
1	M ₃₀	0%		0.74	1.1	1.51
2	M ₃₀	5%		0.76	0.91	1.07
3	M ₃₀	10%		0.79	0.96	1.20
4	M ₃₀	15%		0.80	0.99	1.37
5	M ₃₀	20%		0.82	1.23	1.59
6	M ₃₀	25%		0.70	1.11	1.31
7	M ₃₀	30%		0.69	1.01	1.20



OBSERVATION:

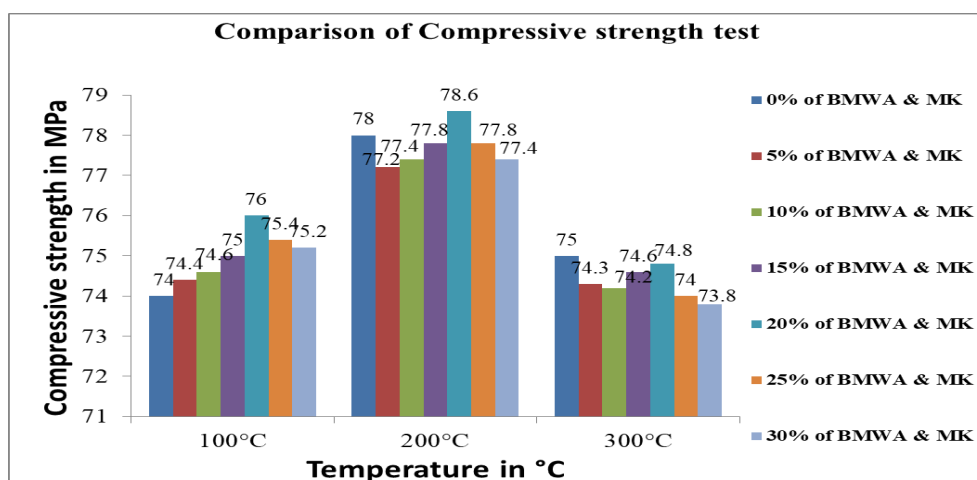
The above graph indicates that the split tensile strength for 7, 14 and 28 days with 5%, 10%, 15%, 20%, 25% and 30% of biomedical waste ash and metakaolin of the weight of cement. The optimum value is obtained at 20% replacement of biomedical waste ash and metakaolin in split tensile strength test.

3. TEMPERATURE STUDIES

COMPRESSIVE STRENGTH RESULTS FOR DIFFERENT PERCENTAGE OF BMWA AND MK AT DIFFERENT TEMPERATURE FOR M30 GRADE

Test result of M30 grade concrete for 100°C, 200°C and 300°C

SL.NO	Grade	Percentage Replacement of BMWA and Metakaolin	Temperature	100°C	200°C	300°C
			Compressive Strength in MPa			
1	M ₃₀	0%		74	78	75
2	M ₃₀	5%		74.4	77.2	74.3
3	M ₃₀	10%		74.6	77.4	74.2
4.	M ₃₀	15%		75.0	77.8	74.6
5	M ₃₀	20%		76.0	78.6	74.8
6	M ₃₀	25%		75.4	77.8	74
7	M ₃₀	30%		75.2	77.4	73.8

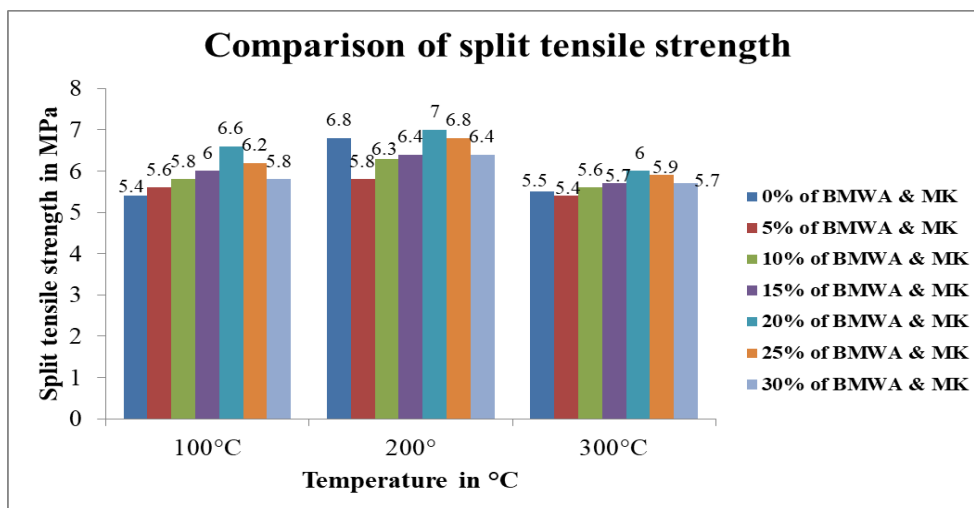
**OBSERVATION:**

The above graph indicates that the compressive strength for 100°C, 200°C and 300°C with 5%, 10%, 15%, 20%, 25% and 30% of biomedical waste ash and metakaolin of the weight of cement. The optimum value is obtained at 200°C for 20% replacement of biomedical waste ash and metakaolin in compression strength test.

SPLIT TENSILE STRENGTH RESULT FOR DIFFERENT PERCENTAGE OF BMWA AND MK AT DIFFERENT TEMPERATURE FOR M30 GRADE

Test result of M30 grade concrete for 100°C, 200°C and 300°C

SL.NO	Grade	Percentage Replacement of BMWA and Metakaolin	Temperature	100°C	200°C	300°C
			Split Tensile Strength in Mpa			
1	M ₃₀	0%		5.4	6.8	5.5
2	M ₃₀	5%		5.6	5.8	5.4
3	M ₃₀	10%		5.8	6.3	5.6
4.	M ₃₀	15%		6.0	6.4	5.7
5	M ₃₀	20%		6.6	7.0	6
6	M ₃₀	25%		6.2	6.8	5.9
7	M ₃₀	30%		5.8	6.4	5.7



V. CONCLUSION

- The Compressive strength and split tensile strength of concrete M30 grade mix is expected to increase with increase in percentage of biomedical waste ash and metakaolin as compared to conventional/normal concrete. It is noticed that the maximum results is obtained for 20% replacement.
- The compressive strength and split tensile strength test of concrete M30 grade mix is increases in increasing the percentage of biomedical waste ash and metakaolin as compare to conventional concrete. It is notified that the strength is optimum at 200°C temperature or 20% of replacement of biomedical waste ash and metakaolin.
- The partial replacement of BMWA and Metakaolin in cement with varying percentages as 0%, 5%, 10%, 15%, 20%, 25% and 30%, the strength results will increase up to 20% replacement of BMWA and metakaolin and further varying the strength starts to decrease when compared with the conventional concrete. The optimum result is obtained for 20 % partial replacement in cement.

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