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DESIGN M55 GRADE OF CONCRETE AND PARTIALLY REPLACEMENT OF CEMENT BY METAKAOLIN FOR ENHANCHING THE PERFORMANCE OF HIGH STRENGTH CONCRETE

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ABSTRACT

The compressive strength was calculated using a 10%, 20%,30%,40% compression ratio. The effect of integrating metakaolin on the mechanical and durability qualities of high strength concrete is shown in this study. The strength reduced after 30 percent replacement, although it remained higher than the control mixture. At 30% replacement, a compressive strength of 80.42 MPa was reached.. The research on partial cement replacement with metakaolin as a wholly extraordinary share in HPC for M55 grade of incorporate is accomplished in this thesis paper. For Metakaolin, the replacement levels were 0%, 10%, 20%, 30 %, and 40% (by weight).The final result (compressive strength) is compared to a standard specimen. Thirty cube specimens of grade M55 of high strength concrete with Metakaolin as a supplementary cementitious material have been tested in laboratory. Six cubes have been cast for each percentage of Metakaolin i.e. 0%, 10%, 20%, 30%, and 40%. Water/binder ratio for all mixes has been maintained at 0.39 with superplasticizer dosage at 1.25% of weight of cementitious material. The effect of partially replacement of cement with varying percentage of Metakaolin enhances the compressive strength. At 30% replacement of Metakaolin by weight of cementitious materials the increase in compressive strength noted was maximum as compare to other percentage mixes. At 40% replacement level there was slightly decrease in compressive strength was noted.

I. INTRODUCTION

Concrete is a composite material which is predominantly used all over the world. It is obtained by mixing cementing materials, aggregates and water in required quantities. The strength characteristics of concrete depend upon the properties of constituent of material and their combined action. In the production of cement Co2 gas emission is more, due to these results in damage of natural climatic conditions. To reduce the consumption of cement partial replacement of cement with some supplementary cementitious materials like Metakaolin, fly-ash, bottom ash, rice husk, and silica fume etc., are used in concrete mix.

Metakaolin is pure clay made up of kaolinite, which is white and has a soft plastic-like texture consisting of hydrated aluminum silicate and mineral kaolinite. It is much different from other supplemental cementitious materials such as fly ash, slag, or silica fume. Also, metakaolin is not a byproduct of an industrial process. MK is a pozzolanic substance. It's a thermally activated aluminosilicate with high pozzolanic activity or better than fume silica and depending on the purity and crystallinity of the precursor clays. When MK is used to partially replace cement, it combines with calcium hydroxide as a byproduct, resulting in an increase in C-S-H g. C-S-H gel is the sole cause of strength development in cement and cement-based concrete. This is a chemical reaction.

C-S-H gel +Calcium hydroxide = Cement + Water C-S-H g = Calcium hydroxide + Metakaolin

It is made by dehydroxylated kaolin clay upon heating temperature range of 650 to 800 degrees Celsius. (Mayo, 1998), has been successfully used SCM in concrete because of its high pozzolanic properties (sabir et al., 2001,Al-Akhras and Nabil,2006).

Metakaolin had 99% particles < 16μm with a mean particle size of about 3 μm.. Metakaolin has also been shown to decrease concrete permeability, which in turn increases its resistance to sulfate attack and chloride ion ingress. Additionally, metakaolin may reduce autogenous and drying shrinkage, which could otherwise lead to cracking. Thus, when used as a partial replacement for portland cement, metakaolin may improve both the mechanical properties and the durability of concrete. In general, metakaolin offers a set of benefits similar to those imparted by silica fume, including comparable strengths, permeability, chemical resistance, and drying shrinkage resistance

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II. METHODOLOGY

The experimental work planned in this study consist of comparing mix proportioning of Metakaolin induced hpc concrete by IS 10262: 2019 for given design strength in terms of cement consumption, percentage of Metakaolin and strength achieved. The use of supplementary cementitious material is as per IS 456:2000 and IS 10262: 2019. In this study, M55 grade of concrete mix was done as per IS: 10262-2009. In this mix design constant water cement ratio of 0.3 with targeted slump of 25-75mm by the replacement of 0%, 10%, 20%, 30%,40 % of cement with Metakaolin was maintained. Based on the design mix the concrete mix is prepared, slump cone test & compaction factor test was conducted on fresh concrete for knowing workability of concrete. All the cubes casted will be cured for 3 days, 7days & 28 days with placing an identity mark on each cube for identity in a curing tank. All the cubes after completion of curing period will be tested for its hardened properties(compressive strength).

III. RESULTS AND DISCUSSION

Table 1: Mix proportion for various trial of Self-Compacting concrete For 1 m3 of volume

Mix no.	**1**	**2**	**3**	**4**	**5**
% of Metakaolin	0%	10%	20%	30%	40%
Cement	492.9	443.6	394.5	345.3	296.1
Water/Binder ratio	0.3	0.3	0.3	0.3	0.3
Coarse Aggregate(kg)	1240.8	1236.3	1231	1226	1220
Fine Aggregate(kg)	625.7	623.2	621.2	619.2	617.5
Water(liter)	167.5	167.5	167.5	167.5	167.5
% Superplasticer(Sika Plast 3001NS)	1.25%	1.25%	1.25%	1.25%	1.25%
Extra water due to correction	19.5	19.5	19.5	19.5	19.5

Cube specimens prepared for compressive strength were tested in laboratory and different compressive strength was found which are listed table2.

Table 2: Compressive strength Test Results of Cube.

Mix No.	% of Metakaolin by weight of binding material	Compressive Strength Test Results of Cube sample (150mm3)	
		14 Days	28 Days
1.	0	40.55	65.36
2.	10	45.63	70.57
3.	20	50.26	74.92
4.	30	54.52	80.42
5.	40	52.34	76.95

IV. CONCLUSION

The following conclusions were made

- We will use the materials for study because the material qualities of the cement, fine aggregates, and coarse aggregates are within acceptable limits according to IS code requirements.
- The value of the Slump cone for Metakaolin concrete grows as the percentage of Metakaolin increases, making the concrete unworkable.

- The value of the compaction factor in Metakaolin concrete falls as the proportion of Metakaolin increases, with the highest values found at 30% Metakaolin.
- The compressive strength of concrete is maximum at 30% of Metakaolin and is the optimum value for 14days curing, 28days curing.

With all situations of durability studies in Metakaolin concrete, the percentage loss of weight and percentage loss of compressive strength increases as the percentages increase. As a result, Metakaolin

Concrete can withstand a 10% replacement rate.

So the replacement of 30% of Metakaolin is generally useful for better strength values in M55 grade of concrete.

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