"Experimental study on compressive strength of concrete with metakaolin by Normal & Accelerated curing"

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ABSTRACT

The manufacturing of cement liberates the green-house gasses into atmosphere. To overcome this problem so many alternative materials has been invented by researchers to minimize addition of cement. The incorporation of these alternative materials as cementitious material in concrete enhances the attributes of concrete. In this scenario metakaolin gained momentum as a substitution to cement in concrete. Most of the researchers studied the performance of concrete incorporating metakaolin as cementitious material in normal curing conditions. There is a need for analyzing the impact of accelerated curing on properties of concrete by incorporating metakaolin as cementitious material. The current construction industry needs high early strength for removal of form work in early ages. The accelerated curing is a method which provides high early strength. In this study, different proportions of metakaolin are added as partial alternative to cement and cured in accelerated curing tank for 3.5 h. The Compressive test results depicted the incorporation of 10,15,20% of metakaolin as substitute to cement amplifies the overall performance of concrete in accelerated curing regime.

Keyword : - *Accelerated Curing, Metakaolin, Boiling Water Method, Normal Curing*

1. INTRODUCTION

Concrete is widely used construction materials. However, the production of Portland cement releases large amount of CO2 (carbon dioxide), a greenhouse gas. One ton of Portland cement clinker production releases approximately one ton of CO2 and other gases. Environmental issues are playing essential role in the sustainable development of concrete industry. Mineral admixtures such as supplementary cementitious materials are an indispensable part of modern concrete. The use of high activity admixtures such as slag and low-activity or inert admixtures such as limestone powder effectively reduces energy and resource consumption by decreasing the amount of cement used in the concrete production process and ensures the green and sustainable development of the concrete industries. More importantly, the use of admixtures reduces the dependence of modern concrete strength on cement strength, improves the rheological properties of the mixture, and increases the durability of concrete structures. Metakaolin is mainly used as a mineral admixture in cement and concrete. Compared to silica

fume and fly ash, metakaolin has a very high reactivity level. Previous studies have shown that metakaolin can increase the mechanical strength of concrete to varying degrees, depending mainly on the replacement rate of metakaolin, the water/binder ratio, and the age at testing Remarkably, metakaolin has a positive effect on reducing drying shrinkage and improving durability. The compressive strength of cement concrete obtained after 28 days of moist curing is considered for quality of concrete in construction works. To get this strength for good quality control one has to wait for 28days. In order to get high early strength and also to reduce time for economical quality control, accelerated curing is used. In this method of curing the temperature of water is increased, which results in increase in concrete temperature and rate of development of strength accelerates which will be more comparing to normal moist curing

1.1 What is Accelerated Curing Test ?

• Usually, the concrete specimen shall be tested after completion of 28 days of concrete curing activity.

• The accelerated curing test is a method of curing concrete specimens to attain its yield strength quickly. So, we can know the 28 days of compressive strength of concrete within a day.

Why do we need it?

• Most of the time, knowing the concrete strength earlier helps avoid dangerous accidents and saves a life.

• This Accelerated curing method is mostly used in the precast construction industry, where the formwork needs to be removed at the earliest for productivity.

• To reduce the waiting period of formwork removal and to save cost eventually.

How do you accelerate the curing of concrete?

• The acceleration concrete curing can be done by following methods,

• Warm water method , Boiling water method We discuss the boiling water method, which is mostly used as an accelerated curing method.

- Apparatus required

1. Curing Tank
2. Clock
3. Compression Testing Machine
4. Weighing Machine
5. Cube Mould

IS code for Accelerated Curing Tank The specification of the accelerated curing tank has been mentioned in IS code 9013 1978. The curing tank should be made of corrosion-resistant material.

2. RESEARCH SIGNIFICANCE

In order to compare strength of concrete with and without metakaolin by Normal & Accelerated curing , an experimental work has been carried out in laboratory, in which total cubes 24 were cast and cured by normal water curing for 28 days, and by Boiling water method. Generally in boiling water method to heat the water up to the temperature 100o C, approximately period of five hours is required. Hence new method has been suggested in which the specimens were kept in the accelerated curing tank initially and were subjected to rising temperature. The compression test was carried out and test results were recorded.

2.1 Accelerated Curing By Boiling Water Method (IS 9013:1978; Reaffirmed In 2004):

In this method after the specimens have been made, they shall be stored in a place free from vibration, in moist air of at least 90% relative humidity and at a temperature of 27 ±20C for 23 hours ±15 minutes from the time of addition of water to the ingredients. The specimens shall then be gently lowered into the curing tank and shall remain totally immersed for a period of three and half hours ± 5 minutes. The temperature of the water in the curing tank shall be at boiling at 100C. The temperature of water shall not drop more than 3°C after the specimens are placed and shall return to boiling within15 minutes. After curing in the tank for a specified period, the specimen shall be removed from the boiling water, removed from the moulds and cooled by immersing in cooling tank at 27 ± 2°C for 2 hours. The strength is calculated.

3. MATERIALS AND EXPERIMENTAL WORK:

The materials required for the experimental work were tested in the laboratory to get necessary data for mix design:

Cement:

Ordinary Portland cement (PPC) of 43 grade (Conforming to IS 8112-1989, reprint 1997) was used. The test results of the cement are given in Table 1.

Fine aggregate:

Type: Natural River Sand Fineness Modulus = 3.97 (Sand conforms to grading zone II) Specific gravity: Sfa = 2.67

Free surface moisture: Nil

Coarse aggregate:

Type: Crushed Basalt Maximum size = 20mm Specific gravity: Sca = 2.79 Free surface moisture: Nil

Concrete mix design:

Concrete Mix design is carried out for concrete grade M30. Following design stipulations are used:

- Degree of workability : Medium
- Degree of quality control : Good
- Batching: Weigh batching7
- Type of exposure : Moderate.
- Max. size of aggregate : 20 mm

Following mix proportions (Table 2) are finalized after taking some trials of each mix of respective concrete grade. Concrete cubes were cast in 150 x 150 x 150 mm cube moulds. Total 24 cube specimens of each proportion were cast and properly vibrated for consolidation. In first phase, 6 specimens were casted without metakaolin and cured by normal curing and accelerated curing method. In second phase 6 specimens were casted by replacing cement with 10% metakaolin and cured by accelerated curing method, and in third phase, phase 6 specimens were casted by replacing cement with 15% metakaolin and cured by accelerated curing method. In last phase of experimental work phase 6 specimens were casted by replacing cement with 20% metakaolin and cured by accelerated curing method. The compression test was carried out in compression testing machine.

4. RESULTS & DISCUSSION

The results for 28 days compressive strength by normal curing method, boiling water method for M30 design mixes have summarized in Table 3 for cubes.

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[1] Properties of cement

[2] Mix design

[3] Test Results

Table 1: Properties of Cement

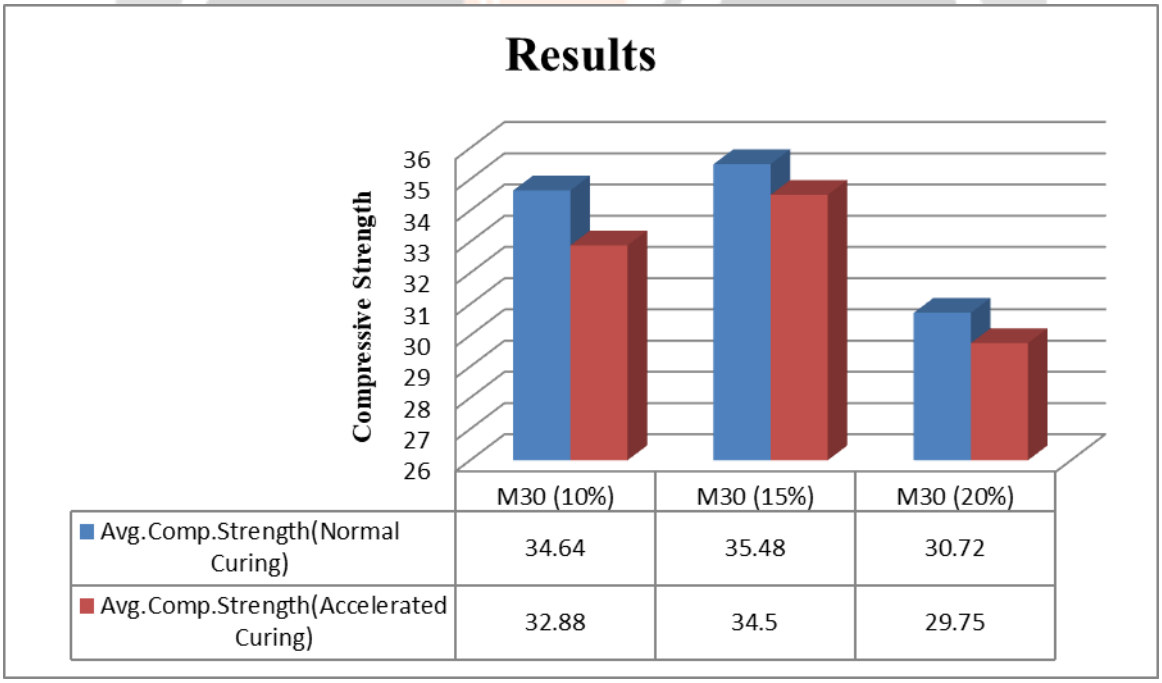
Sr.No.	Description of Test	IS References	Result	IS Req.
1	Fineness of cement	IS 269-1976	1.00%	<10 %
2	Standard consistency of cement	IS 4031-1988	30.5%	26-33%
3	Setting time of cement: (is 12269-1987)	IS 269-1976		
	A) initial setting time		165 min	<30 min
	B) final setting time		275min	>600 min

Table 2: MIX DESIGN

SR.NO.	GRADE	WATER CEMENT RATIO	CEMENT (Kg/M^3)	CA (Kg/M^3)	FA (Kg/M^3)	WATER CONTENT (Kg/M^3)
1	M30	0.45	438	1113	681	231

Grade Of Concrete (With Metakaolin)	Average Strength (Normal Curing) N/mm^2	Average Strength (Accelerated Curing) N/mm^2
M30 (10%)	34.64	32.88
M30 (15%)	35.48	34.50
M30 (20%)	30.72	29.75

Table 3: Test Results



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