ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 7, July 2023

Experimental Study on Development of High Strength Concrete Using Metakaolin

[1] Deepak N, [2] Likith.M.J, [3] Brijesh Patel .K.L, [4] Indu

[1][2][3][4] UG Student, Department of Civil Engineering, Malnad College of Engineering, Hassan, Karnataka, India
[1] deepakn915946@gmail.com

Abstract*— High-strength concrete (HSC) is now widely used in the construction industry all over the world. Mix design is a process of choosing the mixture of ingredients necessary to meet expected properties of fresh and hardened concrete. Metakaolin which is derived from purified kaolin clay is added with ordinary Portland cement as partial replacement. The main objective of the present experimental investigation is to study the strength and behaviour concrete beams ,cubes and cylinders made by adding metakaolin, superplasticizer and other conventional materials. For achieving the above objective a total of 36 cubes of size 150mm x 150mm x 150mm , were casted and tested in the laboratory. The experimental work consists of compressive strength of cubes, The replacement level is 0,10,12,&15% of metakaolin and W/C ratio is constant for all the specimens. W/C ratio is 0.28. Grade of concrete used is M65. Super plasticizer Polycarboxylate ether is added. The test results obtained are presented and discussed in this work.

***Index Terms*— Compressive strength, Metakaolin, Polycarboxylate ether**

I. INTRODUCTION

Concrete is one of the widely used common materials .There is rapid development in the area of cement, concrete technology and also in the admixtures like pozzolanic admixture, which can improve the performance characteristics of concrete. High strength concrete (HSC) may be defined as concrete with a specified characteristic cube strength between 60 and 100 N/mm^2, although higher strengths have been achieved and used. Strength levels of 80 to 100 N/mm^2 and even higher are being used for both precast and in-situ work .

Superplasticizers / high range water reducers should be used to achieve maximum water reduction, although plasticizers may be adequate for lower strength HSC (C60 to C70). Silica fume (microsilica) or metakaoline can be used to enhance the strength at high levels (C80 and above), but is not needed generally at the lower end (C60 to C80).

Metakaolin (MK) is classified as a Mineral Admixture in IS 456:2000 in clause 5.2.1.4. : Metakaolin is produced by heat treating of Kaolin, one of the most abundant natural minerals to a temperature of 600-800 degree Celsius. s. Due to its high surface area and high reactivity, relatively small addition rates of MK produce relatively large increases in strength, impermeability and also the durability while its light colour gives it an aesthetic advantage.

II. LITERATURE REVIEW

High strength concrete by partial replacement of cement by metakaolin

"International Research journal of Engineering and technology (IRJET)e-ISSN:2395-0056 Volume:05 Issue:04/ apr-2018Mohammed samiuddin fazil and Fouzia shaheen(2015)

Analyzed that all the concrete mixes made with various replacement ratios of MK and AF by weight of cement shows more compression and flexural strength when compare to the ordinary concrete mix.10% replacement of AF gives higher flexural strength. 5% MK replacement exhibits optimum content with or without super plasticizer and 10% MK exhibits the optimum content in concrete with the inclusion of super plasticizer 10% replacement o0f MK by weigh of cement gives compressive strength 54.15 N/mm2 at 28 days and flexural strength 6.2 N/mm^2 .

Experimental Study of High Strength Concrete Using Admixture Metakaolin (MKA)"

International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) | e-ISSN: 2319-8753, p-ISSN: 2320-6710| M.Narmatha and Dr. T. Felixkala (2016)

Analyzed that the strength of all MK concrete mixes over shoot the strength of OPC.15% replacement by MK is superior to all other mixes. The increase in MK content improves the compressive strength and split tensile strength and we achieve compressive strength at 15% replacement of MK is 68 N/mm2 and split tensile strength of 5.6 N/mm^2.

Development of high strength concrete by using metakaolin"-ISSN: 0974-2115 www.jchps.com Journal of Chemical and Pharmaceutical Sciences Nova John (2013)

The high strength achievement by replacement of cement by 15% MK ensure suplementary cementitious material. Use of MK as supplementary cementitious material helps in solving environmental, technical and economic issue due to cement production. The peak compressive strength of concrete contaiing15% Metakaolin + 1.2 percent Superplasticizer was found to be 64.65 N/mm2 after 28 days and split tensile strength of 3.7 N/mm2

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 7, July 2023

"Strength and Durability Properties of Concrete with Partial Replacement of Cement by Metakaolin -International Journal of Engineering Research & Technology (IJERT) Er. Amritpal Kaur, Er. Rajwinder Singh Bansal.

The replacement of cement with 9%MK give better results better for strength. And 10% Metakaolin can be taken as the optimum dosage, which can be utilized by using super plasticizer. Mixed as a partial replacement to cement for giving maximum possible compressive strength at any stage. At 28 days the compressive strength of 51.24 N/mm2 we observed ,split tensile strength of 5.76 N/mm2 and Flexural strength of 11.64 N/mm2.

High Strength Concrete"-International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 08 | Aug 2020 P. Dinakar

The optimum replacement level of OPC by MK was 10 %, which gave the highest compressive strength in comparison to that of other replacement levels; this was due to the dilution effect of partial cement replacement. In case of individual percentage replacement of mineral admixtures, the maximum compressive strength achieved in M80 grade concrete is 78 Mpa with 10% replacement of Metakaolin and was achieved split tensile strength of 6.7 N/mm^2 ,flexural strength of 10.65 N/mm^2.

2.1 Summary

This is carried out to study the enhanced strength of concrete and by Replacing cement with Metakaolin a mineral admixture and superplasticizer polycarboxylate ether was used.. Casting of cubes, for each trails and curing the cubes .For 7,14 &28 days test the cubes, calculate the compressive strength, compared with other percentages of metakaolin

The specific objectives of the study are as follows:

To characterize the workability of the concrete.

To Achieve the compressive strength of concrete cubes above 65 N/mm^2 .

2.2 Materials

1) Cement.

Ordinary Portland cement of 53 grade conforming to IS 12269-1987 was used throughout the experiment.

2) Fine Aggregate.

River sand was used in this project. It was tested as per IS 383-1970. The properties of fine aggregates are given in the below experiments results.

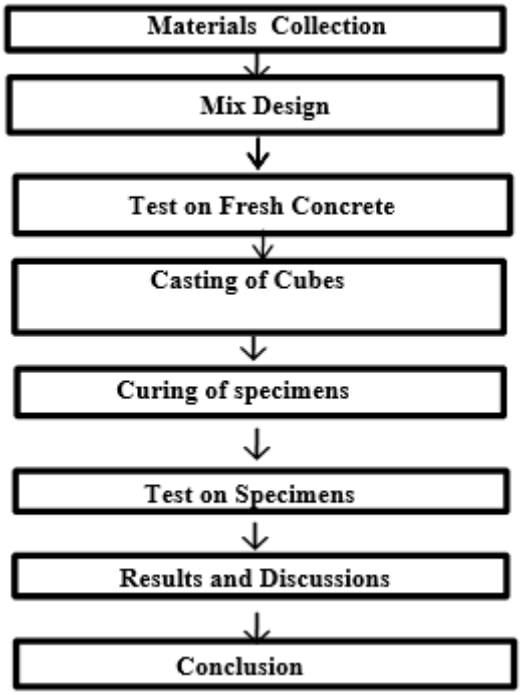
3) Coarse Aggregate.

Crushed stone of 20mm size are used as coarse aggregate was used. The aggregate properties are tested in accordance with IS: 383-1970.

4) Metakaolin

High Reactivity Metakaolin is now established as a value-added concrete admixture and is being increasingly used in the developed countries in place of traditional pozzolanic materials.

2.3 Methodology



2.4 Mix Design

1) Stipulations For Proportioning.

1. Grade designation: M 65
Type of cement: OPC 53 grade conforming to IS 269
Maximum nominal size of aggregate: 20 mm
Exposure conditions as per Table 3 and Table 5 of IS 456: Severe (for reinforced concrete)
Workability: 100 mm (slump)
Degree of supervision: Good
Maximum cement (OPC) content: 450 kg/m3
Chemical admixture type: Superplasticizer (Polycarboxylate ether based)

2) Test data for materials.

1. Cement used: OPC 53 Grade conforming to IS 269
Specific gravity of cement: 3.1
Specific gravity of 1) Coarse aggregate: 2.68
2) Fine aggregate: 2.625
Water absorption 1) Coarse aggregate: 0.36 percent
2) Fine aggregate: 3.0 percent
Moisture content 1) Coarse aggregate: Nil
2) Fine aggregate: 2.08 percent

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 7, July 2023

3) Mix Proportions After Adustment for Wet Aggregates.

Table 1. Design Mix Proportion

Cement	493 kg/m^3
Water	139 kg/m^3
Fine aggregate	612 kg/m^3
Coarse aggregate	1237 kg/m^3
Chemical admixture	2.47 kg/m^3
Water/Cementitious ratio	0.28

III. RESULTS AND DISCUSSION

Test on Fresh Concrete

1) Slump Test Result

Workability is a term associated with freshly prepared concrete. This can be defined as the ease with which concrete can mixed, placed, compacted and finished. Slump test is the most commonly used method of measuring 'workability' of concrete in a laboratory or at site of work.

Table 2. Slump test Results

SL. NO	W/C ratio	Percentage of Metakaolin replaced (%)	Height of mould H1 (mm)	Height of subsided concrete H2 (mm)	Slump $H_1 – H_2$ (in mm)
1.	0.28	0	300	203	97
2.	0.28	10	300	205	95
4.	0.28	12	300	209	91
3.	0.28	15	300	210	90

Slump Test Discussion

The property of fresh concrete is assessed by workability in terms of slump value.

It is observed in all the mixes the workability decreases by 2.08% with increase in metakaolin percentage. This due to its fineness .And it is observed that The 10% replacement of Metakaolin by weight of cement got higher slump of 95mm. Therefore adding admixture is inversely proportional to the slump.

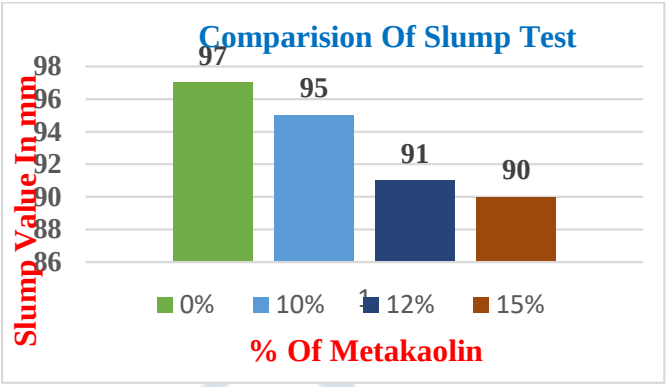


Fig. 1. Slump test result

Test on Hardened Concrete

1) Compressive Strength Result

The compressive strength of is affected by both the aggregate properties and the characteristics of the new cement paste that is developed during the maturing of concrete. Compressive strength of concrete is directly related to the age after casting and increases with age. 150mm sized cube were made for testing the development of compressive strength under the standard curing condition for 7 days, 14 days and 28 days. This present value is the average of three specimens.

Table 3. Compressive Strength

Percentage of metakaolin replaced in %	**Compressive strength in N/mm^2**		
Age of Concrete	7 days	14 days	28 days
0%	46.96	65.12	73.5
10%	41.22	55.8	68.91
12%	30.31	50.84	67.78
15%	27.85	48.01	67.68

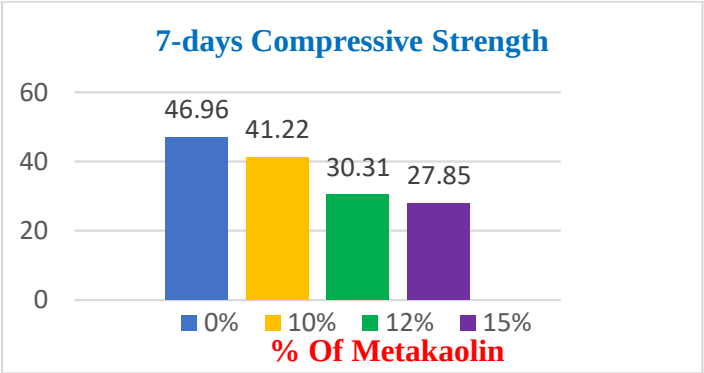


Fig. 2. Compressive Strength for 7 days

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 7, July 2023

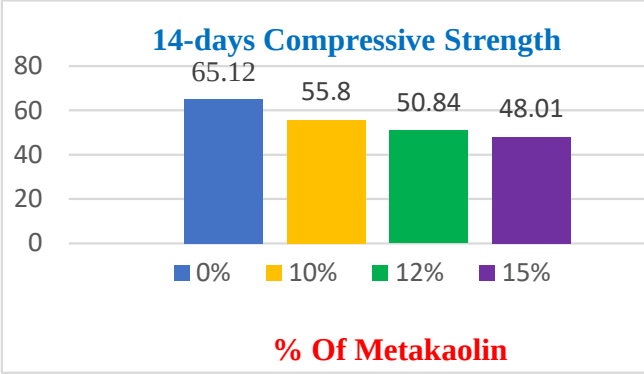


Fig. 3. Compressive Strength for 14 days

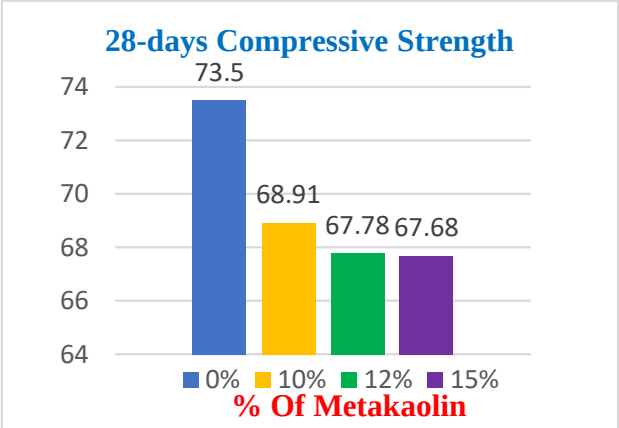


Fig. 4. Compressive Strength for 28 days

2) Discussion

- For 7days, 14days and 28days result 10% replacement of metakaolin by weight of cement has higher strength compared to other two replacement.

Here we can observe that with increase of metakaolin, decreases in strength, so it says adding metakaolin % is inversely proportional to the strength.

IV. CONCLUSION

Based on the present experimental investigation, the following conclusions are drawn:
10% Metakaolin can be taken as the optimum dosage, which can be utilized by using super plasticizer. Mixed as a partial replacement to cement for giving maximum possible compressive strength at any stage.Hence it is advisable to use 10% metakaolin .

REFERENCES

[1] Murali G, Sruthee P - "Experimental study of concrete with metakaolin as partial replacement of cement" - International journal emerging trends in engineering and development, Issue 2 vol. 4(May 2012),ISSN 2249-6149,pp.344-348.
[2] N. John, "Strength Properties of Metakaolin Admixed Concrete," Int. J. Sci. Res. Publ., vol. 3, no. 6, pp. 1–7, 2013, [Online].
[3] Shetty M.S., "Concrete Technology", Chand and company, 2005.
[4] Neville, A.M. and Brooks, J.J.- "Concrete Technology" ECBS edition, Pearson Education, Asia, 2004.
[5] M L Gambhir, "Concrete Manual", Dhanpat Rai and sons, New Delhi -2007Indian standard- Concrete Mix Proportioning guidelines..