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Effect on Flexural Strength by using Glass Fibre and Metakaolin in Concrete

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Abstract*: Concrete is weak in tension. The introduction of fibres with 10% fixed metakaolin by the weight of cement in concrete have significantly improves its Flexural strength. The use of different types of fibres & Metakaolin has shown positive responses among the researchers. In the present study alkali resistant glass fibres were used in the concrete mixes. A total of 7 mixes were prepared by varying the percentages of glass fibres and metakaolin in M25 grade of concrete mixes. Based on the laboratory results the Flexural strength was reported to increase up to 19%. The Flexural strength of concrete is improved which shows the use of glass fibres in concrete mixes may reduce its shortcoming of low Flexural strength without affecting its workability and compressive strength.

Keywords: Glass Fibres, Metakaolin, Grade of concrete, Flexural Strength.

I. INTRODUCTION

Concrete is the most vital construction material of use after water. This is due to its various properties. Generally concrete is weak in tension and strong in compression, so to overcome from this the researchers had tried different things such as Glass fibre which can be added in concrete to improves its poor property of tension. As we know that concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. This is improved by providing Steel reinforcement at appropriate locations at the time of casting the members to take up the tensile stresses and sometimes the compressive stresses if required. The advantage of using reinforcement in concrete improved durability and cracking of concrete. These properties can be improved by the use of Glass fibres and Metakaolin in the concrete. Metakaolin is a pozzolanic material which is manufactured from kaolin's, after refinement and calcination under specific condition. It is a highly efficient pozzolana and react rapidly with the excess calcium hydroxide resulting from OPC hydration by a pozzolanic reaction, to produce calcium silicate hydrate and calcium alumino silicate hydrates. Glass fibres have very large tensile strength and elastic modulus but have brittle stress-strain characteristics and low creep at room temperature. Glass fibres are generally round and straight with diameters from 0.005 mm to 0.015 mm. In this study alkali resistant glass fibres were used throughout the experiments. This study comprises of Flexural strength of M25 concrete by varying the percentages of fibres and replacing the 10% cement by weight with metakaolin.

II. EXPERIMENTAL PROGRAMME & RESULTS

This experimental Programme consist of different processes of material testing, mix proportioning, mixing, casting and curing of test specimens which is elaborated in the following sections. Testing of materials were done in the lab of Material Testing at Integral University Lucknow.

A. Materials used

The materials used in the preparation of concrete mix include cement, fine aggregates, coarse aggregates glass fibres and metakaolin. Each material was tested and its physical properties are described below.

1) *Cement used:* OPC of 43 grade were used conforming To recommendations stated in IS401(1999) the normal consistency and initial setting time of cement was 32% and 40 minutes respectively.
2) *Fine Aggregate:* Coarse sand available at local market was used as fine aggregate. The test procedures as mentioned in IS-383(1970) were followed to determine the physical properties of fine aggregate as shown in Table 1 below

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Table 1: Physical Properties of Fine aggregate

Physical Properties	Observed values	Recommended Values
Grading Zone	2	-
Fineness modulus	3.18	2.9-3.2
Specific Gravity	2.63	2.6-2.67

B. Coarse Aggregate

Two single sized crushed stone aggregates ranging from 12.5 mm to 2.36 mm and 20 mm to 4.75 mm (10mm and 20mm sizes) were used in respective proportions in concrete mixes. The aggregates were tested in accordance to IS-383: (1970). The results obtained are tabulated in Table 2

C. Glass Fibre

Cem-Fil Anti-Crack, HD-10mm, Alkali Resistant glass fibres were used throughout the experimental work. From the micro to the macro fibre range, these fibres control the cracking processes that can take place during the life-span of concrete. The specifications of these fibres are presented in Table 3.

Table 3: Physical Properties of Glass Fibre

Physical Properties	Recommended values by the Supplier
Specific gravity	2.68
Elastic Modulus (GPa)	72
Tensile Strength (MPa)	1700
Length (mm)	10

Table 2: Physical Properties of coarse aggregate

Physical Properties	Observed values		Recommended Values
	10mm Aggregate	20mm Aggregate	
Fineness Modulus	6.916	7.12	6.5-8.0
Aggregate crushing value (%)	18.15	25.13	Not more than 45%
Aggregate impact value (%)	28.63	22.10	Not more than 45%



Glass Fibre

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D. Water

As per recommendation of IS: 456 (2000), the water to be used for mixing and curing of concrete should be free from deleterious materials. Therefore potable water was used in the present study in all operations demanding control over water quality.

E. Metakaolin

Metakaolin is refined kaolin clay that is fired (calcined) under carefully controlled conditions to create an amorphous alumina silicate that is reactive in concrete. Like other pozzolans (fly ash and silica fume are two common pozzolans) ,metakaolin reacts with the calcium hydroxide (lime) by products produced during cement hydration.

metakaolin as a cement replacement in concrete mixes, instead of other pozzolans such as silica fume, to:

1) Boost compressive strength
2) Make finishing easier
3) Mitigate alkali-silica reaction and maintain colour, especially in white concrete



Metakaolin

F. Methodology

The mix proportioning procedure for the concrete was done according to IS 10262: 2009. The proportioning is carried out to achieve specified characteristics at specified age, workability of fresh concrete and durability requirements. Concrete of M 25 Grade was proportioned according to the procedure as mentioned in the code.

G. Mix Proportioning

The basic mix proportion for M 25 grade of concrete is cement, fine aggregate, coarse aggregate and water 1.0:1.39:2.49. Mix 1 contains 0% glass fibre and 0% metakaolin. Mix 2 contain 0% glass fibre and 10% metakaolin replacing cement by weight, then 3,4,5,6 and 7 contains 0.03%, 0.06% ,0.1% 0.13% and 0.16% of glass fibre by weight with 10% metakaolin replaced by cement by weight. A total of 7 mixes were studied. Water/cement ratio of 0.44 for M 25 were maintained for all the concrete mixes. Details of these mixes are presented in Tables 4.

H. Mixing of Concrete, Casting and Curing of Beams

Machine mixing was done during the entire process of casting of beams. Firstly the dry mix constituents of the mix namely cement, fine aggregate and coarse aggregate Metakaoline and required amount of glass fibre was mixed for two minutes in the mixer and then the water were added and mixing continued for another 2 minutes. The total mixing time was kept at 4 minutes until a homogeneous mixture was obtained. Compaction was achieved by means of vibration and stored in water till the 28 days for testing. All specimens were de moulded after 24 hours

I. Flexural Strength Test

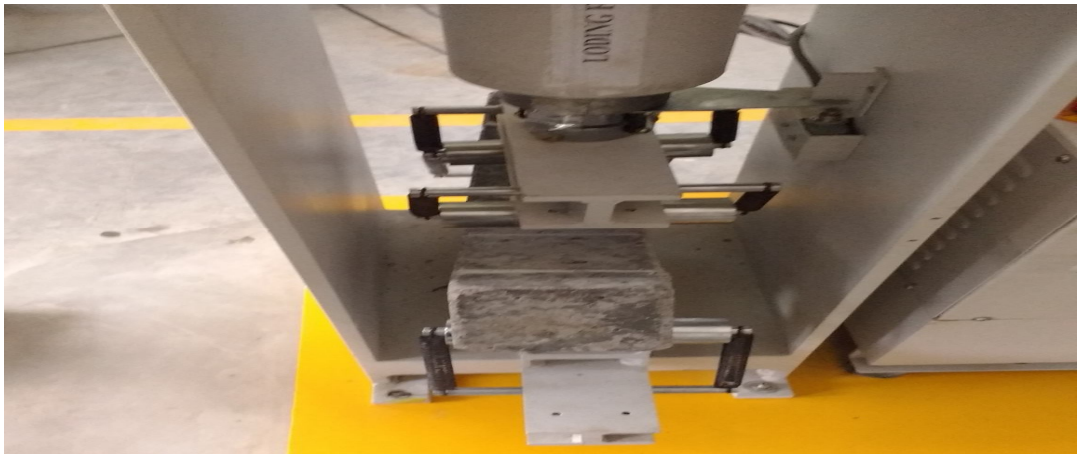
Flexural strength test was performed according to IS 516:1959. Beams of specimen of size 100 mm x 100 mm x 500 mm were prepared for each mix. After 24 hours the specimens were de moulded and cured in water for 28 days until testing. The fractions of glass fibre taken are 0% , 0.03%, 0.06% , 0.1%, 0.13%, 0.016% and the percentage of metakaolin was kept fixed at 10% by weight of cement. After curing for 28 days, flexural test by four points bending is done on flexural testing machine. The Flexural strength reported is the average of three results obtained from three identical specimens.

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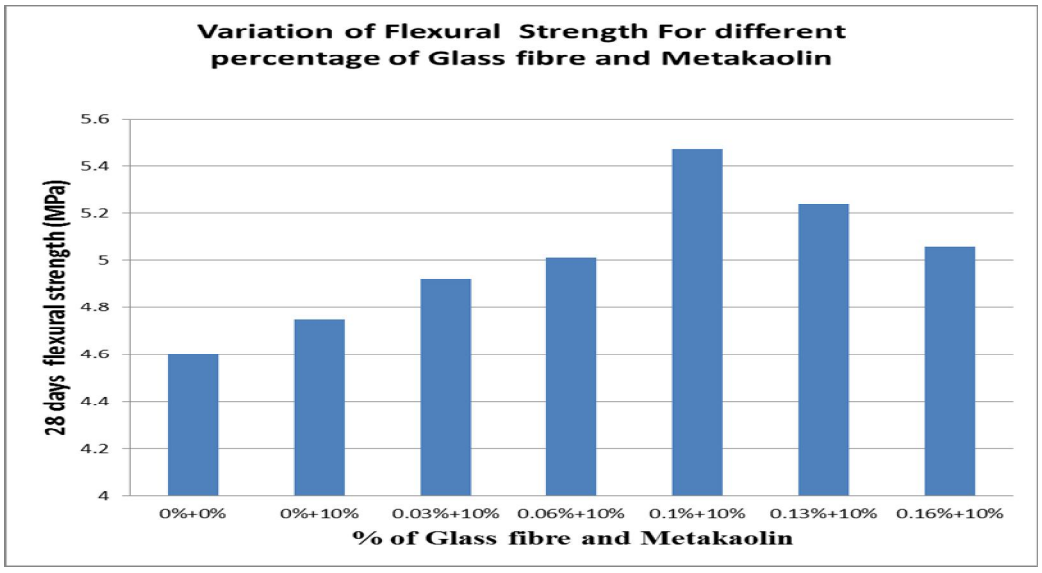
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Table 4: Flexural Strength

	Types of Mix	% of Metakaolin	% of Glass Fibre	Flexural Strength in (MPa)
MIX Grade M25	M1	0%	0%	4.60
	M2	10%	0%	4.75
	M3	10%	0.03%	4.92
	M4	10%	0.06%	5.01
	M5	10%	0.1%	5.47
	M6	10%	0.013%	5.24
	M7	10%	0.016%	5.06



Testing Of Beam By Four Point Loading Under Flexural Testing Machine



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III. CONCLUSION

Based on the experimental study on concrete mixes, the following conclusions could be made:

A. It has been found that Flexural Strength has their maximum values for 10%. Metakoalin dosage. The flexural strength is increase by 3.26% when compared to their nominal strength

B. When 10% Metakoalin is added along with 0.1% Glass fibre dosage, maximum strengths are obtained . The Flexural Strength is increase by 19% when compared to their nominal strength.

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BIOGRAPHIES

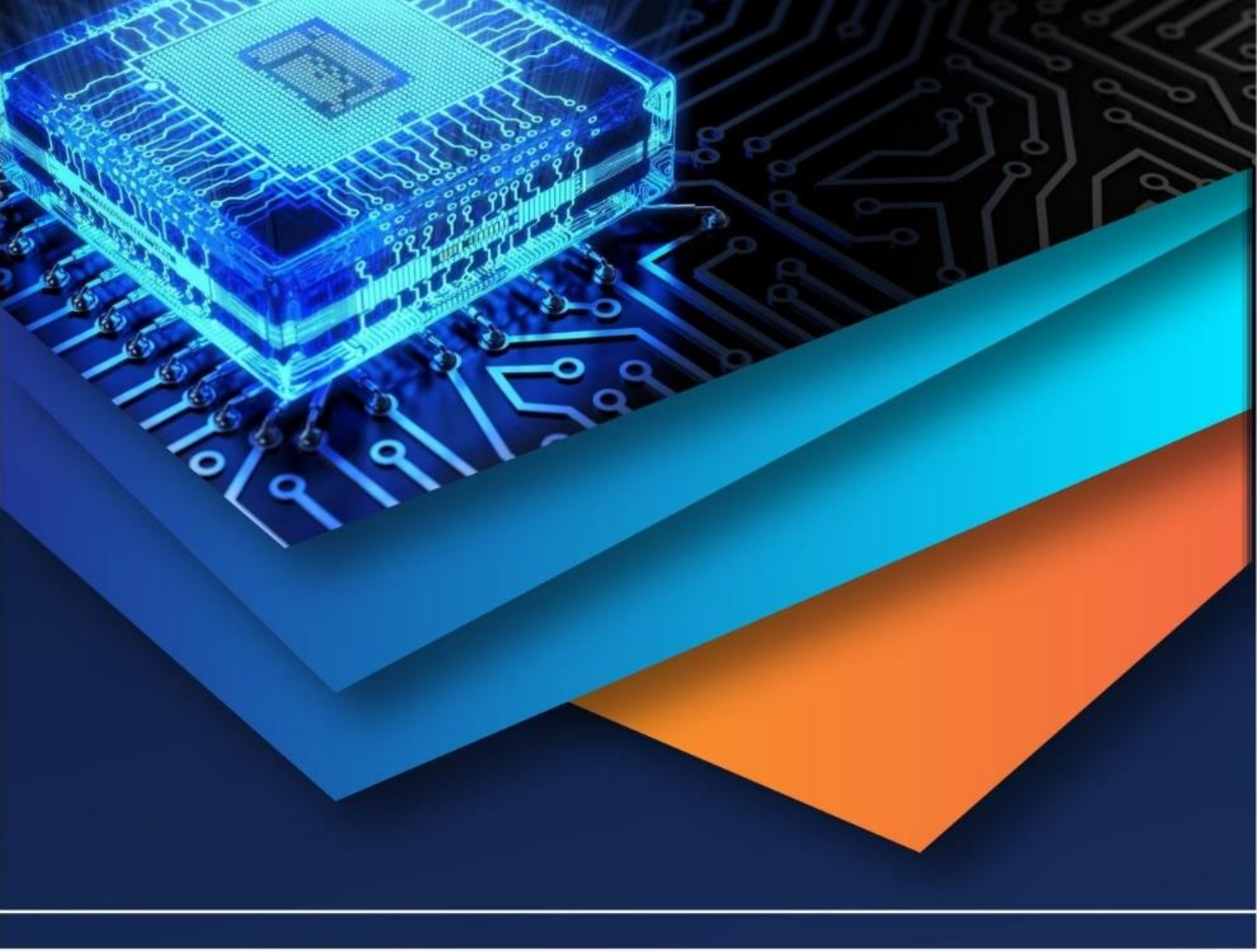


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