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An Experimental Investigation on FRMC

[1]Mr. Lokesh Kumar Sharma, [2]Mr. Anil Kumar Sharma, [3]Mr. Shubham Sharma
[1]M. Tech Scholar, Department of Civil Engineering, Arya College of Engineering & Research Centre, Jaipur
[2]Assistant Professor, Department of Civil Engineering, Arya College of Engineering & Research Centre, Jaipur
[3]Assistant Professor, Department of Civil Engineering, Arya College of Engineering & Research Centre, Jaipur

Abstract

In recent years, some investigations are reported on Ground-granulated blast-furnace slag and Meta kaolin individually. Utilization of steel fibers is known to enhance the flexural strength in concrete beams, but the focus of the present study is to investigate experimentally the flexural behavior of the beam section with steel fibers and Metakaolin. Combination of both known as Fiber Reinforced Metakaolin Concrete. The study reported in the report presents experimental work on combined use of Ground-granulated blast-furnace slag and Calcium Carbide Residue and with Meta kaolin and Calcium Carbide Residue in concrete and showing the comparison at various replacement levels and at various ages. Grade of concrete pick for present study is M-40. The present investigation aims to study the behavior of concrete beams filled with steel fiber reinforced concrete in partial depth ranging from 0.25d to 1d.For this, M 40 grade of concrete mixes with or without Meta kaolin along with 0.5% fibers, 1.0%, and 1.5% fibers were made. The percentage of Meta kaoline used only 10% as a replacement of Cement used. Beam specimens of 100*100*500 mm were cast and tested respectively for flexural strength anddeflection at 28 days.

Keywords: Metakaolin, Steel Fiber, FRMC, M 40 grade of concrete, Fibre reinforced concrete, Flexural Strength Test.

Introduction

The merits of incorporating steel fibers into conventional concrete are increased tensile and flexural strength, ductility and toughness, etc. These may be expected from the composite even with the nominal addition of fibers into a standard concrete mix. Several investigators have developed methods to predict the flexural strength of full-depth fiber reinforced (FRC) composites [5]. Some investigations suggest using steel fibers only in the zone, where tensile stresses are induced in a manner similar to that presently contemplated and used in conventional reinforced concrete. The inclusion of fibers into a matrix over only a partial thickness of the beam is regarded as partial fiber reinforcing a beam. Metakaolin is a dehydroxylated form of the clay mineral kaolinite. Rocks that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain. The particle size of metakaolin is smaller than cement particles, but not as fine as silica fume .The quality and reactivity of metakaolin is strongly dependent of the characteristics of the raw material used. Cement concrete is the most widely used material for various constructions. Properly designed & prepared concrete result in good strength & durable properties. Even such well designed & prepared cement concrete mix under controlled conditions also have certain limitations because of which above properties of concrete are found to be inadequate for special situations & certain special structures .The main ingredient in the convential concrete is the Portland cement .The amount of cement production emits approximately equal amount f carbon dioxide into the atmosphere. Cement production is consuming a significant amount of natural resources .To overcome above ill effects , the advent of newer materials & construction techniques in this drive , admixture has taken newer things with various administers has become a necessity [8].

Materials and Methodology

Steel fiber reinforced concrete (SFRC) is a composite material whose segments incorporate the conventional constituents of Portland concrete cement (hydraulic cement, fine and coarse aggregates, admixtures) and a scattering of haphazardly arranged short discrete steel fibers. Similarly, with all FRC materials, contrasted with plain concrete, the most visual contrasts are improved ductility and post cracking performance.

Steel Fiber - Intheexperiment–Dramixgluedsteelfiberwereused.Thesteelfibercontentwasvariedas 0%, 0.5%, 1.0%, and 1.5% by weight of cement. The steel fibers were 60mm in length, and the aspect ratio of the fiber was80.

Metakaolin – Metakaolin isn't a byproduct. It's obtained by claiming pure or refined mineral clay at a temperature of 6500 to 8500 ° C, so grinding to a fineness of 700 to 900 m two / weight unit. Metakaolin could be a pozzolanic supplement/product that has several specific properties. Metakaolin is obtainable in many alternative varieties and qualities.

IS Code 516: 1959 used for the method of tests for the flexural strength of concrete. The size of the beam 500mm x 100mm x 100mm is used in the present study.The specimens were tested after deep curing for 28 days.

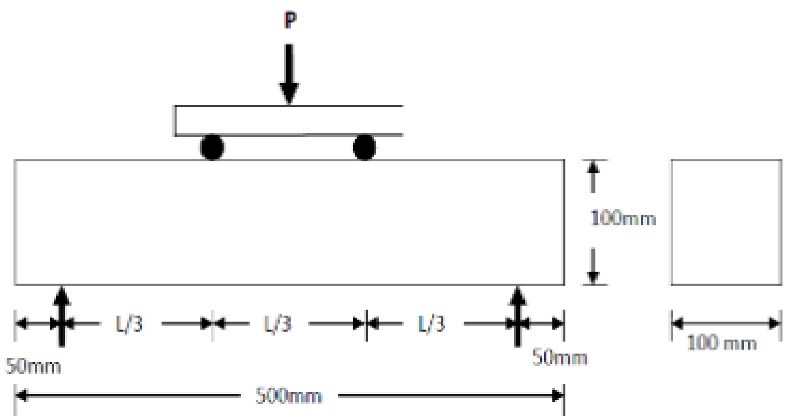

***Fig. 1** Two point loading setup in flexure test*

Results and Discussions

Flexural Strength and Deflectiontest results –

The flexural strength and deflection test results of beam specimens with Metakaolin and 0.5% fiber content at 28 days age are presented in Table 1.

The flexural strength and deflection test results of beam specimens with Metakaolin and 1 % fiber content at 28 days age are presented in Table 2

Table 1: Flexural Strength and Deflection of Concrete Mixes with 1 % Fiber Content, 10% MK, and Variation of Fiber Depth (at the age of 28 days)

Specimen	Fiber Depth	Deflection	Flexural Strength
Cement + Metakaolin	Measured from bottom	(mm)	(N/mm^2)
90+10	25	0.037	6.65
90+10	50	0.045	6.83
90+10	75	0.053	7.01
90+10	100	0.072	7.28

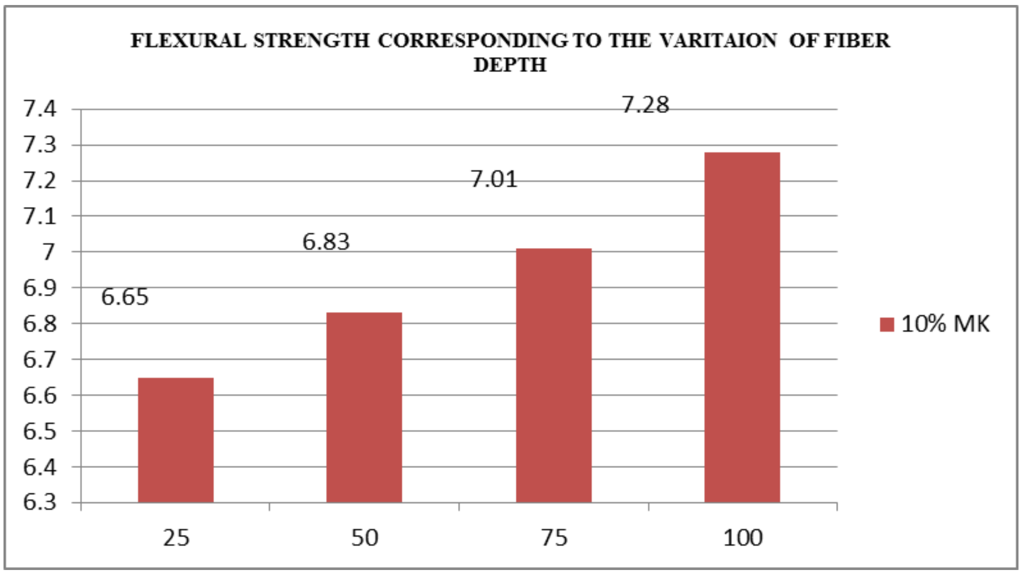

Fig 2: Flexural Strength and Deflection of Concrete Mixes with 1 % Fiber Content, 10% MK and Variation of Fiber Depth (at the age of 28 days)

The flexural strength and deflection test results of beam specimens with Metakaolin and 1.5 % fiber content at 28 days age are presented in Table 2 and figure 3

Table 2: Flexural Strength and Deflection of Concrete Mixes with 1.5 % Fiber Content, 10% MK, and Variation of Fiber Depth (at the age of 28 days)

Specimen	Fiber Depth	Deflection	Flexural Strength
Cement + Metakaolin	Measured from bottom	(mm)	(N/mm^2)
90+10	25	0.050	6.71
90+10	50	0.060	6.95

90+10	75	0.072	7.1
90+10	100	0.088	7.38

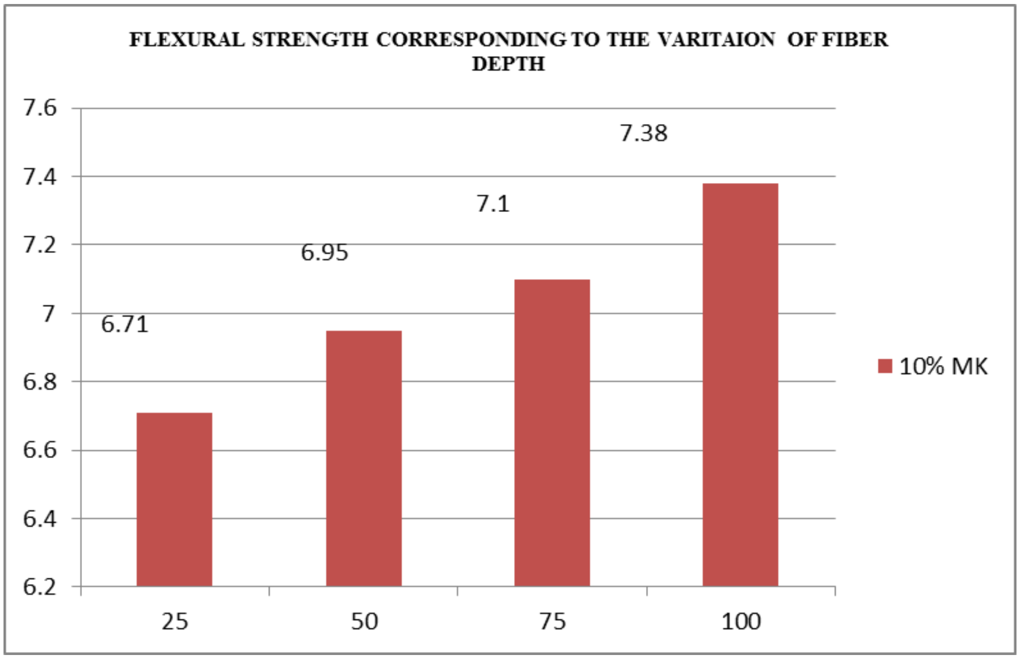

Fig 3: Flexural Strength and Deflection of Concrete Mixes with 1.5 % Fiber Content, 10% MK and Variation of Fiber Depth (at the age of 28 days)

Variation in flexural strength with respect to different fibers content - The flexural strength test results of beam specimens with Metakaolin and 0.5%, 1%, and 1.5% fiber content at 28 days age are presented in Table 3 and figure 4.

Table 3: Flexural Strength of Concrete Mixes with 0.5%, 1% and 1.5 % Fiber Content, 10% MK, and Variation of Fiber Depth (at the age of 28 days)

Specimen	Fiber Depth	Flexural Strength		
Cement + Meta kaolin	Measured from bottom	0.5% SF	1% SF	1.5% SF
90+10	25	6.3	6.65	6.71
90+10	50	6.64	6.83	6.95
90+10	75	6.83	7.01	7.1
90+10	100	7.16	7.28	7.38

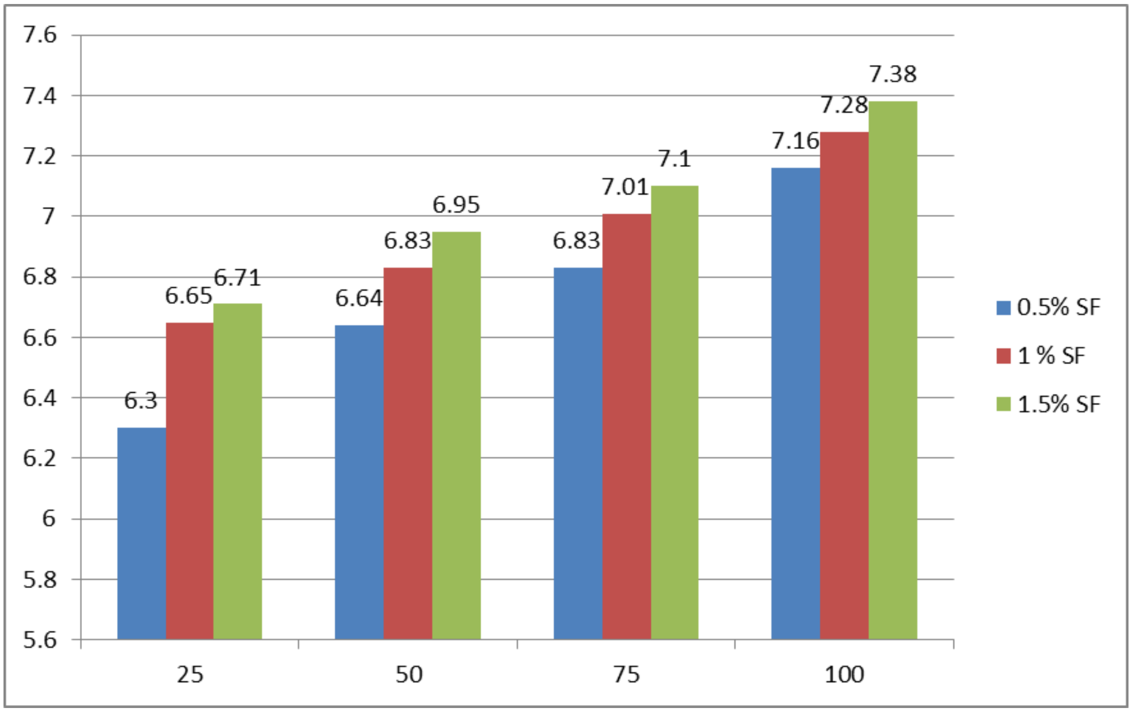

Figure 4: represents the variation of flexural strength at the age of 28 days and Concrete Mixes with 0.5%, 1% and 1.5 % Fiber Content, 10% MK, and Variation of Fiber Depth 25mm, 50mm, 75mm, and full depth of the beam.

Conclusions

1. For the hardened properties of Fiber Reinforced Metakaolin Concrete, the steel fiber and Metakaolin combination enhance the flexural strength.
2. When the depth of fiber is 25mm measured from the bottom of the beam of the mix with 1% and 1.5% SF along with 10% Mk as a partial replacement of Cement, the flexural strength increased 5.5% and 6.5% with respect to the flexural strength of specimen prepared with 0.5% SF and 10% Mk.
3. When the depth of fiber is 50 mm measured from the bottom of the beam of the mix with 1% and 1.5% SF along with 10% Mk as a partial replacement of Cement, the flexural strength increased 2.9% and 4.6% with respect to the flexural strength of specimen prepared with 0.5% SF and 10% Mk.
4. When the depth of fiber is 75 mm measured from the bottom of the beam of the mix with 1% and 1.5% SF along with 10% Mk as a partial replacement of Cement, the flexural strength increased 2.6% and 4% with respect to the flexural strength of specimen prepared with 0.5% SF and 10% Mk.
5. When the depth of fiber is equal to the depth of the beam of the mix with 1% and 1.5% SF along with 10% Mk as a partial replacement of Cement, the flexural strength increased 1.6% and 3% with respect to the flexural strength of specimen prepared with 0.5% SF and 10% Mk.

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