EXPERIMENTAL STUDY ON GLASS FIBER REINFORCED CONCRETE USING METAKAOLIN AS MINERAL ADMIXTURES

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Abstract - Concrete is a major construction materials used in the construction now a day. In this present study we discussed below, Study on glass fibre reinforced concrete using metakaolin. It is a dehydroxylated form of the clay mineral kaolinite. Stone that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain. The particle sizes of metakaolin is smaller than cement particles, but not as fine as silica fume.To estimate and collect the needed metakaolin and glass fiber from available localities. To cut the glass fiber into small pieces say those of 12mm to 20mm.To find out the specific gravity and other physical properties of the glass fiber and metakaolin. Design the concrete for M40 grade and also partially replacing the cement by the Metakaolin. Glass Fiber Reinforced Concrete using Metakaolin admixture increased by 10% to 20%. Strength studies like compressive strength and split tensile strength are to be conducted. The behavior of concrete by partially replacement of cement with metakaolin and glass fiber has been studied. With the increasing in the percentage of metakaolin replacement in concrete, the compressive strength and Split tensile Strength of the concrete significantly reduced.

Key Words: Glass Fiber Reinforced Concrete, Metakaolin, Glass Fiber Compressive Strength, split tensile strength

1. INTRODUCTION

This literature review clearly demonstrates that the Metakaolin being a good mineral for increasing the compressive strength in High Strength Concrete. Pozzolanic materials including silica fumes, fly ash, slag, Rice Husk Ash and Metakaolin have been used in recent years as cement replacement material for developing HSC with improved workability, strength and durability with reduced permeability. Metakaolin, which is a relatively new material in the concrete industry, is effective in increasing strength, reducing sulphate attack and improving air-void network. Pozzolanic reactions change the microstructure of concrete and chemistry of hydration products by consuming the released calcium hydroxide (CH) and production of additional calcium silicate hydrate (C-S-H), resulting in an increased strength and reduced porosity and therefore improved durability [1].

The effect of incorporating metakaolin (MK) on the mechanical and durability properties of high strength concrete for a constant water/binder ratio of 0.3.MKmixtures with cement replacement of 5, 10 and 15 %were designed for target strength and slump of 90 MPa and 100 ± 25 mm. From the results, it was observed that 10 % replacement level was the optimum level in terms of compressive strength. Beyond 10 %replacement levels, the strength was decreased but remained higher than the control mixture. Compressive strength of 106 MPa was achieved at 10 %replacement. Splitting tensile strength and elastic modulus values have also followed the same trend [2].

In order to determine the characteristics of Metakaolin composite cement with the addition of metakaolin cement samples were prepared with the metakaolin addition of 5, 10, 15, 20, 25, 30 and 35 % by mass. To test the compressive strength after 2, 7, 28, 90 and 180 days mortar mixes were prepared according to the standard with water-cement factor (w/c) 0.5.Metakaolin composite cement requires a larger amount of water to achieve a standard consistency of the control Portland cement [3].

1.0% glass fibre volume can be taken as the optimum dosage, which can be used for giving maximum possible compressive strength at any age for glass fibre reinforced high performance concrete. 10% silica fume can be taken as the optimum dosage, which can be used as a partial replacement to cement for giving maximum possible compressive strength at any age for glass fibre reinforced high performance concrete. The percentage increase in compressive strength at 28days of 1% fibre volume with 10% silica fume concrete over plain high performance concrete without fibre and silica fume is 14% [4].

2. MATERIALS AND EXPERIMENTAL METHODOLOGY

2.1 Cement

The Ordinary Portland cement of 53-grade was used in this study conforming to IS: 12269-1987. The specific gravity of cement is 3.15. The initial and final setting times were found as 45 minutes and 185 minutes respectively. Standard consistency of cement was 31%.

2.2 Fine aggregates

The river sand is used as fine aggregate conforming to the requirements of IS: 383-1970, having specific gravity of 2.66 and fineness modulus of 2.83 has been used as fine aggregate for this study.

2.3 Coarse Aggregate

Coarse aggregate obtained from local quarry units has been used for this study, conforming to IS: 383-1970 is used. Maximum size of aggregate used is 20mm with specific gravity of 2.73.

2.4 Metakaolin

Metakaolin is a dehydroxylated form of the clay mineral kaolinite. Stone 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.

Table -1: Physical properties of Metakaolin

SL.NO	Properties	Values
1	Specific gravity (g/cm^3)	2.51
2	Color	White
3	Physical form	<1.0%
4	(45 μm) Residue	< 2.5 μm

2.5 Glass Fiber

Fiberglass is an immensely versatile material due to its light weight, inherent strength, weather-resistant finish and variety of surface textures

Table -2: Physical properties of Glass fiber

Sl.No	Properties	Values
1	Density (g/cm^3)	2.58
2	Tensile strength (Mpa)	1875
3	Co-efficient of thermal expansion (10^{-6}/K)	5.0-6.1
4	Elongation at break (%)	3-4

2.6 Water

The water used for experiments was potable water conforming as per IS: 456-2000 [8].

3.0 EXPERIMENTAL PROCEDURE

M40 grade concrete mixes of different glass fibers levels 0%, 1%, 1.5% and 2% in volume and Metakaolin of 10 % (replacement of cement) with w/c ratio of 0.4 were prepared. The mixes were designated in accordance with IS: 10262-2009. A total of 27 concrete cubes and 27 cylinders were casted for the different percentages of mixes. The specimens were demoulded after 24 hours and curing was done for different age of testing. They were tested for their strength properties on 3rd, 7thand 28thday.

Table -3: Details of Mix Proportions of M40 Concrete

SL.No	Ingredients	Values
1	Cement Content	350 kg/m^3
2	Coarse Aggregate	1115kg/m^3
3	Fine aggregate	866 kg/m^3
4	W/C ratio	0.4
5	Water	140 lit/m^3
6	SP	7 kg/m^3

Table-4: Fresh properties of concrete

SL No.	% of Glass Fiber	W/C Ratio	Slump value(mm)
1	0%	0.4	85
2	0.5%	0.4	85
3	1%	0.4	83
4	1.5%	0.4	81
5	2%	0.4	80

Table-5: Compressive Strength Result on 3, 7, 28 days

Chart-1: Compressive Strength Result on 3rd days

Percentage of Replacement	No. of days		
	3Days (N/mm^2)	7Days (N/mm^2)	28Days N/mm^2)
10%MK + 0%GF	20.3	31.4	48.8
10%MK+0.5%GF	22.4	32.6	49.4
10%MK + 1%GF	24.2	34.8	50.3
10%MK + 1.5%GF	22.8	33.1	48.6
10%MK + 2%GF	19.2	31.2	47.9

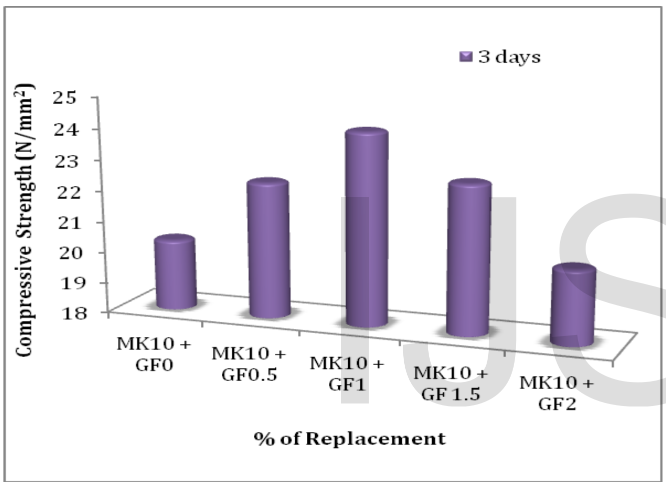


Chart-2: Compressive Strength Result on 7th days

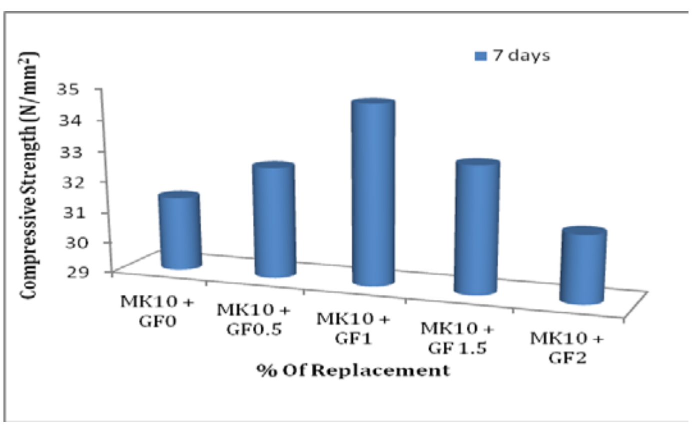


Chart-3: Compressive Strength Result on 28th days

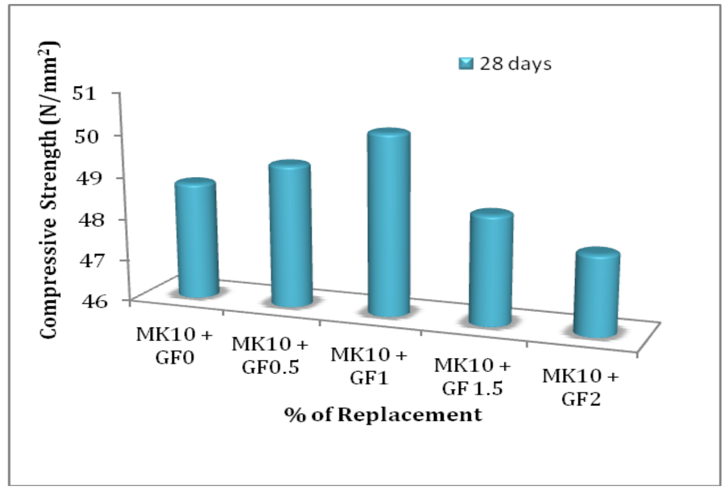


Chart-4: Compressive Strength Result on 3, 7, 28 days

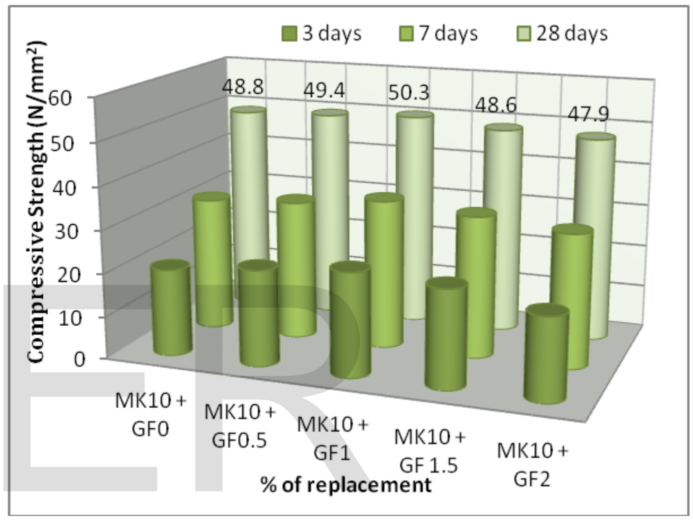


Table-6: Split Tensile Strength Result on 3,7,28 days

Percentage of Replacement	Split Tensile Strength (N/mm^2)		
	3 Days (N/mm^2)	7Days (N/mm^2)	28 Days (N/mm^2)
10%MK + 0%GF	**2.1**	**4.2**	**5.6**
10%MK +0.5%GF	**2.4**	**4.4**	**5.8**
10%MK + 1%GF	**2.6**	**4.8**	**6.2**
10%MK + 1.5%GF	**1.1**	**2.9**	**4.5**
10%MK + 2%GF	**0.9**	**2.6**	**4.2**

Chart-5: Split Tensile Strength Result on 3rd days

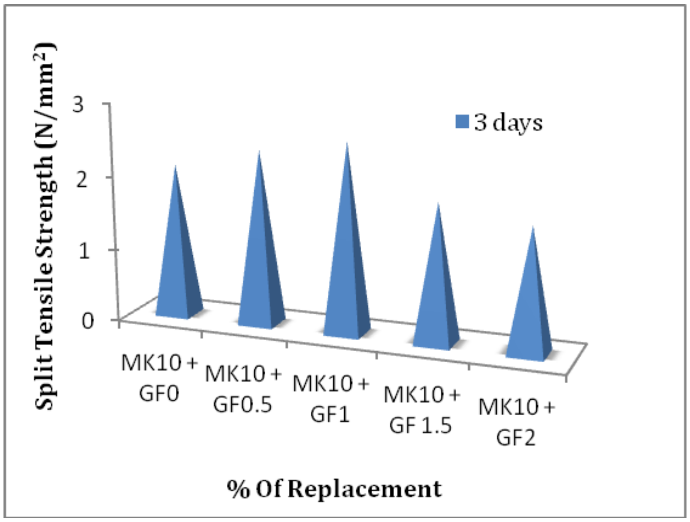


Chart-6: Split Tensile Strength Result on 7th days

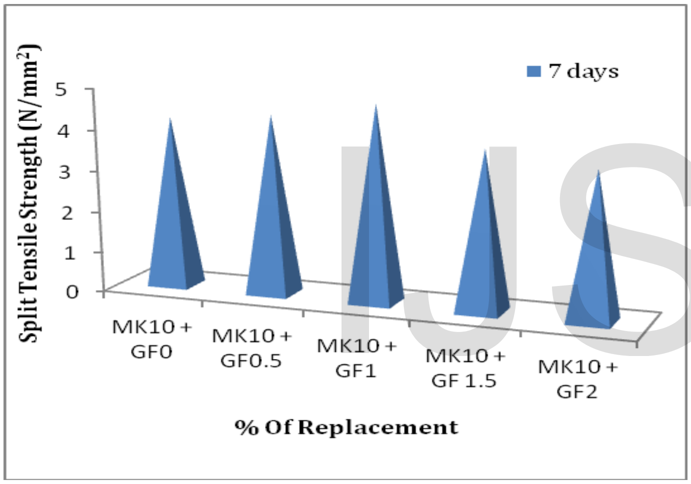


Chart-7: Split Tensile Strength Result on 28th day

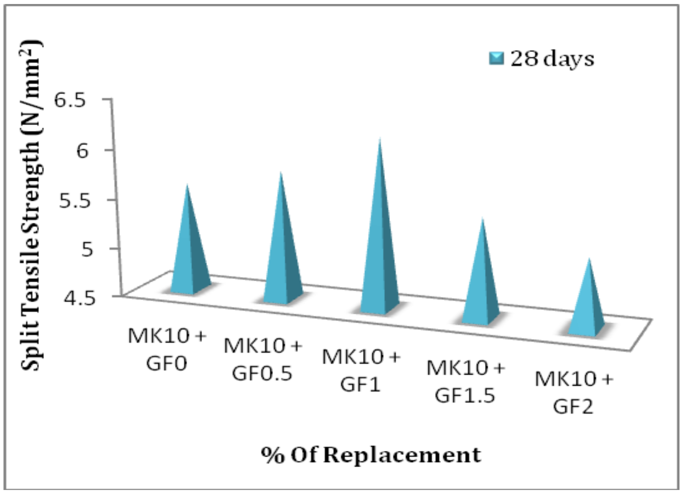
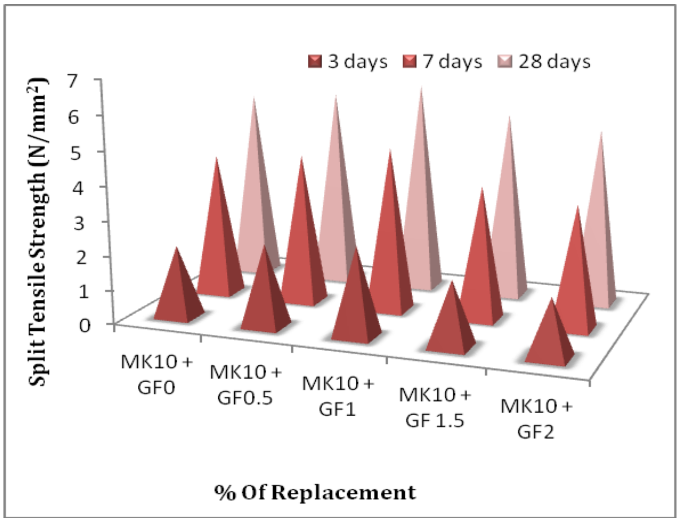


Chart-8: Split Tensile Strength Result 3,7,28 days



4.0 RESULTS AND DISCUSSION.

When the 10% of Metkaolin replaced to cement for all mixes and different percentage of glass fibers varies from 0% to 2% of the following results were drawn.

1. With 10% of Metakaolin and 1% of glass fiber of the compressive strength at the end of 3, 7 and 28 days 24.2, 34.8, 50.3N/mm² respectively.

2. A similar increase in the compressive strength was observed when the glass fiber is increase up to 1 % (50.3 N/mm² at the end of 28 days).

3. The compressive strength at the end of 28 days decreases when the Glass fiber percentage is increased beyond 1%. However the compressive strength of M40 concrete at the end of 28 days for 2% of glass fiber is 47.9 N/mm² as shown in chart -4.

4. With 10% of Metakaolin and 1% of glass fiber of the Split tensile strength at the end of 3, 7 and 28 days 2.6,4.8,6.2N/mm² respectively.

5. A similar increase in the Split tensile strength was observed when the glass fiber is increase up to 1 % (50.3 N/mm² at the end of 28 days).

6. The Split tensile strength at the end of 28 days decreases when the Glass fiber percentage is increased beyond 1%. However the Split tensile strength of M40 concrete at the end of 28 days for 2% of glass fiber is 4.2 N/mm² as shown in chart -8.

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