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Experimental Behaviour of Steel Fiber Reinforced Concrete with partial Replacement of Fly Ash & Metakaolin

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ABSTRACT

Concrete is generally used due to the abundance of uncooked material, low manufacturing and protection cost, excellence in compression, corrosion aspects, and versatility in forming more than a few shapes and its limitless structural purposes in aggregate with metal reinforcement. All these elements have contributed pressures to decrease cement consumption and to intensify lookup in exploring the probabilities of improving strength, sturdiness and corrosion discount via the use of pozzolonas as supplementary cementing materials. Fibre bolstered concrete (FRC) is a fibre reinforcing cementitious concrete composite, and by way of including discrete brief fibres randomly in concrete it famous many appreciably multiplied engineering residences It is manufactured from kaolin which makes the concrete extra long lasting and ecofriendly. In the current investigation mechanical residences of concrete containing each Fly ash and Metakaolin at a number of combos are studied. For the a range of mixtures of Fly ash and Metakaolin, cubes cylindrical and prism specimens are casted with 1% of fibres and the compression strength, break up tensile energy and flexural energy take a look at consequences are got and in contrast with the traditional combine having 1% fibres. It is thereby counseled that utilization of these cementitious substances in concrete will decrease the requirement for cement thereby marching in the direction of green construction.

KEYWORDS: *FRC, FLYASH, METAKAOLIN, POZZOLONAS*

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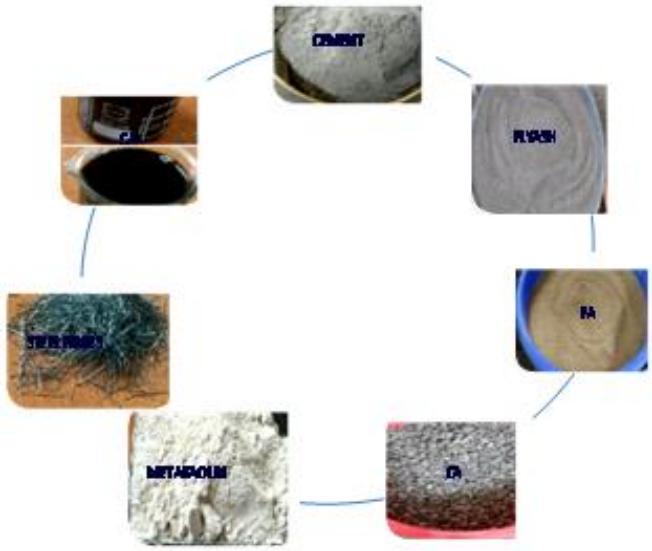
1. INTRODUCTION

Concrete is the most widely used man made construction material in the world, and is the second next to water as the most utilized substance on the planet. It is obtained by mixing cementitious materials, water, aggregates and admixtures (if needed), in required proportions. The mixture when placed in forms and allowed to cure hardens into a rock- like mass known as concrete. Aggregates is one of the important constituents which has effect in strength development in the theory that the gaps of coarse aggregate is filled by the fine aggregate and the gaps of fine aggregate is filled by the binding materials The strength, durability and other characteristics of concrete depends upon the properties of its ingredients on the proportions of mix, water cement ratio, aggregate gradation, aggregate size and shape, cement quality, mixing time, method of compaction and other controls during placing, compaction and curing.

- The objective of this paper is to investigate and compare the compressive, flexural and splitting tensile strength of Steel Fiber Reinforced Concrete with Fly ash and Metakaolin in various proportions in M30 grade concrete with 1% fibres with addition of admixture.
- To study the durability behavior of steel fiber reinforced concrete with Fly ash and Metakaolin in various proportions for M30 grade concrete.

2. MATERIAL COLLECTION

1. Cement
2. Flyash
3. Fine aggregate
4. Metakaolin
5. Coarse aggregate
6. Steel fibers



3. ROPERTIES OF MATERIALS

3.1. Fly Ash

The physical properties of fly ash are,

Specific Gravity	2.40 to 2.60
Color	Off white, gray to buff
Physical Form	Powder
Average Plastic size	<2.5 micron
Brightness	80-82 Hunter L
BET	15 m^2/g
Specific surface	8-1 mm^2/g

3.1.1. Fineness of Fly Ash

As per ASTM, the fineness of the fly ash is to be checked in both dry n wet sieving. The fly ash sample is sieved in 45 micron sieve and the percentage of retained on the 45 micron sieve is calculated. Further fineness is also measured by LeChatelier method and Blaine Specific Surface method.

3.1.2. Specific Gravity of Fly Ash

The specific gravity of fly ash ranges from a low value of 1.90 for a sub-bituminous ash to a high value of 2.96 for an iron-rich bituminous ash.

3.1.3. Size and Shape of Fly Ash

As the flyash is a very fine material, the particle size ranges in between 10 to 100 micron. The shape of the fly ash is usually spherical glassy shaped.

3.1.4. Colour

The colour of the fly ash depends upon the chemical and mineral constituents. Lime content in the fly ash gives tan and light colours where as brownish colour is imparted by the presence of iron content. A dark grey to black colour is typically attributed to an elevated un-burned content.

3.1.5. Properties of Metakaolin

A.	Cement used : OPC 53
B.	Specific gravity of cement : 3.15
C.	Specific gravity of:
1.	Coarse aggregate : 2.74
2.	Fine aggregate : 2.56
3.	Metakaolin : 2.3
4.	Fly ash : 2.62
5.	Super plasticizer(CONPLAST SP 430) : 1.2
D.	Water absorption for:
1.	Coarse aggregate : 0.55%
2.	Fine aggregate : 1%

4. TEST RESULTS

4.1. CUBE COMPRESSIVE STRENGTH TEST

Table 4.1 Compressive strength test results at 7days and 28days

S. no	MIX ID	Cube Compression Strength		%Increase Of Compressive Strength at 28 days
		7days N/mm²	28 days N/mm²	
1	R	18.03	32.8	-
2	M_1	22.17	34.65	5.6
3	M_2	24.54	33.56	2.28
4	M_3	26.28	36.3	10.6

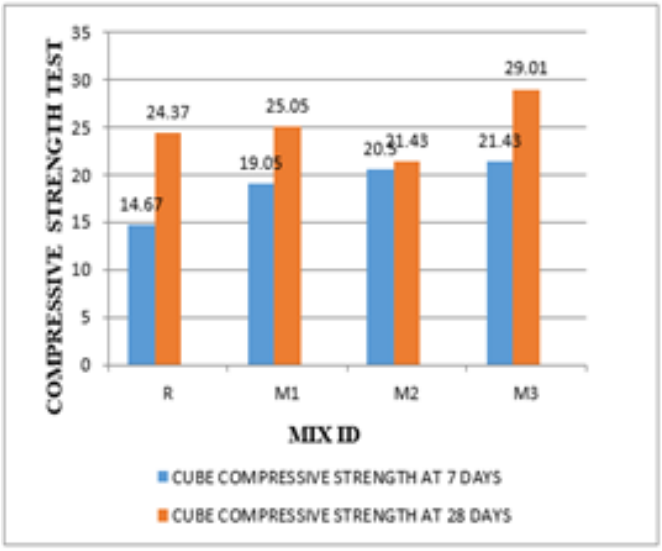


Figure 4.1 compression strength test

4.2. CYLINDER COMPRESSIVE STRENGTH TEST

Table 4.2 Compressive strength test results at 28days

Sl. no	Mix ID	Cylinder compressive test at 7days (N/mm²)	Cylinder compressive test at 28 days (N/mm²)	% Increase of Compressive strength
1	R	14.67	24.37	-
2	M1	19.05	25.05	2.8
3	M2	20.50	21.43	12
4	M3	21.43	29.91	22.7

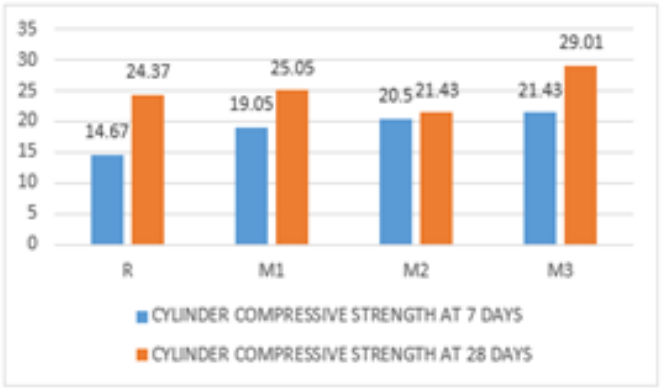


Figure 4.2 Compressive strength test results at 28days

4.3. MODULUS OF ELASTICITY TEST

Figure 4.3 Test set up for Young's Modulus

Table 4.3 Values of Modulus of Elasticity (N/mm²)

S. no	Mix ID	Modulus of Elasticity E_c(N/mm²)	
		Experimental value	Theoretical value ($5000\sqrt{f_{ck}}x10^4$)
1	R	21324.5	23011.2
2	M1	22675.4	25024.8
3	M2	20815.6	23146.2
4	M3	24384.3	27345.1

4.4. SPLIT TENSILE STRENGTH TEST

Table 4.4 Split Tensile Strength test results at 28 days

Sl. no	Mix ID	Split tensile strength at 28 days (N/mm²)	% Increase of split tensile strength
1	R	2.10	-
2	M1	2.24	6.67
3	M2	2.17	3.34
4	M3	2.52	20

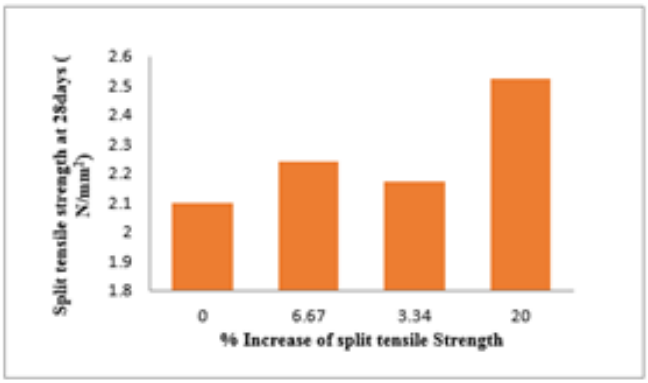


Figure 4.4 Split tensile strength on cylinders

4.5. FLEXURAL STRENGTH TEST

Table 4.5 Flexural strength test results at 28days

Sl. no	Mix ID	Flexure strength at 28days(N/mm²)	% increase of Flexural strength
1	R	3.96	-
2	M1	5.94	49.2
3	M2	5.47	38.13
4	M3	6.59	66.4

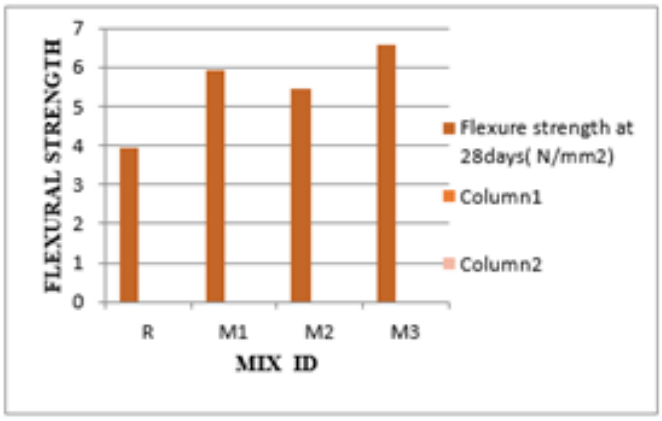


Figure 4.5 Flexural Strength Test

4.6. LOAD DEFLECTION BEHAVIOUR AND STIFFNESS OF THE PRISM SPECIMENS

Table 4.6 Load-deflection and stiffness behavior of prism specimens

Mix ID	Ultimate load (kg)	Deflection at ultimate load(mm)	Stiffness at maximum load(N/mm)	% Reduction stiffness with respect to reference mix
R	960	0.14	67.26	-
M1	1080	0.32	33.108	50.71
M2	980	0.42	22.89	65.96
M3	1120	0.20	54.93	18.33

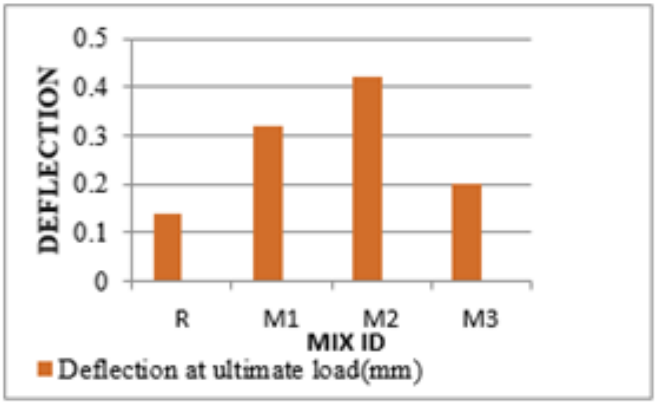


Figure 4.6 Load Deflection Of Prism Specimens

4.7. DENSITY COMPARISION OF CUBES, CYLINDERS AND PRISMS

Sl. no	Mix ID	Density Kg/m³		
		Cubes	Cylinders	Prisms
1	R	2632.88	2486.6	2641.6
2	M1	2610.07	2627.09	2537.36
3	M2	2595.25	2357.92	2504.2
4	M3	2648.29	2304.72	2559.8

5. CONCLUSION

- Based on the test results and discussions the following conclusions are arrived, It was observed from the test results that the compressive strength of concrete cubes replaced with Flyash and Metakaolin showed better results compared with Reference Mix having 1% fiber.
- The two admixtures Fly ash and Metakaolin when used at an optimum combination of (18%, 12%) 18% as Flyash and 12% as Metakaolin respectively, tend to increase the compressive strength of concrete.
- There was significant improvement in the durability properties like water absorption and Sorptivity when flyash and Metakaolin percentage increases in the concrete respectively.

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