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Experimental Behaviour of Steel Fibre Reinforced Concrete with Partial Replacement of Fly Ash & Metakolin

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ABSTRACT

Concrete is largely used due to the abundance of raw material, low manufacturing and maintenance cost, excellence in compression, corrosion aspects, and versatility in forming various shapes and its unlimited structural applications in combination with steel reinforcement. All these factors have contributed pressures to reduce cement consumption and to intensify research in exploring the possibilities of enhancing strength, durability and corrosion reduction through the use of pozzolonas as supplementary cementing materials. Fibre reinforced concrete (FRC) is a fibre reinforcing cementitious concrete composite, and by adding discrete short fibres randomly in concrete it exhibits many substantially improved engineering properties It is manufactured from kaolin which makes the concrete more durable and ecofriendly. In the present investigation mechanical properties of concrete containing both Fly ash and Metakaolin at various combinations are studied. For the various combinations of Fly ash and Metakaolin, cubes cylindrical and prism specimens are casted with 1% of fibres and the compression strength, split tensile strength and flexural strength test results are obtained and compared with the conventional mix having 1% fibres. It is thereby suggested that utilization of these cementitious materials in concrete will reduce the requirement for cement thereby marching towards 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 concretewith 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. PROPERTIES OF MATERIALS

3.1. Fly Ash

The physical properties of fly ash are,

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

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

4. TEST DATA FOR MATERIALS

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%

5. TEST PROCEDURES

5.1. Water absorption test

2kg of sample was taken and weighed as W_1. The sample was completely immersed in water and is left for 24 hours. After 24 hours the sample is taken out and is allowed to surface dry. The water in the surface was removed by using clean cloth. Then the sample was weighed again. This weight was taken as W_2. Now the sample was kept in a oven and is completely dried. The new weight was taken as W_3.

Water absorption for Coarse aggregate = 0.55%

5.2. MARSH CONE :

Marsh cone test is reliable and simple method to study the rheological properties of cements.

- Flow time of cement/mortar through marsh cone is indicator of viscosity, depends upon cement super plasticizer compatibility.
- It is widely used to study the cement super plasticizer compatibility and to determine optimum super plasticizer dosage of a specific cement-super plasticizer combination.
- Saturation Point is taken as the maximum super plasticizer content to be used in concrete.

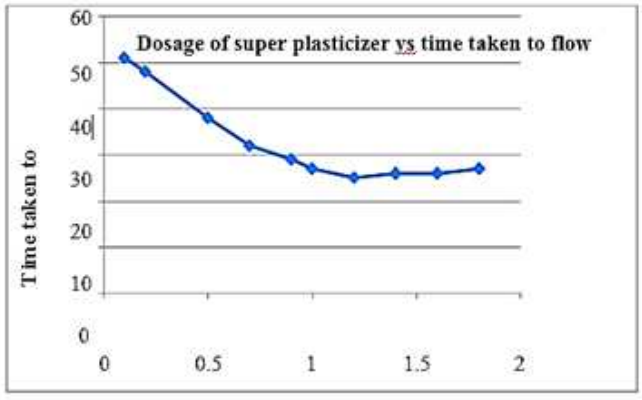
Fig1. Marsh cone test

6. RESULT & DISCUSSION

6.1. MARSH CONE TEST

1 litre of cement paste is prepared in a mortar mixer using 2kg of cement and water cement ratio of 0.45. About 70% of water is added first and the remaining 30% of water is mixed with super plasticizer and added to it. Cement slurry is prepared with a water cement ratio of 0.45 and an admixture dosage of 0.1%. 1 litre of cement slurry is made to flow through marsh cone and time in seconds is measured using a stopwatch. This procedure is gradually repeated by increasing the S.P dosage in steps of 0.2%.

Fig2.Cement Super plasticizer compatibility



6.2. CYLINDER COMPRESSIVE STRENGTH TEST

The compressive strength on cylinder is found to be increased for all the mixes when comparing it with the reference mix.

Table 1.Compressive strength of cylinder at 28 days

Sl. no	Mix ID	28 days (N/mm2)	compressive strength
1	R	24.37	-
2	M1	25.05	2.8
3	M2	21.43	-12
4	M3	29.91	22.7

Compressive strength is measured by breaking cylindrical concrete specimens in a compression-testing machine. Compressive strength is calculated from the failure load divided by the cross-sectional area resisting the load and reported in units of pound-force per square inch (psi) or megapascals (MPa).

Fig3. Compressive strength at 28 days

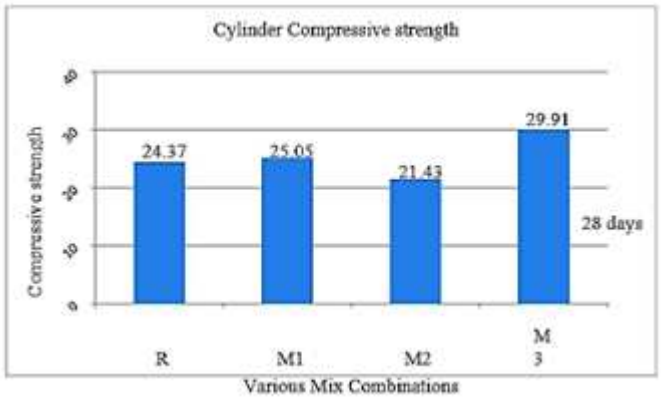
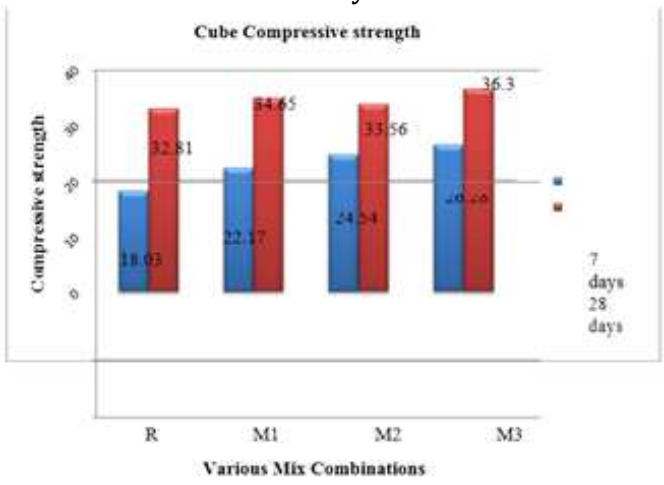


Table2. Comparison of Cylinder compressive strength at 28days

Sl. no	Mix ID	Cube Compressive Strength		% Increase of strength at 28 days
		7 days (N/mm^2)	28 days (N/mm^2)	
1	R	18.03	32.81	-
2	M1	22.17	34.65	5.6
3	M2	24.54	33.56	2.28
4	M3	26.28	36.3	10.6

Fig4. Comparison of cube compressive strength at 7 & 28 days



7. CONCLUSION

Based on the test results and discussions the following conclusions are arrived, It was observed from the test results that the compressive strength and tensile strength of concrete cubes replaced with Flyash and Metakaolin showed better results compared with Reference Mix having 1% fibre.

The two admixtures Fly ash and Metakaolin when used at an optimum combination of (18%, 12%) respectively, tend to increase the compressive strength of concrete. Thereafter there is slight reduction in strength for mixes with FA&MK at (21%&9%) combination than the mix with FA&MK at (24%&6%) and (18%12%) but not less than that of the reference mix.

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