Effect Of Fly Ash And Micro Silica On Hybrid Fibre Reinforced Concrete

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Abstract— Hybrid fibre reinforced concrete is procurement from the grouping of diverse types of fibres, which fluctuate in the substance of properties, keep on bond mutually when supplementary in concrete and retain their identities and properties. The combination of fibres, often called hybridization, concrete is looking into for an M_{50} grade. Hybrid fibre composites were cast by replacing cement with 25% 30% and 35% fly ash and 5%, 10% and 15% of micro silica. A stable percentage of 0.5% Steel and 0.5% polypropylene fibre are used for all three mixes. The density of concrete increases by adding micro silica and steel fibre to concrete which imparts the strength of concrete, Compressive, Spilt tensile and flexural strength of HFRC of mix-2 increases up to 8.76%, 8.12%, and 4.33% respectively that of the normal concrete mix. The boost in steel fiber percentage results only increase in tensile strength. The mix-2 (MS 10%+FA30%) shows superior outcome signifying most favorable substitution to the cement.

Keywords— Polypropylene Fibre (PFs), Steel Fibre (SF), Fly Ash (FA), Micro Silica (MS), Super Plasticizer (SP)

I. INTRODUCTION

A. General

Concrete is the much part abundantly second-hand as building substance moreover which have more compressive strength. It's especially delicate of breakable tension, flexure and crash strength and cracking resistance is less then Fly ash is waste industrial materials of the thermal power station which is dumped in many places to get free access to use in many construction industries and its byproduct of industrials waste. To keep the safe environment and to reduce the carbon dioxide emission of the concrete we will replace cement by fly ash and micro silica. The most common use of fly ash is to partially replace Portland cement used to produce concrete. Pozzolanic materials like fibre like steel fibre(hooked end both side) and Polypropylene (Recron 3S) which are used in this experimental study which is mainly to reduce the microcracks and less porosity. The fast development of the mechanical area has brought about an extensive number of results or waste materials that can be utilized as fly ash remains, Silica Fume, GGBFS, steel slag, and the like. The utilization of these side-effects not just aides in the utilization of these waste materials, yet in addition enhances the execution of the solid in its fresh and hardened state. There are two kinds of crystalline and indistinct materials. Micro silica is a decent shapeless material. It is a generation of basic silicon or silicon-containing compounds in electric bend heaters. It is normally a dim powder like Portland or some fly slag, which is, for the most part, named a supplemental gelling material. Micro silica was initially utilized as a cement replacement material, and in a few regions, it is typically utilized as a pozzolanic blend rather than a little measure of micro silica. [1][4]

II. LITERATURE REVIEW

In this investigation properties of fly ash and silica fume hybrid fiber reinforced concrete adding various fibers in concrete are called hybrid fiber. In this study, steel fibers and polypropylene fibers were used as mixed fibers in concrete. The proportions of steel fibers (75%) and polypropylene fibers (25%) are 0%, 0.5%, 1% and 1.5%, respectively, of the cement weight. A partial replacement of fly ash and GGBS reached 30% of the cement weight. The compressive strength test of the cube, the tensile test of the cylinder and the flexural test of the beam were studied [1]. The current work carried out a series of tests to compare various mechanical properties of Reliance OPC 43 cement concrete. The mixture was replaced with 7.5%, 10%, and 12.5% silica fume. After the absolute percentage of silica fume, the optimum percentage of silica fume reaches 10%. The harden properties were studied at different days of curing [2]. The studied M_{30} Concrete, of which 0%, 25%, 30%, 40% and 50% of micro silica partially replaced cement. When the micro silica content increases at different % the normal concentration increases by 40%. The max compressive strengths and split tensile strength results were obtained at the substitution of cement at 25% micro silica [3].Effect of silica fume on HSC properties shows that up to 10% of the cement can be replaced by silica fume with no effect on the fresh property of concrete. Concrete with 10% substitution of silica fume achieves more compressive strength. Concrete with 15% silica fume achieves the highest flexural strength. Silica fume content of 10% and 15% is a cement substitute that is considered to be the optimal amount to increase compressive strength and flexural strength, respectively [10]. Fly Ash concrete with steel fibres at a constant volume fraction of 1.5% with the utilization of fly ash up to 50% was replaced with cement which showed good composite performance. It was also observed increasing trend in flexural strength results for 1.5% steel fibre. Modulus of elasticity of concrete showed maximum strength increases by 35%, when compared to conventional concrete.[4] Replacing cement with micro silica up to 10% can enlarge the compressive strength of M_{30} concrete. The 15% compressive strength decreased during different days of curing. The compressive test on M_{30}grade concrete is increased from 16% to 29% decreased from 23% to 20% [6]. Studied fresh and hardened properties where cement is substitution by SF. There was reduce in workability as % substitution of SF increase there was more compressive observed for increase %of silica fume substitution there is no effect on hardened properties[7].

III. OBJECTIVES

1. To get the maximum strength of fly ash and micro silica-based hybrid fibre reinforced concrete
2. For studying the mix design of M_{50} based concrete and those result will be matched with normal concrete
3. In this study Fly Ash is added to substitute cement by 25% 30% 35% and silica fume is 5%10%15% and adding fibre like steel and polypropylene as both 0.5% constant.
4. For calculating the optimum percentage it can be replaced for cement with Fly Ash and Micro Silica.

A. The aim of the work

The core principle of the current study the composite fiber concrete part of the cement represented by Fly Ash and micro silica as of the replacement of cement in the effective use composition of the future materials.

IV. MATERIALS AND METHODS

A. Cement

Cement is the concrete bonding material that is used for all building elements. We used 53 OPC grades (Ordinary Portland Cement) throughout the project. The specific gravity is 3.15 of cement while properties of cement tested in the laboratory are indicated below.

Table No 1 Physical Properties of Ordinary Portland Cement

Sl.No	Properties	Results of Conducted Tests
1	Fineness	8%
2	Specific Gravity	3.03
3	Normal consistency	33%
4	Initial setting time	50min
5	Final setting time	400min

B. Fine Aggregates

The sand used for the experimental program was acquired locally at Raichur, CASHUTEC, Shakthi Nagar R & D Center and conformed to the Indian standard specification IS: 383-1970. The sand utilized was watercourse sand with a Specific gravity of 2.61; the fine overall aggregate has a place with zone II. The water retention of the fine total is 1.4%

Table No 2 Physical Properties of Fine Aggregates

Sl. No	Test	Results
1	Fineness module	3.36 (Zone II)
2	Specific gravity	2.61
3	Water	1.4%

	absorption	

C. Coarse Aggregates

The coarse aggregate was extruded into angular dimensions with a most aggregate size of 20 mm. The particularly specific gravity of coarse aggregate is 2.67. Water retention of coarse total is 0.5%.

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Table 3 Physical Properties of Coarse Aggregate

Sl. No	Characteristics	Obtained Value
1	Specific Gravity	2.67
2	Water Absorption	0.19%
3	Fineness Modulus	6.42
4	Surface moisture	Nil

D. Fly Ash

Fly ash is decent grey gunpowder color which having by and large of spherical smooth particles that are created as a result in coal-fired power stations. Fly ash which had pozzolanic properties, means so as to it can act with lime to outline cementations compound its specific gravity of fly ash is 2.10

Table 4 Physical Properties of Fly Ash

Sl. No	Particulars	Features
1	Color	Whitish grey
2	Appearance	Powder
3	Specific gravity	2.10
4	The residue of 45-micron sieve	15.9%
5	Fineness	345 kg/m^2

Table 5 Chemical Composition of Fly Ash

SL.NO	Constituents	Percentage (%)
1	Silica(Si)	55-60
2	Alumina(Al)	20-35
3	Calcium oxide(Cao)	5-15
4	Ferric oxide(Fe2O3)	4-10

E. Micro Silica.

The micro silica its mineral combination collected of SiO_2 of especially fine and solid vitreous spheres of silicon dioxide. Micro silica comes as a by-product in many industries manufacturing ferrosilicon and metallic silicon in a very high temperature, especially in electric furnaces. This silicon produced is obtained from the bottom in a slag form. Further processing of this yields micro silica after intense cooling and condensation. This by-product can be eventually used to strengthen concrete.

Table 6 Chemical Properties of Micro Silica

Sl No	Particulars	Specified (%)
1	SiO_2	99.68%
2	Al_2O_3	0.042%
3	Fe_2O_3	0.037%
4	CaO	0.004%
5	MgO	0.001%

Fig 1 Micro Silica

F. Steel Fibre

Double hooked end steel fibre with an aspect ratio of 50. Length 5cm and diameter 1mm were used in this research work. Steel fibres of the hooked end which are used in concrete reinforcing material, its mixture by way of concrete provides good merits as similarity with conventional reinforcement. Steel Fibres which are prepared from diverse wire materials, fibres are sometimes named as structural fibres with these are proposed to hold the load and for that reason, steel fibre is used to substitute conventional reinforcement in certain non-structural applications as well as curtail and eradicate both premature and overdue age cracking.

Fig 2 Double Hooked End Macro Steel Fibre

G. Recron 3s Poly Propylene Fibre

This fibre which is used in project mainly as reinforcing fiber that improves properties in concrete such as the tear, tensile, burst, and bulk. Special Products of Recron 3S is used in the present study and length of fibre was 4mm and diameter was 0.4mm so aspect ratio was 100

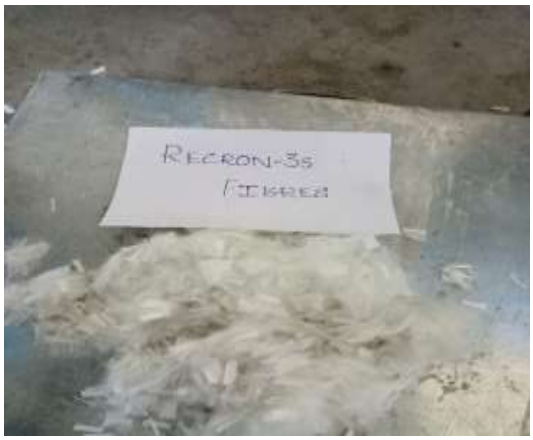

Fig 3 Recron 3s Polypropylene Fibre

H. Super Plasticizer

Conplast SP 430 is super plasticizer had been used at an optimum dosage 1% of cementitious materials. It Polycarboxylate Ether based superplasticizer is good for making for more strength and more workable concrete. It can reduce up to 29% of water.

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Fig 4 Conplast SP 430

I. Water

In this work potable water is used for the purpose of mixing as well as same water is used for curing purpose

F. Mix proportion

Table 7 Mix Proportion of Design

Grade	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (lit./m^3)
M_{50}	424	780.29	1127.88	156.73
	1	1.84	2.66	0.36

G. Types of Mixes

Table 8 Type of Different Mix

Mix	Fly Ash	Micro Silica	Steel Fibre	Polypropylene
Mix1	25%	5%	0.5%	0.5%
Mix2	30%	10%	0.5%	0.5%
Mix3	35%	15%	0.5%	0.5%

TESTS CONDUCTED ON SPECIMENS

The testing will be done as per I.S Specifications.

- Compression Tests
- Split Tensile Tests
- Flexural Tests
- Durability test

1. The above tests are done for knowing the strength characteristics of concrete after 3 days, 7 days and 28days. The table below shows results of 3days, 7days and 28 days strength of specimens

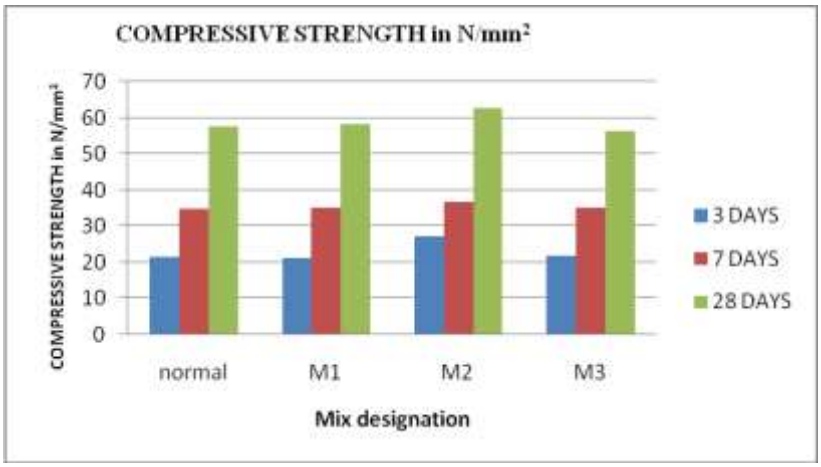
2. Fresh properties of concrete for slump cone and compaction factor test result shown below.

Table 9 the result of slump cone and compaction factor

Sl. No.	Concrete type	slump value (mm)	Compaction factor
01	Normal	85	0.86
02	M1	81	0.9
03	M2	78	0.93
04	M3	85	0.94

Table 10 Compressive Strength of specimens in N/mm^2

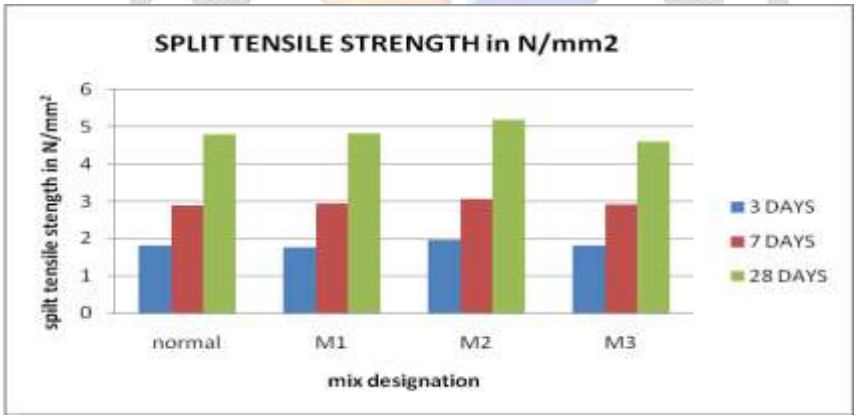
Type of Mix	3 days N/mm^2	7 days N/mm^2	28 days N/mm^2
Conventional	21.69	34.77	57.61
M1	21.33	35.25	58.21
M2	27.25	36.74	62.66
M3	21.92	35.14	56.26



Graph no 1 compressive strength of cubes 3 7 28 days

Table no 11 split tensile strength in N/mm²

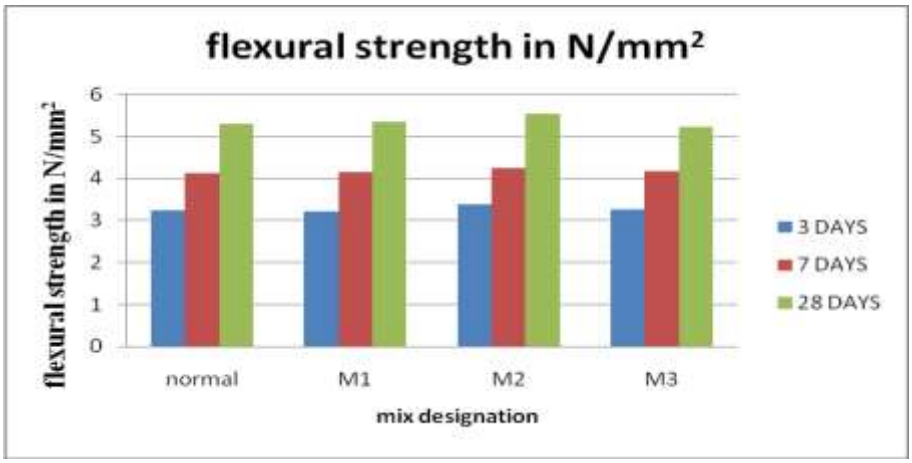
Type of Mix	3 days N/mm²	7 days N/mm²	28 days N/mm²
Conventional	1.80	2.89	4.8
M1	1.77	2.93	4.82
M2	1.965	3.05	5.19
M3	1.812	2.92	4.6



Graph no 2 split tensile strength of cylinder of 3, 7, 28 days

Table no 12 flexural Strength in N/mm²

Type of Mix	3 days N/mm²	7 days N/mm²	28 days N/mm²
Conventional	3.24	4.12	5.31
M1	3.22	4.15	5.34
M2	3.38	4.24	5.54
M3	3.27	4.17	5.24



Graph no 3 flexural strength of cylinder of 3, 7, 28 days

Durability Test

Sulphate attack: When 28 days of curing specimen were weighed accurately. Then they were subjected to the acidity attack of PH=2 and PH =3 for 60 days. Afterward 60 days overall specimen was taken out and, were washed thoroughly with water and dried. At this Point of time they were weighed accurately. Then the cubes of specimen were tested for compressive strength.

Table no: 13 shown the acidity result measured

Mix design	wt of specimen before acidic attack w1	wt of specimen after subjected to acidic attack w2	percentage weight loss
M0	8.44	8.42	0.236
M1	8.40	8.37	0.357
M2	8.42	8.40	0.237
M3	8.03	7.97	0.747

VI. CONCLUSION

1. The Workability of concrete fall out with raise in Micro silica at ease with an accumulation of Steel fibre. Both parameters also decrease with 50% replacement of natural sand by river sand as compared with conventional concrete.
2. The density of concrete increases as adding micro silica and steel fibre to concrete which imparts the strength of concrete.
3. The compressive strength of concrete increases up to 8.76% for 28 days compared to normal concrete mix2.
4. Spilt tensile strength of concrete increase up to 8.12% over normal concrete mix2.
5. The boost in the percentage of steel fiber results only increase of tensile strength. The nominal percentage of steel fiber should not exceed 1% of the volume of concrete.
6. Flexural strength of concrete is increased up to 4.33% compared to normal concrete for 28 days of mix2.
7. Polypropylene fiber gives a considerable strength increase in compression and since it reduces workability it must be added in lesser amount compared to steel fiber
8. The optimum level of fly ash replacement should be between 10 to 30% in order to obtain the maximum strength of the concrete.
9. draw on of micro silica and fly ash in concrete origin saving of cement and address the trouble of throwing away of micro silica and fly ash and decide ecological harms Utilization of smaller scale silica and Fly Ash limit the ozone-depleting substances and prompt manageable development.

FUTURE SCOPE OF PROJECT STUDY:

1. For further study made on micro silica can be replaced up to a limit of 20% by weight of cement which will give the better results.
2. The micro silica and natural sand with different percentages for further work can be used as replacement materials in various percentages for making high strength & durable good strength of concrete

3. The micro silica with natural river sand gives the durability properties of concrete which can be utilized for further study.

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