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RESEARCH ARTICLE

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A CASE STUDY ON EFFECT OF FLY-ASH BASED SIFCON ON STRENGTH OF CONCRETE

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ABSTRACT

The main objective of this research programme is to find out the strength characteristics of Slurry Infiltrated Fibre Reinforced Concrete (SIFCON) using fly ash as a partial replacement to cement by 20%. The strength formed after 7th, 14th and 28th days from the time and date of casting are studied in detail. In this investigation the different fibres planned for usage are Galvanised Iron Fibre (GIF), High Density Polyethylene Fibre (HDPEF). The cement-sand slurry used is of the proportion 1:2 with a water cement ratio 0.6. The percentage of fibres (by volume fraction) used in the experimentation is 6 % for mono fibres.

Key words: SIFCON, Fly Ash, GI Fibre, HDPE Fibre, Strength Parameters.

INTRODUCTION

Nowadays, we talk much about high performance concrete. It has higher strength, better durability and elasticity. Although high strength concrete is often considered as relatively new material, its development has been gradually taking place over many years.

In the discussion of high performance concrete role played by FRC is vital. FRC is defined as a composite material which consists of conventional concrete reinforced by randomly dispersed short length fibres of specific geometry, made up of steel, synthetic material or natural fibres. The fibres are distributed evenly throughout the mix without balling or clustering. The randomly oriented fibres help to bridge and arrest the cracks. As such, crack widening is gradual as compared to plain concrete. This leads to better performance of concrete. Fibres have reported to be superior to wire mesh, for shortcrete. Also they overcome a difficultly in placing the mesh, especially on irregular surfaces.

The concept of steel fibre reinforcement is very old. Steel fibres have been used since early 1900. Presently, steel fibres are considered as structural fibres as they enhance strength of the structure to a great extent. The addition of steel fibres into concrete mass can dramatically increase the strength properties like compressive strength, tensile strength, and flexural strength and impact strength of concrete. The strength properties of FRC can be increased by increasing the percentage of fibres in the concrete. But as the percentage of fibres increases, there are certain practical problems which have to be faced. The higher percentage i.e. higher volume content of fibres may cause balling effect in which the fibres cling together to form balls. Thus uniform distribution of fibres cannot be guaranteed, if percentage of fibres is more. Also longer fibres interfere with the aggregates during compaction thus hindering the proper orientation of fibres.

OBJECTIVES OF THE WORK

- The main objective is to find out the effect of fly-ash based SIFCON on the strength characteristics of concrete. The strength characteristics such as compressive strength, tensile strength, flexural strength are studied with respect to different replacement of fly-ash of SIFCON.
- Mix design of 1:2 i.e. 1- cement, 2- sand (slurry) with water cement ratio as 0.6
- Fly ash has been replaced for cement i.e., 5%, 10%, 15% and 20%.
- Different fibres such as, GIfibre (GIF), HDPEF are used respectively. 6% of fibres have been used for each.
- GIF having aspect ratio 50mm length, 1mm diameter
- HDPEF having aspect ratio 50mm length 1mm width

MATERIALS AND METHODOLOGY

The materials used in this study include ordinary portland cement (OPC 43), fly ash, fine aggregate, mixing water, galvanised iron fibre(GIF), high density polyethylene fibre (HDPEF).

- **Cement**

  In this experimental work, 43 grade ordinary Portland cement (OPC) conforming to IS: 8112 – 1989 was used. The cement used was Rajashree cement from the local distributors.

- **Fine aggregate**

  Natural sand confirming to IS 383-1970 of Zone II is used. Specific gravity, moisture content and absorption capacity of fine aggregate is calculated according to the procedures confirming to IS 2386 and results obtained comply with the code specifications.

- **Galvanized iron fibres (GIF)**

  GI fibres were procured locally. Round GI wire of 1mm diameter was cut to the required length of 50 mm giving an aspect ratio of 50. The ultimate strength and density of fibres was found to be 395 MPa and 7850 kg/m^3 respectively. These GI fibres are commercially available and are generally used for electrical work.

CASTING OF SPECIMEN

Following points are noted while filling moulds.

1. The cement, is weighed and is dry mixed uniformly with weighed quantities of fly ash and fine aggregates. Calculated quantity of water is added to the mix to get a uniform wet mix in a batching tray.
2. Moulds are cleaned and lightly oiled.
3. Weighed quantity of fiber is dispersed in the mouldand slurry is poured until no more bubbles are seen. This ensured a thorough infiltration of slurry into the fibres. Concrete is filled above the layers of SIFCON with sufficient compaction.
4. Mould data and grade is marked on specimen after initial set or final set by paint.
5. After 24 hours, the specimens were demoulded and were transferred to curing tank where they are allowed to cure for 28 days.

Distribution of fibers

Casted specimen

Demoulded specimens

TEST RESULTS

Overall results of compressive strength: Following table 1 gives the overall results of compressive strength of SIFCON for a replacement of fly ash 5%, 10%, 15% & 20% for different fibres. Fig 1 shows the comparison of compressive strength of SIFCON for a replacement of fly ash 5%, 10%, 15% & 20% for different fibres.

Table 1 –Overall results of compressive strength

No of days of curing for replacement of fly ash in SIFCON by 5%, 10%, 15% & 20%	Average compressive strength of GI Fibre (Mpa)	Average compressive strength of HDPE Fibre (Mpa)
7	14.45	9.11
14	22.95	16.06
28	25.28	19.28

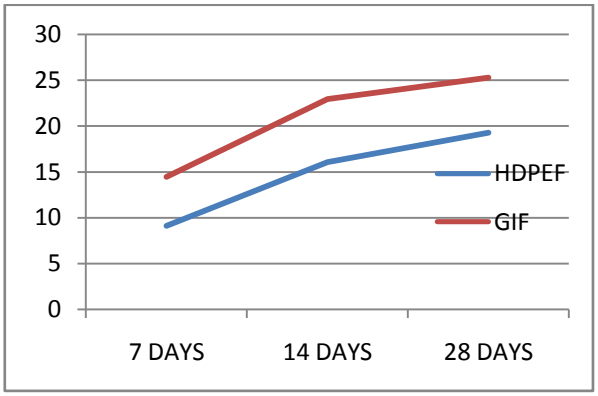

Fig 1-Comparison of compressive strength of SIFCON for different fibres.

Overall results of tensile strength: Following table 2 gives the overall results of tensile strength of SIFCON for a replacement of fly ash 5%, 10% & 15% for different fibres. Fig 2 shows the comparison of tensile strength of SIFCON for a replacement of fly ash 5%, 10% & 15% for different fibres.

Table 2-Overall results of tensile strength

No of days of curing for replacement of fly ash in SIFCON by 5%, 10% & 15%	Average tensile strength of GI Fibre (Mpa)	Average tensile strength of HDPE Fibre (Mpa)
7	1.27	0.85
14	1.75	1.15
28	2.11	1.63

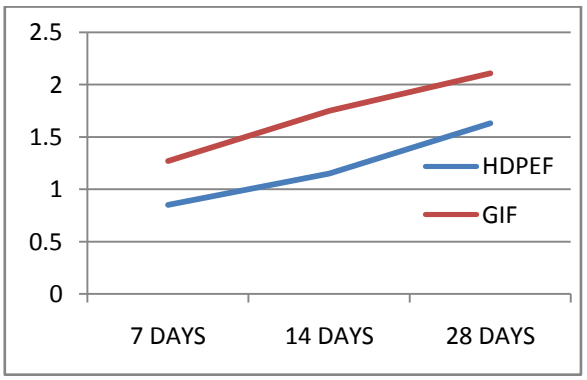

Fig 2-Comparison of tensile strength of SIFCON for different fibres.

Overall results of flexural strength: Following table 3 gives the overall results of flexural strength of SIFCON for a replacement of fly ash 5%, 10%, 15% & 20% for different fibres. Fig 3 shows the comparison

of flexural strength of concrete with different depths of SIFCON layers for different fibres.

Table 3-Overall results of flexural strength

No of days of curing for replacement of fly ash in SIFCON by 5%, 10% & 15%	Average flexural strength of GI Fibre (Mpa)	Average flexural strength of HDPE Fibre (Mpa)
7	3.11	1.89
14	3.73	2.55
28	4.44	3.23

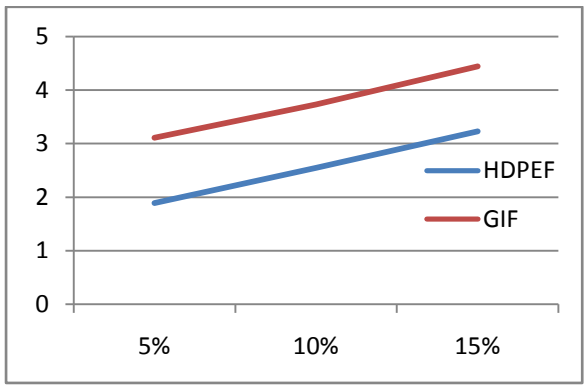

Fig 3-Comparison of flexural strength of SIFCON for different fibres.

OBSERVATIONS AND DISCUSSIONS

Following observations can be made based on the experimentation conducted on the effect of SIFCON on the strength characteristics of concrete.

1) It is observed that compressive strength of concrete with SIFCON produced by GI fibre is more compared to that of HDPE fibre.
2) It is observed that tensile strength of concrete with SIFCON produced by GI fibre is more compared to that of HDPE fibre.
3) It is observed that flexural strength of concrete with SIFCON produced by GI fibre is more compared to that of HDPE fibre.
4) This is due to the fact that the SIFCON with GI fibre can induce more ductility properties to concrete as well they can resist crack formation and crack propagation in a more efficient way, thereby enhancing the compressive strength of concrete, tensile strength and flexural strength.

CONCLUSIONS

Based on the observations made in the experimentation, the following conclusions can be drawn.

1) It can be concluded that the concrete with SIFCON produced with GI fibre yields higher compressive strength as compared to that of GI and HDPE fibres.
2) It can be concluded that the concrete with SIFCON produced with GI fibre yields higher tensile strength as compared to that of GI and HDPE fibres.
3) It can be concluded that the concrete with SIFCON produced with GI fibre exhibit more flexural strength as compared to that of GI and HDPE fibres.

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