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An Experimental Investigation of the Characteristics of Silica Fume Concrete with Polypropylene Fibre Addition

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Abstract-- **Concrete is a significant material used these days in the construction sector. Steel offers more resistance when under stress, while concrete offers better resistance under pressure. Ordinary cement has a low effect, a scraped surface, limited malleability, and little break protection. Stringy cement is created by adding short, irregular, and discrete strands to plain concrete in order to increase its pre breaking and post breaking conductivity. Other than silica fume, half-and-half filaments are consolidated to improve the properties of cement. Various fiber-added materials can be combined with cement in this study to plan for specific applications and improve synthetic and strength properties. By using different fiber extents of steel and polypropylene, the combination of strands—often referred to as "hybridization"—is presented. According to the IS code method of mix design, silica fumes ranging from 0 to 15 percent by volume of cement and poly-propylene fiber, steel (crimped) fibers, and hybrid fiber (poly-propylene and steel (crimped) fibers) were used as additives for each of the concrete mixes of M30 grade. All mixtures included a super plasticizer as well to enhance. Along with casting M30 grade concrete cubes and beams with 0 and 15% silica fumes, various amounts of steel fiber, polypropylene fiber, and hybrid fibers, by volume of cement, this study also identifies the fiber combinations that show the maximum compressive, flexural, and shear strength of concrete. Finally, we discovered that adding fiber and mineral admixtures to concrete causes it to have better properties than plain concrete.**

Keywords: **M30 Grade of Concrete, Cement, polypropylene fiber, silica fume, sand, coarse aggregate, Workability.**

I. Introduction

The A composite material, concrete is made up of a few different constituent parts. Concrete, water, aggregate (sand and stone), and typically at least one extraordinary additional component are included in this mixture to ensure the substantial has the desired properties. They may speed up the concrete's solidification process and lengthen it. There will be a heat age when the different minerals in the concrete react with water. As a result, keep the substance moist as it solidifies to prevent drying out and breaking.

Concrete

These properties might be constrained by changing the proportionality of the fundamental minerals.

Despite the fact that the remainder of the minerals make up a little piece of the concrete, these can affect sly affect the concrete's properties too. The potassium-and sodium oxides (the alkalis) are significant. They can cause the concrete to solidify quicker and make it extend. At the point when the various minerals in the concrete respond with water there will be heat age. Because of this keep the substantial clammy while solidifying to stay away from drying out and breaking.

Figure no. 01 Concrete

Fiber

Fiber is a characteristic or manufactured substance that is fundamentally more than it is wide. Manufactured filaments can regularly be created efficiently and in huge sums contrasted with normal strands, yet for apparel regular filaments can give a few advantages, like solace, over their engineered partners.

Fiber Types

Natural Fiber – Regular strands create or happen in the fiber shape, and incorporate those delivered by plants, creatures, and topographical cycles. They can be grouped by their starting point.

1. Vegetable strands
2. Wood fiber
3. Animal filaments
4. Mineral filaments
5. Biological filaments

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Man-made Fiber – Man-made or synthetic filaments are stranding whose compound creation, design, and properties are fundamentally adjusted during the assembling cycle. Man-made filaments comprise of recovered strands and engineered strands.

1. Synthetic strands
2. Semi- Synthetic fiber
3. metallic filaments

Polypropylene Fiber

Two very delicate issues have come to light as a result of the current global health emergency: hygiene and safety. It's crucial to strictly adhere to all safety measures in regards to routine cleaning and thorough hygiene of the environments in which we live as well as the items with which we come into contact. The contemporary situation in which the consumer gives the concept of "well-being" and health an even greater value than aesthetic taste and comfort causes the modern features of polypropylene to reappear in this scenario.

The fact that polypropylene yarn can be easily sanitized with a 70% hydroalcoholic solution or with sodium hypochlorite up to 0.5% makes it especially suitable for the current state of public health. This is in addition to the significant advantages of being completely recyclable and guaranteeing the best degree of sustainability among all natural and synthetic fibres (production requires lower temperatures than other polymers and has a reduced impact in terms of water, energy, and CO2 emissions). This is the legal requirement for sanitization, and tests on fabrics in our lab using intense colours as well as light and dark shades revealed that the colour was completely resistant to mechanical and washing actions. In order to meet the new requirements for cleanliness and environmental protection, the time has come.

Polypropylene has the following properties:

1. Fairly low physical properties
2. Fairy low heat resistance
3. Excellent chemical resistance
4. Translucent to opaque
5. "living hinge" capability
6. Low price
7. Easy to process

Fiber Characteristics Thanks to Polypropylene Origin

1. Able to give good bulk and cover
2. Resistant to abrasion, deterioration from chemicals, mildew, perspiration, rot, stain, soil and weather conditions
3. Colorfast
4. Quick drying
5. Low static
6. Thermally bondable
7. Strong
8. Dry hand (transports body moisture from the skin)
9. Very comfortable and lightweight

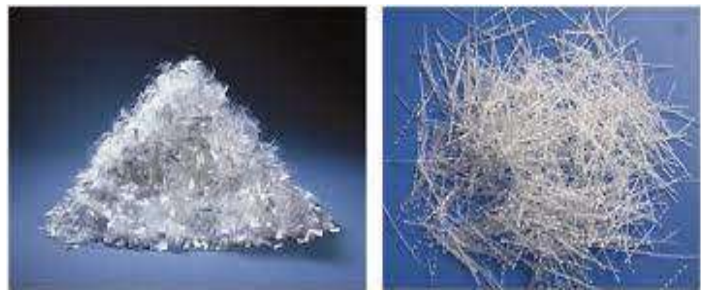

Figure no. 02 Polypropylene fibers

Silica Fume

Micro silica, also referred to as silica fume, is an amorphous (non-crystalline) polymorph of silica, which is silicon dioxide. It is an ultrafine powder with spherical particles and an average particle diameter of 150 nm that is gathered as a waste product from the production of silicon and ferrosilicon alloys. The primary use is as a pozzolanic component in high performance concrete.

Figure no. 03 Silica Fume

II. OBJECTIVES OF STUDY

In more detail, the study's objectives are as follows:

1. Studying silica fume and polypropylene fibre has an impact on strength when coupled with compelling samples.
2. To investigate the impact of cement when mixed with polypropylene fibre that emits different levels of silica fume.
3. To talk about the strength variation adjustment.
4. To prepare the concrete cubes & beams using by silica fume and Polypropylene Fiber mix concrete.

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5. To compare various mixes, including normal mix and fiber-mixed concrete, and to determine the compressive strength of hardened concrete at 7 and 28 days of curing.
6. To compare various mixes, including normal mix and fiber-mixed concrete, and to determine the flexural strength of hardened concrete at 7 and 28 days of curing.

III. Methodology And Experimental Analysis

Table no.01
Properties of Cement

S. No	Properties		Chart Results
1	**Specific gravity**		3.144
2	**Fineness (specific gravity)**		314 m^2/kg
3	**Normal consistency**		30%
4	**Setting time in min.**		
	1.	Initial setting time	130
	2.	Final setting time	197
5	**Soundness Test:**		
	By 1. Le Chatelier		0.5mm
	2. Auto clave method.		0.09%
6	**Compressive strength**		
	1.	3 – days	33.5 N/mm²
	2.	7 – days	46.50N/mm²
	3.	28 –days	61.00N/mm²
7	**Temperature during testing**		27 ˚c

Table no.02
Physical Properties of Fine Aggregate

S.No.	Characteristics	Result
1	Aggregate type	Natural
2	Specific gravity	2.62
3	Fineness modulus	2.74
4	Water Absorption	0.81

Table no.03
Physical properties of 40 mm coarse aggregate

S.No.	Characteristics	Result
1	Aggregate type	Crushed Stone
2	Maximum size of aggregate	40 mm
3	Specific gravity	2.67
4	Fineness modulus	7.26

Total weight taken = 5 kg

Table no. 04
Physical properties of Silica Fume

Properties	Values
Specific gravity	**2.25**
Particle size	**01 micron**
Bulk density	**2.247 Mg/m^3**

Table no. 05
Physical properties of Poly-Propylene Fiber

Properties	Values
Specific gravity	**0.91**
Particle size Fiber length	**Single cut length**
Water absorption	**nil**
Acid & salt resistance	**high**
Melt point	**324^0C**
Alkali resistance	**Alkali proof**

Table no. 06
Types of Slumps for experimental work

Concrete Type	Water content	Height of Slump
Conventional concrete	0.45	75mm
Silica fume added concrete	0.45	77mm

Table no. 07
Mix proportion by mass

Cement	Fine aggregate	Coarse aggregate
440	**706**	**1190**
1	**1.6**	**2.7**

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IV. Result Analysis

Compressive strength

Table no. 08
Compressive strength of conventional concrete and Poly-Propylene Fiber added with silica fume concrete cubes after 28 days for M30 grade

Concrete	Silica Fume	Sample No.	Failure of Load (Tons)	Compressive Strength (N/mm2)	Mean Compressive Strength (N/mm2)
Conventional Concrete	0%	C-1	83.0	36.2	36.47
		C-2	84.0	36.6	
		C-3	84.0	36.6	
M-PPF-A	5%	M-PPF-1	87.0	37.9	38.36
		M-PPF-2	88.0	38.4	
		M-PPF-3	89.0	38.8	
M-PPF-B	10%	M-PPF-4	98.0	42.7	43.02
		M-PPF-5	99.0	43.2	
		M-PPF-6	99.0	43.1	
M-PPF-C	15%	M-PPF-7	102.0	36.6	37.10
		M-PPF-8	104.0	36.6	
		M-PPF-9	105.0	37.9	

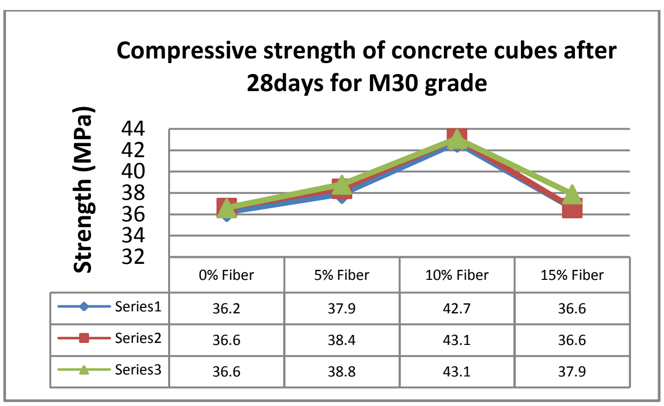


Figure 04 Compressive strength of conventional concrete and Poly-Propylene Fiber added with silica fume concrete cubes after 28 days for M30 grade

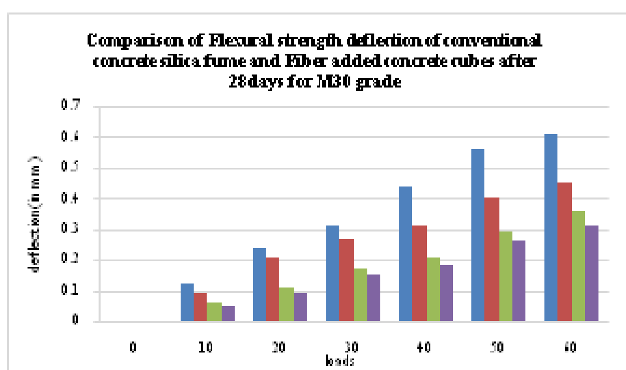
Flexural strength

Table no. 09
Flexural strength of conventional concrete and Poly-Propylene Fiber added with silica fume concrete Beams after 28 days for M30 grade

Concrete Grade	Sample number	silica fume	Failure of load (KN)	Flexural strength (N/mm2)	Mean (N/mm2)	Deflection (mm)	Mean deflection (mm)
M30	C-1	Nil	14.97	5.98	5.99	0.09	0.09
	C-2		14.98	5.99		0.09	
	C-3		15.01	6.00		0.09	
	M-PPF-1	5%	16.00	6.41	6.43	0.08	0.08
	M-PPF-2		16.10	6.44		0.08	
	M-PPF-3		16.13	6.45		0.08	
	M-PPF-4	10%	18.00	7.21	7.23	0.07	0.07
	M-PPF-5		18.09	7.24		0.07	
	M-PPF-6		18.13	7.26		0.07	
	M-PPF-7	15%	15.15	5.55	5.68	0.09	0.09

Load and deflection

Conventional concrete		5% silica fume introduced concrete		10% silica fume introduced concrete		15% silica fume introduced concrete	
Load (KN)	Defl. (mm)	Load (KN)	Defl. (mm)	Load (KN)	Defl. (mm)	Load (KN)	Defl. (mm)
0	0	0	0	0	0	0	0
2	0.006	2	0.006	2	0.004	2	0.004
4	0.018	4	0.018	4	0.013	4	0.013
7	0.034	7	0.034	7	0.024	7	0.024
10	0.056	10	0.056	10	0.036	10	0.036
13	0.072	13	0.072	13	0.042	13	0.042
15	0.085	15	0.08	15	0.051	15	0.041



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V. CONCLUSIONS

The following conclusions have been observed from the above experiments done on of conventional concrete and Poly-Propylene Fiber added with silica fume concrete:

1. There is a gain of 5.20%, 17.91% and 32.71% in compressive strength after adding 5%, 10% and 15% Poly-Propylene Fiber added with silica fume concrete respectively of M30 grade concrete respectively after 28 days.
2. There is a gain of 6.43%, 7.23% and 7.74% in flexural strength and reduction in deflection 11.91%, 16.06%, 16.54%after adding 5%, 10% and 15% Poly-Propylene Fiber added with silica fume concrete respectively of M30 grade concrete respectively after 28 days.
3. There is a gain of 15.8%, 31.4% and 46.9% in shear strength and reduction in deflection 13.1%, 40.1%, 38.7% after adding 5%, 10% and 15% Poly-Propylene Fiber added with silica fume concrete respectively of M30 grade concrete respectively after 28 days.

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