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Mechanical Properties of Concrete by Using Micro Silica and Synthetic Fibers

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ABSTRACT

It was observed and noted that since decade the cost of the building materials is so high that to do meaningful construction. Industrial by-products can be used in concrete as admixtures in cement, raw materials in cement clinkers or as coarse aggregates in concrete. Ordinary Portland cement (OPC) is acknowledged as the major construction material throughout the world. The most replacement materials are fly ash ,silica fume, non-silica and metakaolin, whose using with cement and concrete is thus likely to give significant development of concrete technology in the coming few decades.

This study is to compare mechanical properties as well as fresh properties of concrete containing Silica Fume, Fibrillated fiber and Ordinary Portland Cement. The aim of the study is to enable the evaluation of the suitability of mechanical properties. Concrete mixes will be prepared with Portland cement with the addition of silica fume and fiber.

INTRODUCTION

Concrete is considered as sturdy and solid material. Strengthened concret [1] is a standout amongst the most well known materials utilized for development around the globe .Reinforced concret [2] is presented to decay in a few areas particularly in beach front locales. Therefore scientists around the globe are coordinating their endeavors towards building up another material to defeat this issue. Innovation of huge development plants and gear's far and wide added to the expanded utilization of material. This situation prompted the utilization of added substance materials to enhance the nature of concrete. As a result of the analyses and looks into bond based solid which meets unique execution as for workability, quality and strength. Utilization of high strength concrete in development segment, has expanded because of its enhanced mechanical properties contrasted with standard concrete [3]. High-quality solid alludes to solid that has a uniaxial compressive strength more prominent than the typical strength concrete got in a specific locale. This definition does exclude a numerical strength for compressive strength demonstrating an exchange from a typical strength to high strength concrete. In 1950's, concrete with a compressive strength of M35 MPa was considered as high strength concrete. In the 1990's solid with a Compressive strength [4] more noteworthy than 110MPa was utilized as a part of created nations. In any case this numerical strength (110MPa) could be impressively lower contingent upon the attributes of the neighborhood materials utilized for these solid items.

Report of ACI council 363 in 1979 characterized high-strength concrete as having compressive strength more than 41.37 MPa (6000 Psi). at present days high strength and superior concrete are in effect broadly utilized everywhere throughout the world. Most utilizations of high strength concrete have been in elevated structures, long traverse spans and in some uncommon applications in structures. In created nations, utilizing high strength concrete as a part of structures today would bring about both specialized and practical preferred standpoint. In high strength concrete, it is important to lessen the

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water/bond proportion and which all in all expands the concrete substance. To overcome low workability issue, various types of pozzolanic mineral admixtures (flyash, rice husk fiery remains, metakaoline, and so on and substance admixtures are utilized to accomplish the required workability [5]. In the present test examination, the mechanical and durable properties of concrete of evaluations M25, at 28 and 56, 90days trademark quality with various supplanting levels of concrete with silica sfume and manufactured fiber are considered

FIBERS

Synthetic fibers or fibers are the aftereffect of broad examination by researchers to enhance normally happening animal and plant fibers. When all is said in done, synthetic fibers are made byextruding fiber framing materials through spinnerets into air and water, shaping a string. Before engineered strands were created, misleadingly made fibers were produced using polymers acquired from petro chemicals. These strands are called synthetic or natural fibers [6] . A few strands are made from plant-inferred cellulose.

Synthetic fibers are produced using incorporated polymers or little atoms. The intensifies that are utilized to make these strands originate from crude materials, for example, petroleum based chemicals or petrochemicals. These materials are polymerized into a long, straight compound that bond two nearby carbon particles. Contrasting substance mixes will be utilized to create distinctive sorts of strands.

There are a few techniques for assembling manufactured strands yet the most well-known is the Melt-Spinning Process. It includes warming the fiber until it starts to liquefy, then you should draw out the melt with tweezers as fast as could reasonably be expected. The following stride would be to draw the atoms by adjusting them in a parallel course of action. This unites the strands and permits them to solidify and situate. Finally, is Heat-Setting. This uses warmth to pervade the shape/measurements of the fabrics produced using heat-touchy strands [7].

Fibers are normally utilized as a part of concrete to control splitting because of plastic shrinkage and to drying shrinkage. They additionally diminish the penetrability of concrete and along these lines lessen seeping of water. A few sorts of filaments produce more noteworthy impact–, abrasion–, and shatter–resistance in cement. For the most part filaments don't build the flexural strength of cement, thus can't supplant moment–resisting or auxiliary steel support. For sure, a few filaments really decrease the quality of cement [8].

Advantages

Synthetic fibers are more tough than most common fibers and will promptly get distinctive colors. Also, numerous synthetic fibers offer shopper agreeable capacities, for example, extending, waterproofing and stain resistance. Daylight, dampness, and oils from human skin cause all strands to split down and wear away. Common strands have a tendency to be considerably more delicate than engineered mixes. This is for the most part since normal items are biodegradable. Common fibers powerless to larval creepy crawly infestation. Manufactured filaments (fibers) are not a decent nourishment hotspot for fabric-harming creepy crawlies.

Disadvantages

- Most of synthetic fibers' disadvantages are related to their low melting temperature:
- Synthetic strands don't smolder more promptly than regular.
- Prone to warmth harm. Dissolve moderately effortlessly.
- More electrostatic charge is created by rubbing than with characteristic strands.
- Non-biodegradable in contrast with characteristic strands

Common synthetic fibers

- Nylon (1931)
- Modacrylic (1949)
- Olefin (1949)
- Acrylic (1950)

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- Polyester (1953)

SILICA FUME

Silica fume, otherwise called microsilica, is an undefined (non-crystalline) polymorph of silicon dioxide, silica. It is a ultrafine powder gathered as a by-result of the silicon and ferrosilicon compound creation and comprises of circular particles with a normal molecule distance across of 150 nm. The principle field of utilization is as pozzolanic material for elite concrete.

Application in concrete

Silica fume is added to Portland concrete to enhance its properties, specifically its compressive strength, bond strength, and abrasion resistance. These changes stem from both the mechanical upgrades coming about because of expansion of a fine powder to the concrete glue blend and in addition from the pozzolanic responses between the silica fume and free calcium hydroxide in the mix [9].

Expansion of silica fume additionally decreases the permeability of concrte tochloride particles, which shields the strengthening reinforcement of concrete from corrosion, particularly in chloride-rich situations, for example, waterfront districts and those of damp continental roadways and runways (in light of the utilization of deicing salts) and saltwater bridges.

EXPERIMENTAL PROGRAM

MATERIALS

Constituent materials used to make concrete can have a significant influence on the properties of the concrete. The following sections discuss constituent materials used for manufacturing of both conventional concrete (CC) and coal washery rejects (CWR) based concrete [11-12]. Chemical and physical properties of the constituent materials are presented in this section.

Cement

Ordinary Portland Cement 53 grade (Penna) was used corresponding to IS 12269 (1987). The chemical properties of the cement as obtained by the manufacturer are presented in the Table 3.1.

Table 3.1. Chemical composition of cement

Particulars	Test result	Requirement as per IS:12269-1987
Chemical Composition		
% Silica(SiO_2)	19.79	
% Alumina(Al_2O_3)	5.67	
% Iron Oxide(Fe_2O_3)	4.68	
% Lime(CaO)	61.81	
% Magnesia(MgO)	0.84	Not more Than 6.0%
% Sulphuric Anhydride (SO_3)	2.48	Max. 3.0% when $C_3A>5.0$ Max. 2.5% when $C_3A<5.0$
% Chloride content	0.003	Max. 0.1%
Lime Saturation Factor CaO-0.7SO_3/2.8SiO_2+1.2Al_2O_3+0.65Fe_2O_3	0.92	0.80 to 1.02
Ratio of Alumina/Iron Oxide	1.21	Min. 0.66

Coarse aggregate

Crushed granite stones of size 20 mm and 10 mm are used as coarse aggregate [10]. The bulk specific gravity in oven dry condition and water absorption of the coarse aggregate 20 mm and 10mm as per IS 2386 (Part III, 1963) are 2.6 and 0.3% respectively. The bulk density, impact strength and crushing strength values of 20 mm aggregate are 1580 kg/m^3, 17.9% and 22.8% respectively.

Table 3.3. Sieve analysis of 20 mm coarse aggregate

Sieve size	Cumulative percent passing	
	20 mm	IS 383 (1970) limits
20 mm	100	85-100
16 mm	56.17	N/A
12.5 mm	22.32	N/A
10 mm	5.29	0-20
4.75 mm	0	0-5

Table 3.4. Sieve analysis of 10 mm coarse aggregate

Sieve size	Cumulative percent passing	
	10 mm	IS 383 (1970) limits
10 mm	99.68	85-100
4.75 mm	8.76	0-20
2.36 mm	2.4	0-5

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Fine aggregate

Natural river sand is used as fine aggregate. The bulk specific gravity in oven dry condition and water absorption of the sand as per IS 2386 (Part III, 1963) are 2.6 and 1% respectively. The gradation of the sand was determined by sieve analysis as per IS 383 (1970) and presented in the Table 3.5. The grading curve of the fine aggregate as per IS 383 (1970) is shown in Fig. 3.3. Fineness modulus of sand is 2.26.

Table 3.5. Sieve analysis of fine aggregate

Sieve No.	Cumulative percent passing	
	Fine aggregate	IS: 383-1970 – Zone III requirement
3/8" (10mm)	100	100
No.4 (4.75mm)	100	90-100
No.8 (2.36mm)	100	85-100
No.16 (1.18mm)	99.25	75-100
No.30 (600μm)	65.08	60-79
No.50 (300μm)	7.4	12-40
No.100 (150μm)	1.9	0-10

RESULTS

The test results cover the strength properties of concrete using cement is replaced with silica fume and synthetic fibers are added to the concrete as in amount of (0%, 20%, 30%, 40%).The strength and fresh concrete test include compressive, splitting tensile and flexural strength, v-funnel ,L-Shape, slump cone test of concrete at different curing periods. The compressive strength values tested at 7,28,56,90 days of curing, flexure strength, spilt tensile strength values of concrete mixes were measured after 28 and 56 days of curing.

Mechanical properties of copper slag based concrete
This section discusses the mechanical properties of both CC (SF AND SYF_0) and SF AND SYF based concrete mixes at different curing periods.

Compressive strength

Table 4.1 shows the compressive strength values of concrete with silica fume and synthetic fibers.

MIX	7days	28days	56 days	90 days
M1	27.56	36.28	36.66	39.54
M2	27.87	36.69	37.1	39.98
M3	29.13	38.01	39.12	42.36
M4	29.4	39.4	41.89	43.25
M5	25.23	32.2	33.45	35.5
M6	22.12	29.75	29.33	30.25

M1-(silica fume(SF) 0% and synthetic fiber (SYF)0%),
M2 –(SF 5% and SYF 5%),
M3-(SF 10% and SYF 10%)
M4-(SF20% and SYF20%)
M5-(SF 30%and SYF30%)
M6-(SF40% and SYF40%)

From the results it seen that the values of the concrete ,cement replaced with silica fume and added with synthetic fibers at different curing periods they are compared with the values of CC (SF 0 % and SYF 0 %) as shown in fig below

Maximum compression strength of the concrete is obtain at M4 the values of different curing periods of M4 is compared with the conventional concrete and the lowest value of the compression strength obtained at the M6 mix proportions of the concrete. The values of the compression strength increased up to replacement of silica fume and adding of synthetic fiber up to 20% i.e M4 mix proportion ,to obtain the target values it is recommended the replacement and addition of silica fume and synthetic fibers up to 20%.,

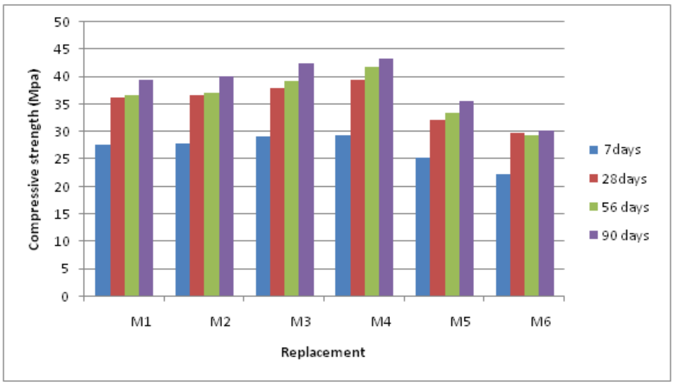

Fig 4.1 Compressive strength results

Splitting tensile strength

Table shows that the split tensile strength values of concrete partially replaced with silica fume and addition of synthetic fibers.

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Table 4.2 Split tensile strength

MIX	28days	56 days
M1	4.14	4.54
M2	4.17	4.21
M3	4.32	4.65
M4	4.22	4.48
M5	4.12	4.22
M6	4.11	4.15

From the outcomes its watched that the part elasticity of the routine concrete is contrasted and the bond mostly supplanted with silica smoke and expansion of the engineered fiber concrete , the greatest part rigidity got at the blend configuration of M3 (SF 10% and SYF 10%),the estimations of the part rigidity increments up to 10 % substitution of both materials and after that it is progressively diminishes, so as to get the longing estimation of the part rigidity of the concrete the substitution level of silica smoke and manufactured fiber is upto 10% is suggested

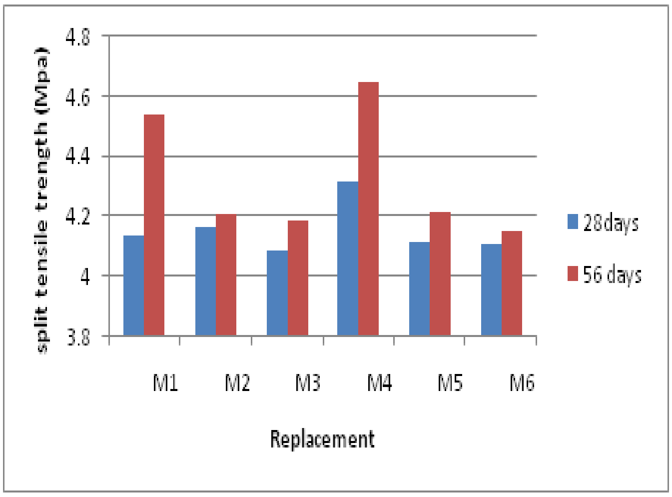

Fig 4.2 Splitting tensile strength

Flexural strength

Table shows that the flexural strength values of the concrete replaced with silica fume and adding of synthetic fibers at different mix proportions

Table 4.3 flexural strength

MIX	28days	56 days
M1	4.58	5.42
M2	4.57	5.38
M3	4.96	5.71
M4	3.79	4.45
M5	3.30	3.92
M6	3.24	3.68

From the values of the flexural strength it is observed that and compared to the values of the 0% replacement mix of the concrete, the values of the flexural strength increases at the level of M3(10%) at both curing periods of the concrete and then the values of the flexural strength decreases .

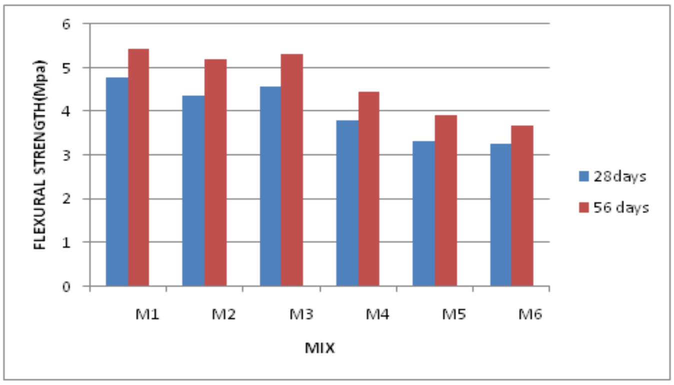

Fig 4.3 Flexural strength values

Compaction factor test:

Table 4.6 compaction factor test

Mix	Compaction factor
M1	0.92
M2	0.95
M3	0.92
M4	0.92
M5	0.92
M6	0.92

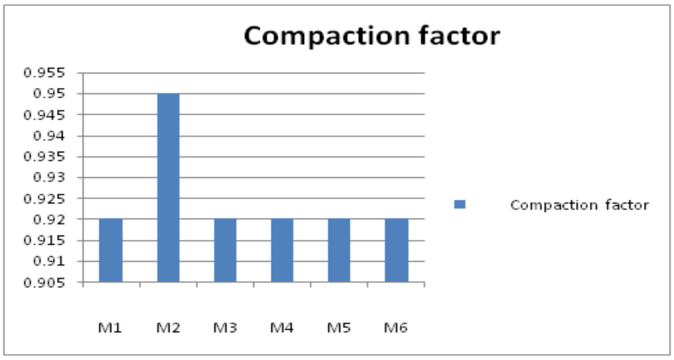

Fig 4.8 compaction factor values

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CONCLUSIONS

- The compression strength of the concrete increases with increase in the silica fume and synthetic fibers up to replacement and adding 20 % after that the values compressive strength decreases gradually.
- The flexure strength of the concrete is increased up to 10 % replacement of silica fume and adding of the synthetic fiber when compared with conventional concrete.
- The splitting tensile values are also increases up to 10 % replacements and after that gradually decreases.
- The tests made on the fresh concrete results shows that the workability of the concrete increases with increase in silica and synthetic fiber.
- Passing ability of concrete with silica fume is low when compared with conventional concrete.
- Compact ability of the concrete with silica fume and synthetic fiber is more better when compared with normal concrete.

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