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STUDY ON DURABILITY PROPERTIES OF CONCRETE USING SILICA FUME WITH ADDITION OF POLYPROPYLENE FIBRE

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ABSTRACT:

The main intension of the present experimental case is to study the fallout of Silica Fume restoration on Durability properties. Effect of combined application of polypropylene fibre and silica fume on water absorption test (Durability Test). Dosage of Silica Fume is 5%, 10% and 15% by the weight of cement. Dosage of Polypropylene Fibre used are 0.25%, 0.5% of the total weight of the Cube. Water absorption test on the cubes was done for 28 days. It is observed that Water Absorption for the Control Concrete is 4.21%. The Water Absorption for the Concrete with Silica Fume and Polypropylene Fiber is minimum when correlated to Control Concrete. Least percentage in Gain of Weight is 2.97% for Concrete with 10% Silica Fume and 0.5% Polypropylene Fiber.

KEYWORDS: Silica Fume, polypropylene Fibre, water absorption test.

1. INTRODUCTION:

The use of polypropylene strands has effectively expanded the sturdiness of the concrete. In spite of the truth that polypropylene strands are portrayed by low the modulus and poor physiochemical holding with the cement glue, it is obvious that the heap conveying capacity of a structure under the flexural stacking. A significant measure of research has done to assess the properties of the fiber strengthened concrete. Test information have been ordered for concrete strengthened with polypropylene filaments at volume going from 0.1% - 10.0%. The material properties of the polypropylene fiber barricaded concrete are Somewhat factor, depending incredibly by fiber fixation and type of the fiber strengthened.

Common structures made of steel strengthened concrete regularly experience the ailling effects of consumption of steel by salt, which brings the disappointment of those structures. Consistent upkeep and repairing is expected to upgrade the life cycle of those common structures. There are great approaches to limit the disappointment of the concrete structures made of steel reinforcement concrete. This expands the sturdiness and elasticity and augments the breaking and disfigurement qualities of resultant composite. In any case, this technique includes, another layer, which is inclined to debasement. These fiber composites have been appeared to experience the diseased effects of decay when presented to marine condition because of surface rankling. Accordingly, the glue bond quality is decreased, which brings about the cover of the composite. Another approach is to supplant the bars in the steel with Synthetic fiber strengthened concrete and this named as FRC.

The purpose behind joining strands into a cement framework is to expand the sturdiness and rigidity, and intensify the breaking disfigurement attributes of the resultant composite. Just a pair of the conceivable several fiber sorts have been discovered appropriate for the business applications. This undertaking manages the concrete strengthened with the "fibrillate polypropylene fiber". The goal of the exploration is to inspect the properties of the polypropylene fiber is to which the business FRC's are uncovered alongside fractional replacement of cement by silica fume.

2. LITERATURE REVIEW:

J. Yajun and J. H. Cahyadin-2004

Recreation of silica fume mixed cement hydration. The pozzolanic response degree, volume portion of hydration items, hairlike porosity and gel porosity can get from demonstrate recreation. By utilizing the appropriate part of silica fume replacement, the microstructure of the silica fume which is mixed with cement glue is upgraded since the volume division of C-S-H gel is expanded, $Ca(OH)2$ substance and narrow porosity are diminished due to the pozzolanic response contrasted and conventional Portland cement (OPC) glue.

T. D. Hapuarachchi & G. Ren & M. Fan & P. J. Hogg & T. Peijs-2007:

Fire Retardancy of Natural Fibre Reinforced Sheet Moulding Compound. Because of ecological mindfulness and prudent contemplations, regular fiber strengthened polymer composites appear to display a suitable other option to manufactured fiber fortified polymer composites, for example, glass filaments. This is an achievability concentrate to evaluate the potential utilization of normal fiber fortified sheet shaping compound materials (NF-SMC) for the utilization in building applications, with specific accentuations to their response to flame. The strengthening filaments in this investigation were modern hemp strands. The cone calorimeter which asses the fire danger of materials by Heat Release Rate (HRR) was utilized, brilliant warmth motions of 25 and 50 kW/m2 were used to reenact a start source and completely created room fire conditions separately. The outcomes procured here exhibit that the NF-SMC can rival current building materials regarding their fire conduct.

T. D. Hapuarachchi & G. Ren & M. Fan & P. J. Hogg & T. Peijs-2007:

Because of the ecological mindfulness and prudent contemplations, regular fiber strengthened by the polymer composites appear to be a display a suitable other option to manufactured fiber fortified polymer composites, for example, glass filaments. This is the achievability of concentrate to evaluate the potential utilization of normal fiber fortified sheet shaping of the compound materials (NF-SMC) to the utilization in building applications, with the specific accentuations to their response to flame. The strengthening filaments in this investigation were modern hemp strands. The cone calorimeter which asses the fire danger of the materials by Heat Release Rate (HRR) was utilized, brilliant warmth motions of 25 and 50 kW/m^2 are used to react a start source and completely created room fire conditions separately. The outcomes procured here exhibit that the NF-SMC can rival current building materials regarding their fire conduct.

This work assed the possibility of utilizing regular strands in SMC sort material for use in the development business, for example, floor covers which are right now not controlled regarding response to flame properties. Inward divider linings where satisfactory execution under the British standard response to flame tests can be connected may enable the material to rival ordinarily utilized plasterboard linings. The consolidation of aluminum trihydrate into the unsaturated polyester tar framework had a huge impact on the response to flame conduct of the composite. The start defer times are drawn out and pinnacle warm discharge esteems were lessened at both brilliant warmth motions. The discoveries demonstrated that with sufficient fire resistant added substances being consolidated into the SMC glue the NF-SMC cancompete with some option building materials as far as response to flame execution.

G.L. GUERRINI-1999.

Propelled composites and the central comprehension of their conduct is a quickly growing branch inside a field of the structural designing materials. Specifically, fiber-strengthened cement based materials have had an incredible advancement in these years, with the goal that they are increasingly used in the building segment. In addition, substantial endeavors have been made to grow elite cements and concretes demonstrating further execution enhancements. Superior fiber-strengthened cement composites incorporate, for instance, materials, for example, SIFCON (Slurry Infiltrated Fiber Concrete), Fiber-fortified DSP (Densified with Small Particles), and fiber-strengthened MDF (Macro-Defect-Free) cements. Advancements of these materials were conceivable due to: (a) the presentation of the new reinforcement frameworks; (b) the advancement of superior cement-based lattices, which show incredibly enhanced micro basic properties as far as quality and sturdiness; (c) the improvement of satisfactory preparing procedures (counting controlling compound responses) which enable us to get composite materials with amazing the durability properties. After a short depiction of elite cement-based frameworks and relative composites, two distinct cases among the above-refered to items will be profoundly displayed. From the above depiction it can be seen that fiber-strengthened DSP and MDF items are ease back to discover beneficial outlets.

In the primary case (DSP and relative items), there are restrictions for basic applications, most importantly, because of the high material cost and to the absence of configuration tenets and measures including high quality concretes: current applications are just in extraordinary market specialties. MDF composites are extremely encouraging materials which offer startling properties regarding processability and durability properties, be that as it may, right now, their commercialization is by all accounts constrained by the water affectability.

Ezeldin,A.S.and Balaguru ,P.N-1989

Test comes about on the bond conduct of ordinary and high-quality concrete made with and without strands are accounted for. Aggregate of 18 blend extents were explored .The fiber lengths and the reinforcement bars sizes were 30,50,and 60mm and #3,5,6, and 8 (9,16,19 and 25mm) individually. The bond test led to utilizing an adjusted pullout test in which the concrete encompassing the bar was in uniform pressure .Addition of the silica fume brings about the higher bond quality however causes weak bond disappointment. Filaments can be utilized to upgrade the pliability to an impressive degree. The slip (relative development between the bar and the concrete) at a greatest bond stack increments with increments in fiber content. Post top conduct is enhanced generously by the filaments.

3 MATERIALS AND PROPERTIES:

3.1 CEMENT:

Cement plays vital role in concrete. One of the important criteria tricalcium aluminate (C_3A) content, tricalcium silicate (C_3S) content, dicalcium silicate (C_2S) content etc. It is necessary to make sure the compatibility of chemical and the mineral admixtures with the cement.

In this study, Zuari Cement of 53 grade Ordinary Portland Cement conforming to IS: 12269–1987 was used for the entire work. The cement was purchased from the single source and was is used for the casting of all specimens. The physical properties of cement are furnished in Table No.1

Table 1 physical properties of cement

S. No	Characteristics	Test Results	Requirements as per IS 12269 – 1987
1	Fineness (retained on 90-µm sieve)	5%	<10%
2	Normal Consistency	32%	--
3	Initial setting time of cement	62 min's	30 minutes (minimum)
4	Final setting time of cement	420 min's	600 minutes (maximum)
5	Expansion in Le-chatelier's method	3 mm	10 mm (maximum)
6	Specific gravity	3.15	3.10 – 3.25

3.2 FINE AGGREGATE:

The natural sand taken for this investigation is the locally available natural river sand. It was collected and cleaned for impurities, so that it is free from the clayey matter, salt and organic impurities. Particles passing through IS sieve of 4.75 mm conforming to grading zone-II of IS: 383-1970 were used in this work. Properties such as gradation, specific gravity, fineness modulus, bulking, bulk density had been assessed. The physical properties of sand are furnished in Table 2.

Table 2 physical properties of Fine Aggregate

S. No	Characteristics	Test results	Requirements as per IS 12269 – 1987
1	Fineness (retained on 90-µm sieve)	5%	<10%
2	Normal Consistency	32%	--
3	Initial setting time of cement	62 min's	30 minutes (minimum)
4	Final setting time of cement	420 min's	600 minutes (maximum)
5	Expansion in Le-chatelier's method	3 mm	10 mm (maximum)
6	Specific gravity	3.15	3.10 – 3.25

3.3 COARSE AGGREGATE:

Locally available machine Crushed angular granite, retained on 4.75mmI.S. sieve of maximum size of 20mm confirming to I.S: 383-1970 was used in the present experimental investigation. It should be free from impurities such as dust, clay particles and organic matter etc. The coarse aggregate is tested for its various properties such as specific gravity, fineness modulus, elongation test, flakiness test, sieve analysis, bulk density in according to IS 2386 – 1963. The physical properties of Coarse Aggregate are furnished in Table 3

Table 3 physical properties of Coarse Aggregate

S. No	Characteristics	Test results	Requirements as per IS 12269 – 1987
1	Fineness (retained on 90-µm sieve)	5%	<10%
2	Normal Consistency	32%	--
3	Initial setting time of cement	62 min's	30 minutes (minimum)
4	Final setting time of cement	420 min's	600 minutes (maximum)
5	Expansion in Le-chatelier's method	3 mm	10 mm (maximum)
6	Specific gravity	3.15	3.10 – 3.25

3.4 WATER

Water which is used for mixing and curing should be clean and free from injurious quantities of alkalies, acids, oils, salts, sugar, organic materials, vegetable growth (or) other substance that may destroy bricks, stone, concrete, or
steel. Potable water is generally considered satisfactory for mixing.

Water acts as a lubricant for the fine and coarse aggregates and acts chemically with cement to form the binding paste for the aggregate and reinforcement. Less water in the cement paste yield a stronger and more durable concrete; adding too much water will reduce the strength of the concrete and can cause bleeding. Impure water in concrete, effects the setting time and causing premature failure of the structure.

To avoid such problems quality (potable) water must be preffered in construction works and PH value of water should not be less than 6. And also Quantity of water should be taken is important

3.5 FLY ASH:

Fly ash, Polypropylene (PP), otherwise called polypropene, is a thermoplastic polymer utilized as a part of a wide assortment of uses including bundling and marking, materials, stationery, An expansion polymer which is produced by using the monomer propylene, it is tough and curiously impervious to the numerous concoction solvents, bases and acids.

Polypropylene has a moderately dangerous "low vitality surface" that implies that the numerous normal pastes won't frame satisfactory joints. Joining of polypropylene is frequently done using the welding forms. Polypropylene Fibre properties are explained in Table No. 3.8 and Molecular Structure

Table 4 Properties of Polypropylene Fibre

S No	Properties	Value (As per MTC)
1	Specific gravity of fibre	0.9-0.91
2	Length	6mm to 12mm
3	Water absorption	0.3% after 24 hours (The water absorption of polypropylene fibre is about 0.3% after 24 hours immersion in water, and thus its regain – the amount of water absorbed in a humid atmosphere – is virtually nil)

3.6 SILICA FUME (SF):

Silica fume is an exceedingly pozzolanic mineral admixture, which is a predominantly used to enhance the concrete quality and the strength of concrete. Silica fume responds with calcium hydroxide framed with hydration of cement brings about the expansion in quality and Further more the Silica fume fills the voids between cement particles prompts increment in the strength. The properties of Silica fume are given in Table 3.9 and Fig. 3.4 shows the Silica fume sample used for Concrete preparation.

Table 5 Properties of Silica fume

S.NO.	Characteristics	ASTM-C-1240	Analysis Results
1	SiO2 (Min)	85%	90.20%
2	LOI (Max)	6%	2.80%
3	Moisture (Max)	3%	0.20%
4	Pozzolanic Activity Index (Min)	105%	127%
5	Specific surface Area (m^2/gm)	> 15	> 21
6	Bulk density (Kg/m^3)	550 to 700	604
7	> 45 Microns (Max)	10%	0.20%
8	Specific Gravity	2.2 – 2.3	2.23

3.7 MIX PROPORTIONS:

Table 6 Quantities of Ingredients per Cum of M30 Grade Concrete

Concrete	SF	PF	Dry Weight (W1)	Wet Weight (W2)	% Gain in Weight ((W2-W1)/W1) x 100
Control Concrete	0	0	8.36	8.71	4.21
SF 5%	5	0	8.61	8.96	4.02
SF 10%	10	0	8.23	8.51	3.46
SF 15%	15	0	8.07	8.37	3.69
SF 5% + PF 0.25%	5	0.25	8.80	9.09	3.34
SF 10% + PF 0.25%	10	0.25	8.59	8.87	3.26
SF 15% + PF 0.25%	15	0.25	8.56	8.85	3.36
SF 5% + PF 0.5%	5	0.5	8.23	8.50	3.29
SF 10% + PF 0.5%	10	0.5	8.75	9.01	2.97
SF 15% + PF 0.5%	15	0.5	8.23	8.49	3.18

4 EXPERIMENTAL INVESTIGATION:

4.1 CONCRETE MIX PREPARATION:

It can be portrayed as the path toward picking fitting components of concrete and choosing their relative degrees with objective of the making concrete of required quality and quality as fiscally as could be normal the situation being what it is. The layout of concrete mix is not a direct endeavour by the prudence of comprehensively contrasting properties of the constituent materials.

Plan of the concrete mix requires a complete data of various properties of the constituent materials, the disarrays, if there ought to be an event of changes on these conditions at the site. At first the fixings, for instance, cement, Silica Fume and Polypropylene Fibers are mixed, to which the fine aggregate and coarse aggregate are incorporated and totally mixed and Water is measured absolutely. By then it is added to the dry mix and it is totally mixed until the point that a mix of uniform shading and consistency is expert which is then arranged for testing. Going before tossing of cases, workability is measured according to the code IS 1199-1959 and controlled by hang and compaction factor tests.

4.2 DURABILITY OF CONCRETE:

The concrete cubes of size 150 mm × 150 mm × 150mm were casted and it is tested for its durability at the age of 28 days. The percentage loss of weight of the concrete specimen and percentage loss in compressive strength were calculated.

5 RESULTS AND DISCUSSIONS:

5.1 DURABILITY OF CONCRETE:

A) WATER ABSORPTION:

The water absorption characteristic of the concrete plays an important role for the durability of the structure. Ingress of water deteriorates concrete and in reinforced concrete structure, corrosion of the bars took place which results it no cracking and spalling of the concrete and ultimately reduces the life span of the structure. Test results of water absorption test are shown in Table 6.4. The result which indicates the water absorption of Concrete with Silica Fume & Polypropylene Fibre is less compared to control concrete. Although the difference in % of gain in weight is very less.

6 CONLUSIONS:

7.3.1 WATER ABSORPTION:

1. Test results of the water absorption test shows that the porosity of concrete with Silica Fume and Polypropylene Fibers is less as Silica Fume is lot

finer than OPC and results in to less water absorption than the control concrete.

2. It can be observed that the Water Absorption for Control Concrete is 4.21%. The Water Absorption for the Concrete with Silica Fume and Polypropylene Fiber is minimum when compared to Control Concrete. Least percentage in Gain of Weight is 2.97% for Concrete with 10% Silica Fume and 0.5% Polypropylene Fiber.

FURTHER RESEARCH:

1. Further investigation using x-ray or electron scanning microscopy is recommended to provide visual assessment of the effect of Silica Fume and Polypropylene Fibre on the microstructure of concrete.

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