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Effect of Partial Replacement of Cement with Silica Fume and Cellulose Fibre on Workability & Compressive Strength of High Performance Concrete

KEYWORDS: Cellulose Fibre, Compressive Strength, Silica Fume, Workability

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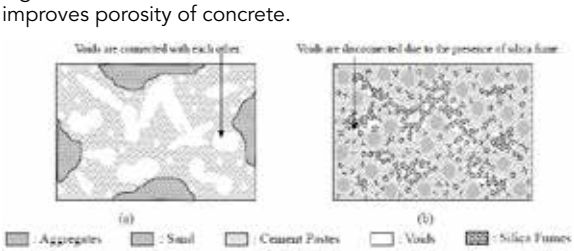
ABSTRACT *High performance concrete exceeds the properties & constructability of normal concrete. Normal and special material are used to make these specially designed concretes that must meet a combination of strength and performance requirements. Special mixing, placing, and curing practices may be needed to produce and handle high performance concrete. High performance concrete is widely used in construction due its high strength, high workability, and high durability. The different types of pozzolonic materials like GGBS, Silica Fume, Fly Ash, RHA, etc. May be used in concrete as partial replacement of cement to add on durability properties owing to the pozzolanic properties of supplement and there by producing a better performance concrete as compared to conventional mix with more amount of virgin cement. This experimental instigations study the effect of rheological and engineering properties of with partial replacement of OPC by silica fume. Further investigations are also made to observe effect of inclusion of cellulose fibre on the properties of fresh and harden concrete. This paper describes the experimental study of compacting factor and compressive strength through standard HPC test practice laid down by Bureau of Indian Standards,(BIS) and also describes the test results of different ingredients.*

1. Introduction

Cement-based composites have long been used for civil structures such as highways, bridges and buildings. However, unexpected deterioration of reinforced or pre-stressed concrete structures has lead to address the issue of durability of concrete and ultimately fineness and high silica content; Silica Fume is a highly effective pozzolanic material sustainability of concrete technology at large. Traditionally, the constituents of cement-based composites include cementitious material, water, aggregate and/or admixtures. Silica fume also known as micro silica is a by-product of the reduction of high-purity quartz with coal in electric furnaces in the production of silicon and ferrosilicon alloys. Because of its extreme. Filling of micro cavities and pores with in cement paste in which usually water is entrapped by silica fume forms a crystalline C-S-H gel forming a dense and strong bond as compared to conventional C-S-H gel. Silica Fume is used in concrete to improve its properties like compressive strength, bond strength, and abrasion resistance; reduces permeability; and therefore helps in protecting reinforcing steel from corrosion. Use of fibre in cement-based composites is to enhance fresh and harden concrete properties like homogeneity of matrix ,reduced bleeding and segregation, early age cracking due to heat of hydration, tensile strength, Flexural strength, abrasion resistance and energy absorbing capacity. Figure below shows mechanism how inclusion of silica fume improves porosity of concrete.



2. Significance and Objectives

The objective of the present investigation is to investigate the workability, mechanical properties for HPC mixes of grade M25 by replacing 0, 7, 9, and 12 percentage of the mass of cement with Silica Fume and 0.5, 1 percentage of Cellulose Fibre and using a super plasticizer. Also, an attempt is made to find the optimum cement replacement level by SF and CF for better strength of HPC.

3. Experimental Program:

3.1Material:

Table 1 Property of Material

Material	Specific Gravity	Reference Code
Cement	3.14	IS 4031 & IS 12269-1987
Fine Aggregate	2.675	IS 383-1987
Coarse Aggregate	2.85	IS 383-1987
Silica Fume	2.22	ACI- 234R-96
Cellulose Fibre	-	ASTM D 7357
Super Plasticizer	-	IS 9103-1999

3.2 Mix Design:

Table 2 Mix Design for M25 Grade

Mix	Fibre (Kg/m^3)		Cement (kg/m^3)	Silica Fume (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)		Water (lit)
	0.5%	1%				10mm	20mm	
Mix-1	0	0	350	0 (0%)	744.53	815.05	427.98	175
Mix-2	1.75	3.5	325.5	24.5 (7%)	744.53	815.05	427.98	175
Mix-3	1.75	3.5	318.5	31.5 (9%)	744.53	815.05	427.98	175
Mix-3	1.75	3.5	308	42 (12%)	744.53	815.05	427.98	175

4. Test Results:

Compacting Factor and Compressive Strength of M25 Grade Concrete

Sr. No	Description of Mix	Average Compressive Strength (N/mm^2)		Compaction Factor
		7 Days	28 Days	
1	Normal Concrete Mix	31.95	38.95	0.95
2	Concrete + 7% S.F & 0.5% C.F	32.55	45.99	0.89
3	Concrete + 7% S.F & 1% C.F	30.79	42.13	0.86
4	Concrete + 9% S.F & 0.5% C.F	30.30	43.21	0.89
5	Concrete + 9% S.F & 1% C.F	28.29	41.03	0.86

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6	Concrete + 12% S.F & 0.5% C.F	27.55	43.90	0.90
7	Concrete + 12% S.F & 1% C.F	29.89	40.71	0.88

S.F=Silica fume, C.F.=cellulose fibre

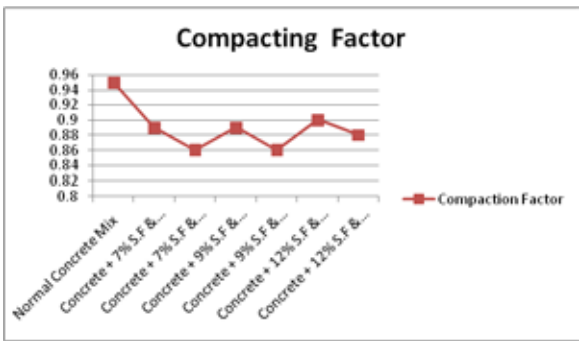

Figure 1 Compaction Factor of M25 Grade Concrete

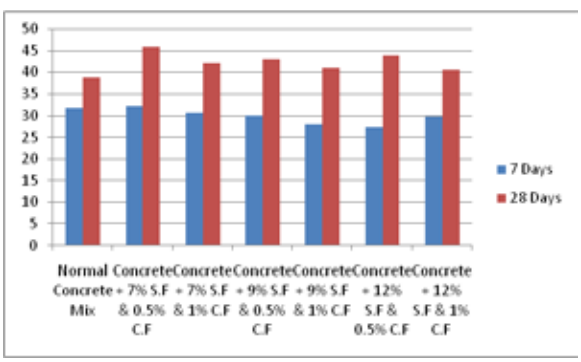

Figure 2 Compressive Strength of M25 Grade of Concrete

4.1 Conclusions:

1. Compaction factor decreases when the percentage of cellulose fibre increases with silica fume.
2. The values of compacting factor are within range of 0.86 to 0.95 which meets the requirement of BIS-456.
3. 7% replacement of silica fume and 0.5% of cellulose fibre gives an optimum compressive strength. Beyond 7% silica fume and 0.5% cellulose fibre compressive strength decreases.

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