

Study on the Use of Silica Fume in Concrete as the Partial Replacement to Fine Aggregate

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ABSTRACT: in the present work, experimental results on workability, compressive strength and permeability of concrete with various mixture proportions have been presented to study the effect of silica fume on concrete mixes. It has been found that micro silica increases the workability of the fresh concrete up to a certain limit of micro silica addition (up to 20%) as cement replacement. Compressive strength was also increased on addition of micro silica. The Ultrasonic Pulse Velocity results showed that during initial compression the UPV was increased slightly but on further increasing the compressive load the UPV was decreased. When the load was about 75-80 percent of ultimate strength, an abrupt reduction in UPV was observed. It has been found from the study that addition of micro silica (up to 20%) in concrete reduces the permeability by 35%-50%.

KEYWORDS: Workability, compressive strength, permeability, micro silica, ultrasound pulse velocity

I. INTRODUCTION

Recognizing the problems arising from C&D waste, the Government of India notified "Construction and Demolition Waste Management Rules" in 2016. Definition of C&D Waste under the 2016 Rule is "Waste comprising of building material, debris and rubble resulting from construction, remodeling, repair or demolition of any civil structure".

According to the Building Material Promotion Council (BMPTC), India generates an estimated 150 million tons of construction and demolition (C&D) waste every year out of which it is being able to recycle merely about 1 per cent. C&D waste is bulky in nature and a significant proportion of this waste stream can be potentially recycled and reused and brought back to construction to replace the dependence on virgin raw material. In addition, recycling C&D waste can help reduce the environmental footprints of buildings and infrastructure.

Construction by nature is not an eco-friendly activity. Construction, renovation and demolition activities lead to the formation of waste. Construction and demolition waste is generated whenever any construction/demolition activity takes place, such as, building roads, bridges, flyover, subway, remodeling etc. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics etc. The masonry, concrete and mortar together constitute over 65% of this C&D waste. A part of this waste comes to the municipal stream. These wastes are heavy, having high density, often bulky and occupy considerable storage space either on the road or communal waste.

Construction waste recycling is the process of separating and recycling recoverable waste materials created during construction. Scraps of new materials that are not utilized, old materials, packaging, and debris all are essentially recoverable materials. Recycling reduces the issues of water and soil pollution by the waste generated from chemically treated wood or other harmful substances.

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Although the material is collected as a very fine powder with a bulk density in the region of 200kg/m³, it can be processed to densify it, making the bulk density around 650Kg/m³, it can be slurried. This latter process involves the blending of the micro silica, normally straight from the filter silos, with an equal weight of water. The slurry is easy to transport, store, dose and mix in to concrete.

Silica fume, also known as micro-silica, it is a very fine pozzolanic material, composed of amorphous silica produced by electric arc furnaces as a byproduct of the production of elemental silicon or ferro silicon alloys. Silica fume can be used in a variety of cementitious products such as concrete, grouts, and mortars as well as elastomer, polymer, refractory, ceramic and rubber applications.

II. OBJECTIVES

- 1) To study the to investigate the performance characteristics of the Silica fume concrete such as Workability compressive strength, infiltration rate etc
- 2) To compare the properties of Silica fume concrete with the existing concrete
- 3) Suggesting the base suitable condition for silica fume concrete

III. MATERIALS AND EQUIPMENT SPECIFICATION

1. Standard aggregate with specific gravity 2.68, available for regular construction works were used.
2. Ordinary Portland cement specific gravity 3.15, of 53 grades was used.
3. Portable water is used for preparation of mixture and curing.
4. No admixtures were used.
5. Curing is performed in the curing tank.
6. Concrete mixture is mixed by hand mixing method
7. Cubical size metallic moulds of 150 mm are used for test cubes.
8. Steel tamping rod of 16mm diameter 0.6m long along with bullet ends used for tamping.
9. Universal testing machine (1000KN) is used for testing compressive strength
10. Steel Mould size 15 x 15 x 15 cm used for casting of blocks
11. Crush sand is used in permeable concrete for fineness material and strength increasing.

IV. MIX DESIGN PROPORTIONS REPLACING F.A IN % (M30 GRADE CONCRETE)

Material	0% of silica fume (KG)	10% of silica fume (KG)	20% of silica fume (KG)	30% of silica fume (KG)
Cement	3.125	2.812	2.500	2.187
Micro silica	0	0.312	0.625	0.937
Coarse Aggregate	5.5	5.5	5.5	5.5
Sand	3.5	3.5	3.5	3.5
Water	1.145	1.145	1.145	1.145

Table 1. Contribution of Concreting Ingredients

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Sr. No.	Sample No.	Replacement of S.F by C in %	Average compressive strength (N/mm ²)
1	1	0	25.21
2			
3			
4	2	10	34.12
5			
6			
7	3	20	35.90
8			
9			
10	4	30	36.80
11			
12			

Table 2 Compressive strength at 7 day (N/mm²)

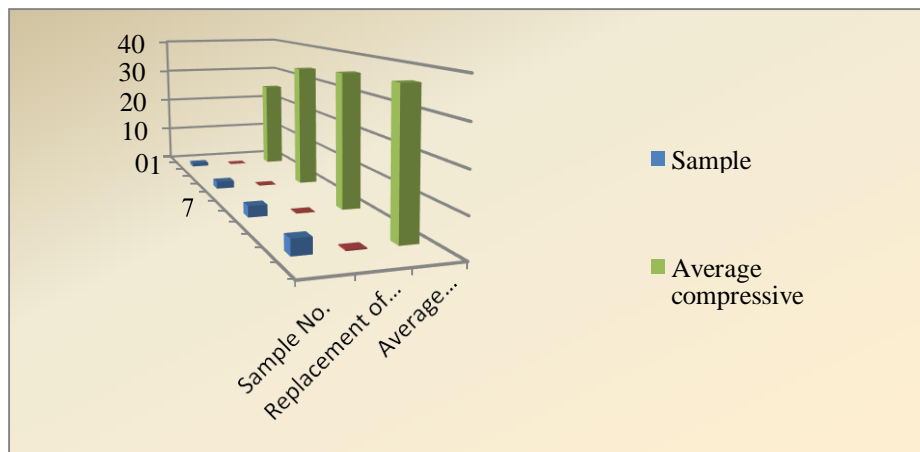


Figure 1-Compressive Strength for 7 day

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Sr. No.	Sample No.	Replacement of S.F by C in %	Average compressive strength(N/mm ²)
1	1	0	35
2			
3			
4	2	10	38.6
5			
6			
7	3	20	40.5
8			
9			
10	4	30	42
11			
12			

Table 3 Compressive strength at 28 day (N/mm²)

V. CONCLUSION

In this study, the silica fume is replaced to 0%, 10%, 20%, 30% and 40%. It clears that, 20% of silica fume by weight of cement is the optimum content which does not affect the properties of concrete.

From the above observation, it is possible to use the silica fume up to 20% by weight of fine aggregate. The silica fume in concrete reduces the unit weight of concrete. The maximum compressive strength occurred at the age of 28days.

Test result indicates that addition of silica fume by 30% paver block attains maximum compressive strength.

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