Studies on Effect of Silica Fume on Properties of Pervious Concrete for Pavement

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Abstract-Silica fume has long been used as a supplementary cementing material to provide a high density, high strength, and durable construction material. Silica fume has a particle size a fraction of any conventional cement, which allows it to increase pervious concrete strength by decreasing the porosity especially near the aggregates surface. Because cement is the most important ingredient of concrete and is a versatile and relatively high cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. This threat to ecology has led to researchers to use industrial by products as supplementary cementations material in making concrete. The main parameter investigated in this study is M30 grade pervious concrete with partial replacement of cement by silica fume by 0, 5, 10,15 and 20%. This research presents a detailed experimental study on Compressive strength, split tensile strength, flexural strength at age of 7 to 56 day. Test results indicate that use of Silica fume in concrete has improved the performance of concrete in strength.

Keywords: Silica fume, Compressive strength, Split tensile strength, Flexural strength, pervious concrete, performance of concrete.

Objective of Work

- The main objective of the work to study the effect of Silica Fume as partial replacement of cement in Pervious concrete by using road construction.
- Design Mix for M-30 Pervious concrete by partial replacement of cement by silica fume and to study its strength & other properties.

I. INTRODUCTION

Concrete is generally utilized for developing structures, establishments, block/square dividers, asphalts, spans/bridges, interstates, runways, stopping structures, dams, pools/stores, funnels, footings for doors, fences and posts and even pontoons. Pervious cement is utilized as a part of incalculable amount wherever humanity has a need for framework. The volume of pervious cement utilized around the world, ton for ton, is twofold that of steel, wood, plastics, and aluminum consolidated. Pervious solid's utilization in the contemporary world is outperformed just by that of normally happening water. Pervious cement is likewise the establishment of an extensive business industry. Inside and out, the prepared blend pervious solid industry, the biggest division of the pervious solid market, is anticipated to outperform $100 billion in income by 2015. In the United States alone, pervious solid assembling is a $30-billion-every year, considering just the estimation of the prepared blended pervious cement exchanged every year. Given the span of the pervious solid industry, and the basic way pervious cement is utilized to figure the framework of the advanced world, it is risky to exaggerate the part this material plays today. In current circumstances, scientists have tried different things with the expansion of different materials, similar to water-based cross connecting polymers, to create pervious cement with enhanced properties, for example, higher quality, electrical conductivity, or protection from harms through spillage.

II. RIGID PAVEMENT

Inflexible asphalt is the useful term for any street surface made of pervious cement. Pervious solid streets are called inflexible while black-top secured streets are adaptable. These wordings allude to the measure of twisting made in the street surface itself when being used or after some time. The prime advantages of utilizing pervious solid asphalts are in its strength and capacity to get a handle on a shape. Outline of inflexible asphalt is extremely basic. A surface layer, made up of pieces of Portland bond pervious cement (PCC), sits over a bunch of sub-layers. The layer straightforwardly under the PCC is more adaptable than the previous cement, yet at the same time very inflexible.

Silica Fume

A “Very tiny non-crystalline silica formed in electric arc furnaces as a byproduct of the assemblage of elemental silicon or alloys having silicon is known as condensed silica fume or micro-silica”. (ACI 116R-90 cement and pervious concrete technology). Silica fume, also famous as micro silica, is a result of the reduction of high-purity quartz with coal in electric furnaces in the making of silicon and Ferro-silicon alloys. Silica Fume is also composed as a byproduct in the making of other silicon alloys such as Ferro-chromium, Ferro-manganese, Ferro-magnesium, and calcium silicon (ACI Comm. 226 1987b).

Pervious Concrete

Pervious cement (likewise called permeable pervious concrete, penetrable pervious cement, no fines pervious concrete and permeable asphalt) is an extraordinary sort of

pervious cement with a high porosity utilized for pervious solid flatwork applications that permits water from precipitation and different sources to go specifically through, subsequently lessening the spillover from a site and permitting groundwater energize. Pervious cement is made utilizing expansive totals with practically no fine totals. The pervious solid glue at that point coats the totals and enables water to go through the pervious solid chunk.

III. MATERIALS AND DESIGN METHODOLOGY

The properties of material used for designing pervious concrete mix are determined in laboratory as per relevant code of practice. Different materials used in present study were cement (OPC 43 grade), coarse aggregates (20 mm and 10 mm), fine aggregates, and super plasticizer in addition to silica fume. The aim of studying of various properties of materials is to check the appearance with codal requirements and to enable an engineer to design a pervious concrete mix for a particular required strength. The description of various materials which were used in this study is given in following sections

3.1. Material Used

In this section a brief discussion is done on the material used in this work. Various tests performed on this material are also discussed.

Cement
Aggregate
Water
Silica fume

Mix	Silica Fume %	Cement kg	Silica Fume in kg	FA kg	CA kg	Water Lit
M-30	0	413.33	0	671.22	1137.44	186
	5	392.66	20.67	671.22	1137.44	186
	10	372.00	41.33	671.22	1137.44	186
	15	351.33	62.00	671.22	1137.44	186
	20	330.66	82.67	671.22	1137.44	186

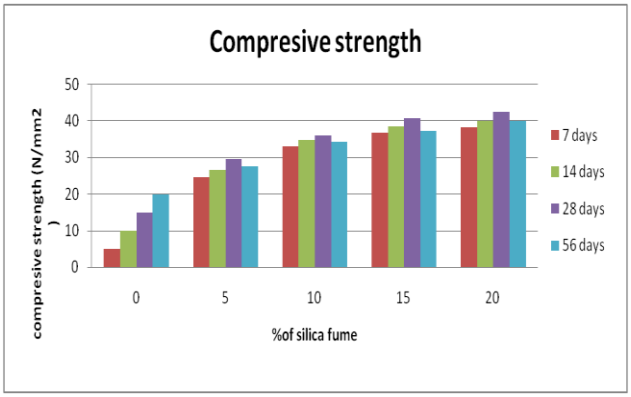
IV. RESULTS AND DISCUSSION

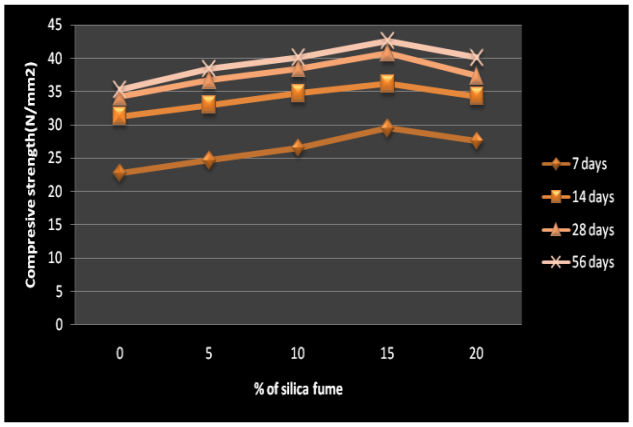
This chapter deals with the observation of the results from the various tests conducted on pervious concrete for use as pavement. The results are compared with the pervious concrete mixes with 5%,10%,15% and 20% replacement of cement with silica fume. The strength characteristics of pervious concrete containing silica fume discussed in this chapter. Tests were performed on hard pervious concrete cured under standard laboratory conditions, and compressive strength, flexural strengths and flexible tensile strength were observed at7,14,28 and 56 day of curing age.

Compressive Strength Test

Test specimens of size 150×150×150 mm were prepared for testing the compressive strength of pervious concrete with 5%,10%,15% and 20% replacement of cement with silica fume. Compressive strength test results at 7 to 56 day curing for different mixes are shown in the Table 5.1.

Mix	% of Silica Fume	7days-Compresive Strength (N/mm2)	14days-Compresive Strength (N/mm2)	28days-Compresive Strength (N/mm2)	56days-Compresive Strength (N/mm2)
M-30	0	22.80	31.29	34.23	35.27
	5	24.69	32.98	36.71	38.39
	10	26.56	34.73	38.45	40.12
	15	29.52	36.17	40.79	42.61
	20	27.63	34.29	37.34	40.06

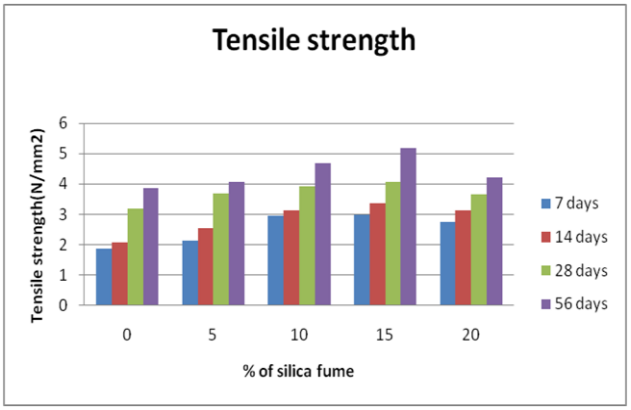


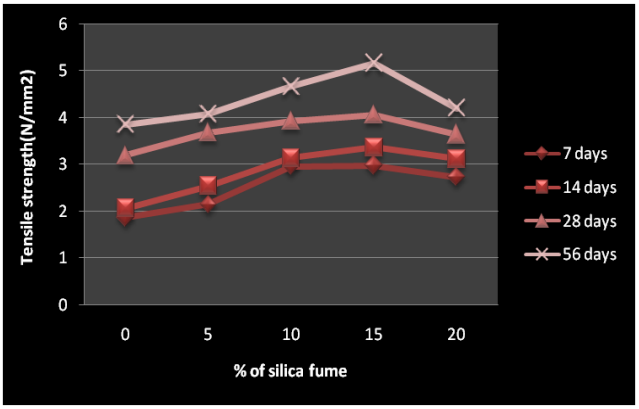


Split Tensile Test

The part rigidity test were done on the chamber size of The extent of barrels 300 mm length and 150 mm width are set in the machine with the end goal that heap is connected on the contrary side of the 3D squares are threw. Adjust precisely and stack is connected, till the example breaks. The greatest load connected should then be recorded. The presence of the solid and any bizarre highlights in the sort of disappointment are additionally noted down. According to IS : 5816-1999 The recipe utilized for count;

Mix	% of Silica Fume	7days-Tensile Strength (N/mm2)	14days-Tensile Strength (N/mm2)	28days-Tensile Strength (N/mm2)	56days-Tensile Strength (N/mm2)
M-30	0	1.87	2.07	3.20	3.86
	5	2.15	2.55	3.69	4.08
	10	2.97	3.14	3.93	4.67
	15	2.98	3.37	4.07	5.17
	20	2.74	3.12	3.65	4.21

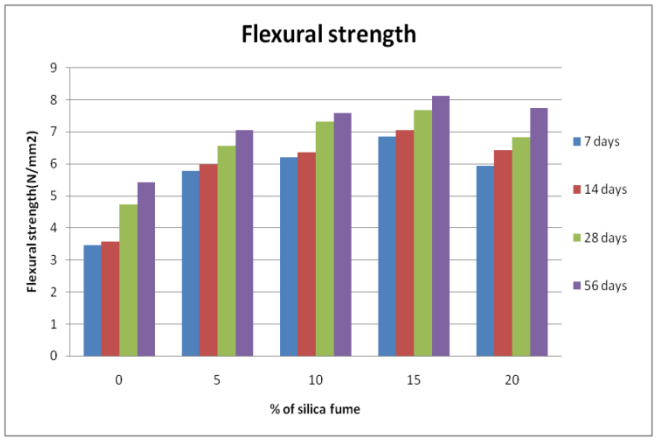


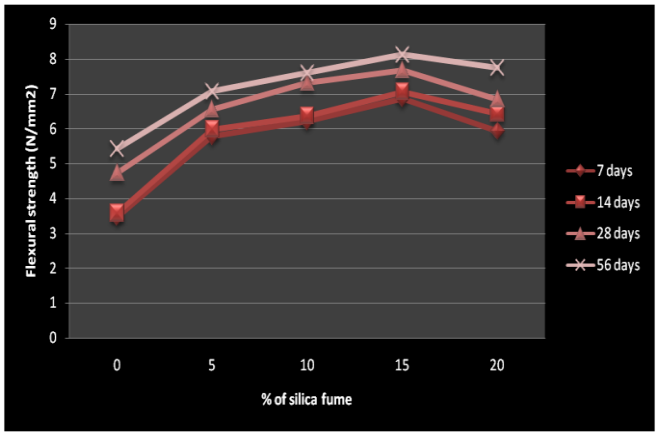


Flexural Strength Test

In the study load applied axially without subjecting the specimen to any tensional stress or restraints. During the testing, Apply the load at a rate that constantly increases the maximum stress until rupture occurs. The fracture indicates in the tension surface within the middle third of span length.

Mix	% of Silica Fume	7days-Flexural Strength (N/mm2)	14days-Flexural Strength (N/mm2)	28days-Flexural Strength (N/mm2)	56days-Flexural Strength (N/mm2)
M-30	0	3.46	3.58	4.74	5.42
	5	5.78	5.98	6.56	7.06
	10	6.21	6.37	7.32	7.59
	15	6.86	7.06	7.68	8.12
	20	5.93	6.43	6.84	7.74





V. CONCLUSION

The present study was undertaken to investigate the compressive strength flexural strength and tensile strength of pervious concrete with different level of replacement of cement with silica fume. Cement was partially replaced by 5%,10%,15% and 20% silica fume for calculating compressive flexural and tensile strength of the mixes after curing period of 56 days.

From the experimental results, the following conclusion can be drawn:

• Pervious concrete mix at water-cement ratio 0.45 with 15% silica fume as replacement of cement is the optimum level and it has been observed a significant increase strength.

• The compressive strength also tends to increase with increase percentage replacement of cement with silica fume similar to results of flexural strength and tensile strength.

• On increasing the percentage replacement of cement with 15% silica fume beyond 15%, there was decrease in flexural, tensile and compressive strength of the pervious concrete.

SCOPE FOR FUTURE WORK

In the present study experimental programs was devised to study the strength characteristics of mixes containing silica fume. The work can be extended to study the durability characteristics as well.

The performance of the pavement quality pervious concrete slabs containing silica fume. The behavior of these Pavement Quality Pervious concrete (PQC) slabs can be analyzed under repetition loading for the fatigue life consumed.

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