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Aniket Kumar Sharma, Shobhit Pandey, Ayush Jain and
Shreya Shekhar

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Effect of Water Temperature on the Compressive Strength of Silica Fumes based Porous Concrete

Aniket Kumar Sharma¹, Shobhit Pandey², Ayush jain¹, Shreya shekhar¹

¹Assistant Professor, ²Research Student

Department of civil Engineering, KIET Group of Institutions
Ghaziabad, Uttar Pradesh, India

Abstract— Pervious concrete is a zero droop solid, which comprises of coarse aggregates, water and different cementitious materials. As there is no fine utilized in the concrete so it's at some point referred as no-Fine concrete. Also pertaining to its water draining capacity it is also known as called permeable concrete. Pervious concrete is special kind of high porosity solid which permits water from precipitation to either infiltrate into the ground water or to the other storage facility. Since it provides better friction to vehicle tyres and hence also prevents skidding. It utilized for asphalt since it gives a genuine presentation against sliding for vehicles in stormy days and a far superior sound retention property. In this examination the concrete supplanted with silica fumes with different mixing water temperature were tested, so as to arrive at an optimum level of workability and strength. Concrete Blocks of Standard Sizes were prepared and relieved at a standard time period of 7, 14 and 28 days and then the compressive strength was tested. Distinctive solid blend extents, for example, OPC and SPC are set up to the check the compressive quality of pervious concrete. The outcomes show the Pervious Concrete containing 5%, 10%, 15% silica smoke can accomplish compressive quality of 14.4 N/mm², 17 N/mm², 19.1 N/mm² for 28 days of relieving individually and at low mixing water temperature 10°C the workability and slum value enhances. With addition of more silica fume in mixer the value of permeability was decreasing.

Keywords—OPC(ordinary pervious concrete); SPC(silica fume pervious concrete); PC(pervious concrete)

INTRODUCTION

Pervious concrete is a specific kind of high porosity concrete. Due to presence of voids, the required interlocking is not achieved and its strength is less than conventional concrete. However It can be used in areas of low traffic and high rainfall accounting for its permeability. When mixed with asphalt, it also provides better protection against skidding of vehicles. However it is difficult to work with as no fine aggregates are present, Also durability of this type of concrete can be put into question. To encounter the solution, Pozzolanic materials like silica fumes can be added to increase the mechanical properties and strength. Different mixing water temperature also has an effect of workability and strength [1]. Countries like India have seasonal characteristics; hence the temperature

of the aggregates as well as water can vary with seasons. Hence this study was carried out to check the compressive strength, workability and permeability of the porous concrete in the presence of silica fumes with different mixing water temperatures. Silica fume is a byproduct resulting from the reduction of pure quality of quartz with coal or coke and wood chips in electric arc furnace during the production of silicon metal or silicon alloy. The use of silica fume is desirable as it enhances the durability of the concrete. There are differences among researchers on how workability is affected after addition of silica fumes as a cement replacement. Strength and Wear Resistance of Sand -Replaced Silica Fume Concrete Hamidou and gafoori 2007 [2], Compressive quality of 10% SF supplanted pervious concrete expanded around 30%. but the wanted porosity was not accomplished so ideal level of silica fume for 20% porosity was 8% [3], Khayat investigate that Blended silica fumes also contribute to increased strength, cohesiveness and enhancing scaling resistance. It also have a diminishing effect on permeability [4], Kadri and Dual reported that workability is increased when silica fumes is added as an replacement to the cement [5], Vikas have discovered that an ideal degree of silica fume expanded strength is around 5% by weight. Anyway beyond that there is a misfortune in compressive quality anyway the workability is seen as expanded [6]. The experiment was done on OPC and SPC with varying water temperatures as 10 degrees and 25 degrees. A fixed water cement ratio i.e. 0.33 was used in all the experiment with variation of silica fumes as 5% 10 % and 15 % of the total cementitious materials. In the end, the permeability of the attained concrete after 28 days was tested. This paper presents the results of this investigation.

MATERIALS

SILICA FUME: It is a side-effect accomplished by gathering fumes gas essentially of non-crystalline silicon dioxide (SiO₂), and the normal molecule distance across of every essential molecule is around 0.1 to 1.0 µm. By including the superfine particles of silica smoke to solidify and different materials, the holes between the particles are filled. This impact picked up the creation of thick, high-quality items.

AGGREGATE: Pervious cement has almost no fine totals inside the blend. Total size is normally between 3/8 to 1/2 inch at maximum. Bigger total probably won't be reasonable in light of the fact that it might make the surface be excessively coarse, which cannot be adequate regarding surface unpleasantness. When all is said in done, adjusted total would require less compaction exertion than squashed total. The total ought to be saved damp particularly when high temperatures are recognizable. On the off chance that dry total is utilized, the ingestion and dampness content must be considered as pervious solid blend structures work with low w/c proportion.

WATER: Water satisfying guideline necessities for regular cement are frequently utilized for the gathering of pervious cement. No unique prerequisites as far as water quality are fundamental. The water substance of pervious cement is chosen inside a similar path as ordinary cement. Testing has shown that a water/concrete proportion inside the scope of 0.27–0.35 takes into account best scattering of concrete glue/mortar and best covering of total particles. With lower w/c proportion, balling of the mix are frequently watched. For this situation, 0.33 w/c is taken and water temperature is changed for mixing

CEMENT: Concrete is utilized as a coupling material in concrete having some property given beneath in table. Type Ordinary pressure driven concrete 53 evaluations is utilized as essential fastener. SF is utilized as a concrete substitution to switch the cover properties. Compound creation of Cement was as appeared in table admixtures were utilized for this examination.

TABLE 1. Binder ingredients

SERIAL.	CONSTITUENTS	BINDER (%)
1	Calcium oxide	63
2	Silicon Di-oxide	20.2
3	Aluminium Oxide	4.7
4	Ferric oxide	3.2
5	Tri-Oxido silicate	2.4
6	Magnesium oxide	2.3
7	Potassium Oxide	0.8
8	LOI	1.9

METHODOLOGY

At first preliminary investigation of silica fumes and cement were done and the details provided by manufactures were studied in detail. After this investigation, Cement, silica fume, aggregates are selected for this experiment.

Weigh batching had adopted for weighing of materials. And weight machine was used for the calculation of weights. Blending is achieved in a lab clump Mixer. After mixing the samples, slump test has done to check the workability of the samples. For the preparation of specimen, cubes of size 15cm × 15cm × 15cm are utilized. Concrete Prepared from the mix was filled in the mould in layers of 5 cm thick and each layer is compacted after applying 35 strokes for every layer with the assistance of packing pole. Top surface is leveled and smoothened with a trowel.

Finally curing was done for 7, 14 and 28 days respectively for these samples by keeping these samples into water. Finally compressive strength test was done by putting the specimen in the compression testing machine.

This process was repeated for all the specimens.



Fig. 1. Cubes of Pervious Concrete

MIX DESIGN

For the experiment the moderate exposure condition was assumed and M20 grade of concrete chosen to be designed. Specific gravity of cement and aggregates were measured and they were 3.15 and 2.65 respectively. Ordinary Portland cement of grade 53 was used. Four types of samples are prepared with varying silica fumes content of 0% 5%, 10% and 15% .w/c ratio is kept 33 percent in all those samples. The further details are tabulated below

TABLE2. Quantities of Material per 1 M³ of PC

Mix Type	Aggregates	Cementitious material		w/c
	kg	Cement(kg)	SF(kg)	
Blend 1	1669.73	391	0	0.33
Blend 2	1669.73	370.5	19.5(5%)	0.33
Blend 3	1669.73	351	39(10%)	0.33
Blend 4	1669.73	331.5	58.5(15%)	0.33

RESULTS

The consequences of droop and unit weight for all Blends are given beneath in table

TABLE3. Test result for slump and unit weight

BLEND	Blend1		Blend 2		Blend 3		Blend 4	
Temperature (°C)	10	25	10	25	10	25	10	25
Slump (Cm)	3	2.5	4	2	5	4.5	8	4.8
Unit weight (kg/m ³)	2170	2170	2178	2178	2181	2180	2199	2179

For Blend 1 and Blend 2 blends the droop (slump) worth and usefulness (Workability) is low having the worth reaches between 0-4 cm at various blending water temperatures as 100c and 250c. While the Blend 3 and Blend 4 included with huge estimation of silica smoke and afterward 5-8 cm estimation of droop was recorded when the trial is finished. Same outcomes

are seen at the temperature 100c blending water as produces increments in droop worth and usefulness and onwards. The estimation of unit weight was determined somewhere in the range of 2170 and 2199 kg/m³.

TABLE4. Compressive Strength of Different blends at 10⁰c

BLENDS	Compressive Strength (MPA)			Permeability (mm/sec)
	7 Days	14 Days	28 Days	
Blend 1	5.2	7	10.1	16.23
Blend 2	8.5	10.6	14.4	14.81
Blend 3	10.2	13.4	17	13.1
Blend 4	11.4	14	19.1	12.3

TABLE5. Compressive Strength of Different Blends at 25⁰c

BLENDS	Compressive Strength(MPA)			Permeability (mm/sec)
	7 Days	14 Days	28 Days	
Blend 1	5.1	6.9	10.0	16.12
Blend 2	8.4	10.5	14.3	14.35
Blend 3	10.1	13.30	16.9	12.90
Blend 4	11.2	13.8	18.9	12.25

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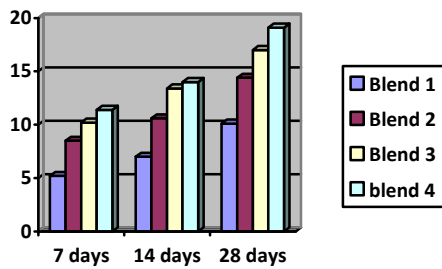


Fig. 2. Chart between compressive strength (on y-pivot) and Time (on x-pivot) of various blends at 10°C.

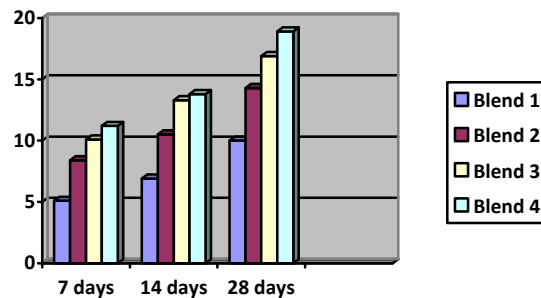


Fig. 3. Chart between compressive strength (on y- pivot) and Time (on x-pivot) of different blends at 25°C.

CONCLUSION

From the trial, the significant ends were noted as underneath

- With increment in blending water temperature compressive quality decreases marginally for the solid blend.
- As increment in silica fume content the compressive quality increments for the pervious cement.
- For increment in silica content the penetrability of solid demonstrating noteworthy diminishing
- As increment in the blending water temperature the workability and slump esteem upgrades.