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Research Paper

Study of Silica Fume Incorporation in Pervious Concrete

Engineering

KEYWORDS :

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ABSTRACT

Pervious concrete is a zero-slump, open graded material consisting of hydraulic cement, coarse aggregate, admixtures and water. Because pervious concrete contains little or no fine aggregates such as sand, it is sometimes referred to as "no-fines" concrete. It is a special type of concrete having a high void content of about 30%, is becoming popular nowadays due to its potential to reduce the runoff to the drainage systems which can provide a water flow rate around 0.34 cm/second. To achieve the porous concrete ordinary Portland cement is used. Herein this investigation the cement is replaced with silica fume in which ordinary Portland cement has been reduced by introducing silica fume as a cementitious agent. Compressive strength is carries out on hardened pervious concrete. This paper mainly focuses on the compressive strength of the pervious concrete. To investigate the compressive strength, "Cubes" of size 150mm x 150mm x 150mm are prepared and cured at a regular interval of 3,7,14 and 28 days, the specimens were tested I compression testing machine. Pervious concrete is made by replacing cement with silica fume to the extent of 10% by weight and strength tests were carried out. Different concrete mix proportions such as 1:4, 1:6 and 1:8 are prepared to the check the compressive strength of pervious concrete. The results indicate the pervious concrete containing 10% silica fume can achieve compressive strength of 17.0 N/mm2, 9.01 N/mm2, 6.32 N/mm2 for the proportion of 1:4 , 1:6 and 1:8 for 28 days of curing respectively, whereas the strength of pervious concrete for normal PPC cement without mixing any admixture are 9.14 N/mm2, 5.92 N/mm2, 4.28 N/mm2 for 28 days of curing respectively.

I. INTRODUCTION:

Porous Concrete are different than conventional concrete . The finished surface is not tight and uniform, but it is open and varied. The purpose is to admit large quantities of storm water . Porous concrete also known as Permeable concrete , No-fines concrete and Pervious concrete . Porous concrete is a mixture of Portland cement, controlled amount of water and uniformly graded coarse aggregate. In some cases, chemical admixture and/or supplementary cementations materials needed for the mixture. The different between dense concrete and porous concrete are the porous concrete contain little or no fines in the mixture. It is to enhance the porosity of the concrete. Porous concrete pavement is being used as one of the solution for decreasing the storm water runoff by capturing and allowing rain water to drain into the land surface. Porous pavements are able to increase water availability and also alter soil pH and micronutrient availability beneath the pavement. Some of the Porous concrete pavement applications which are for low-volume pavements, residential roads, alleys, driveways, sidewalks, pathways and also parking lots. The main problem of porous concrete is their strength. Recently, a lot of study by other researchers concentrated on how to improve the strength of the porous concrete. It was found that, the increasing in porosity will decrease the compressive strength and flexural strength of the concrete. It is because when the structure's void in the concrete is relatively high, the strength of the concrete will decreased. As there are four major factors that will influence porous concrete strength which are concrete porosity, water to cementations material ratio, cement paste characteristic and size and volume content of coarse aggregate . Due to voids in the porous concrete, it is difficult to obtain high strength porous concrete by using common material and mixture. In order to enhance the strength of the concrete, silica fume and super plasticizer can be used in the mixture's design. Silica Fume is a highly reactive material that is used in relatively small amounts to enhance the p[properties of concrete. It is a by-product if producing certain metals in electric furnaces.

II. OBJECTIVES

- The following objectives are there of our study
- To study the compressive strength development of Silica Fume mixed pervious concrete.
- To study the development of compressive strength of pervious concrete made with ordinary Portland cement without mixing any admixtures in it.
- To compare the compressive strength development of plain pervious concrete and pervious concrete made with incorporation of admixtures that is Silica Fume.

III. METHODOLOGY

Pervious concrete of different mix proportion is prepared with standard method in concrete technology laboratory o f kct engineering collage kalaburgi the mix ratios maintained are 1:4, 1:6 and 1:8 by using 20mm and down size aggregate and ordinary portland cement of 53 grade in which cement is replaced by Silica fume to the extent of 10% with water cemet ratio of 0.45. The cube of 150x150x150mm sizes are prepared and minimum of 3 cubes were cast for each batch and they are cured for 3, 7, 14 and 28 days of curing totaling the quantum of cubes to 36 numbers. Similarly pervious concrete with only mixing cement and coarse aggregate similar in sizes as above mentioned without replacing cement with Silica fume are cast totaling to 36 numbers. Thereafter all the cubes were cured for respective curing period and tested in compression testing machine of building material of testing laboratory of KCTengineering collage kalaburgi.

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HARDENED PROPERTIES OF PERVIOUS CONCRETE:

1. COMPRESSIVE STRENGTH TEST: [IS 516:1959]

The compressive strength test will be carried out on the pervious concrete specimens at the end of 3 days, 7 days, 14 days and 28 days of curing. The procedure to be followed is as given below.

- After cleaning the bearing surface of the compression testing machine, the concrete Block will be placed on its face side having dimension 150 mm × 150 mm. The axes of the specimen are to be carefully aligned with the center of the lower pressure plate of compression testing machine. Then an upper pressure plate is to be lowered till the distance between the pressure plate and the top surface of the specimen achieved. No packing used between the face of the pressure plates and block.
- The load will be applied without shock and increased gradually at the rate of 35kg/cm2/min until the specimen was crushed.
- The compressive strength calculated inN/mm2from the maximum load sustained by the cube before failure.

Compressive Strength= P/A (N/mm2)

Where, P = Failure Load (N)

A = Cross Sectional Area (mm2)

An average of three values was taken for determining compressive strength of concrete.

TABLE 2 CHEMICAL COMPOSITIONS OF ORDINARY PORTLAND CEMENT 53 GRADE (OPC)

Oxide	Cement (%)in OPC
Lime CaO	60 -67
Silica SiO2	17 – 25
Alumina Al2O3	3 – 8
Iron Oxide Fe2O3	0.5 – 0.6
Magnesia MgO	0.5 – 4
Alkaline K2O, Na2O	0.3 – 1.2
Sulfates SO3	1.0 – 3.0M

TABLE 1 PHYSICAL PROPERTIES OF ORDINARY PORTLAND CEMENT 53 GRADE (OPC)

Properties	Value for cement for OPC	IS code Recommendations IS : 12269 – 1987
Specific Gravity	3.15	3.10-3.15
Consistency (%)	28%	30 – 35(%)
Initial setting time (min)	35 min	Minimum 30 min
Final setting time (min)	178 min	Maximum 60 min
Compressive strength at 7 days (N/mm2)	38.49 N/mm2	43 N/mm2
Compressive strength at 28 days (N/mm2)	52.31 N/mm2	53 N/mm2

PHYSICAL PROPERTIES OF SILICA FUME

TESTS	RESULTS
Specific Gravity	1.76
Absorption	0.3-0.5%
Bulk density	1027.6kg/m3

IV. EXPERIMENTAL RESULT AND

DISCUSSION

Compressive strength of 17.0 N/mm^2, 9.01 N/mm^2, 6.32 N/mm^2 for the mix proportion of 1:4, 1:6 and 1:8 for 28 days of curing respectively were obtained with Silica Fume mix pervious concrete

Whereas the strength of pervious concrete for normal PPC cement concrete without mixing any admixture are 9.14 N/mm^2, 5.92 N/mm^2, 4.28 N/mm^2 for mix proportion of 1:4, 1:6 and 1:8 after 28 days of curing respectively.

The development of compressive strength for the admixture that is SILICA FUME mixed pervious concrete higher strength for all mix proportion and at all the stages of curing compared to pervious concrete without Silica Fume.

TABLE 3Compressive Strength Test (N/mm2) on Cube with OPC 53 Grade Cement and silica fume mixed concrete [IS516:1959]

Admixture	Concrete mix	3 days	7 days	14 days	28 days
Silica Fume	1:4	6.93	11.10	15.24	17.0
	1:6	3.68	6.12	8.08	9.01
	1:8	2.58	3.92	5.67	6.32

TABLE 3 Compressive Strenght Test (N/mm2) on Cube with OPC 53 Grade Cement Plain concrete [IS516:1959]

Concrete mix	3 days	7 days	14 days	28 days
1:4	3.85	5.96	8.30	9.14
1:6	2.48	3.87	5.21	5.92
1:8	2.28	3.72	4.06	4.28

V. CONCLUSION

From the experimental result following conclusion were found out,

1. Compressive strength of 17.0 N/mm^2, 9.01 N/mm^2, 6.32 N/mm^2 for the mix proportion of 1:4, 1:6 and 1:8 for 28 days of curing respectively were obtained with Silica Fume mix pervious concrete
2. Whereas the strength of pervious concrete for normal PPC cement concrete without mixing any admixture are 9.14 N/mm^2, 5.92 N/mm^2, 4.28 N/mm^2 for mix proportion of 1:4, 1:6 and 1:8 after 28 days of curing respectively.
3. The development of compressive strength for the admixture that is Silica Fume mixed pervious concrete higher strength for all mix proportion and at all the stages of curing compared to pervious concrete without Silica Fume.

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