International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 05 | May-2018 www.irjet.net p-ISSN: 2395-0072

Pervious Concrete for Transportation Application

Karthik Navada R[1], Dr. Mithun B.M.[2], Shriram Marathe.[2]

[1]PG student, Construction Technology, Department of Civil Engineering, NMAMIT, Nitte, Karnataka, India
[2]Assistant Professor, Department of Civil Engineering, NMAMIT, Nitte, Karnataka, India

---

Abstract - *The pervious concrete system and its corresponding strength are as important as its permeability characteristics. The strength of the system not only relies on the compressive strength of the pervious concrete but also on the strength of the soil beneath it for support. Previous studies indicate that pervious concrete has lower compressive strength capabilities than conventional concrete and will only support light traffic loadings. . Since voids are supposed to reduce the strength of concrete, the goal is to find a balance between water, aggregate, and cement in order to increase strength and permeability, two characteristics which tend to counteract one another. Also important is appropriate traffic loads and volumes so that the pervious concrete is able to maintain its structural integrity. Pervious concrete is a special type of concrete having a high void content of about 30%, is becoming popular nowadays due to its potential to decrease the runoff to the drainage systems which can provide a water flow rate around 0.32 cm/second. Pervious concrete contains less or no fine aggregates such as sand, it is sometimes stated as "no-fines" concrete. In this Study the cement is replaced with silica fume in which ordinary Portland cement has been reduced by incorporating silica fume as a cementitious agent. This paper mainly focuses on the compressive strength and permeability of the pervious concrete. Pervious concrete is made by replacing cement with silica fume to the extent of 5%, 10% and 15% by weight and strength tests were carried out.*

Key Words: **Pervious Concrete, Compressive Strength, Permeability, Silica fume.**

1. INTRODUCTION

Pervious concrete is a composite material consisting of coarse aggregate, Portland cement, and water. It is different from conventional concrete in that it contains no fines. The aggregate usually consists of a single size and is bonded together at its points of contact by a paste formed by the cement and water. The result is a concrete with a high percentage of interconnected voids that, when functioning correctly, permit the rapid percolation of water through the concrete. Unlike conventional concrete, which has a void ratio anywhere from 3-5%, pervious concrete can have void ratios from 15-40% depending on its application. Pervious concrete characteristics differ from conventional concrete in several other ways. Compared to conventional concrete, pervious concrete has a lower compressive strength, higher permeability, and a lower unit weight, approximately 70% of conventional 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 decrease. 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 properties of concrete.

1.1 OBJECTIVES

In this paper, the effects of varying silica fume in pervious concrete on its compressive strength are investigated. The aim is to achieve a highest compressive strength without constraining the permeability characteristics of the pervious concrete. To compare the compressive strength development of plain pervious concrete and pervious concrete made with incorporation of Silica Fume.

1.2 METHODOLOGY

Pervious concrete is prepared 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 5%, 10% and 15% with water cement ratio of 0.25. The cube of 150x150x150mm sizes are prepared and they are cured for 28 days Similarly pervious concrete with only mixing cement and coarse aggregate similar in sizes as above mentioned without replacing cement with Silica fume are cast Thereafter all the cubes were tested for compressive strength and permeability.

2. RESULTS AND DISCUSSION

Table 1 Details of mix designations and mix proportions of mixes (all ingredient contents are in kg/m^3)

Cement	Silica Fume	Coarse Aggregate	Super plasticizer	Water
400	-	1520	12.0	100
380	20	1520	12.8	100
360	40	1520	14.0	100
340	60	1520	15.2	100

In this research cement is replaced by 5, 10 and 15% of silica fume respectively with a water cement ratio of 0.25. No fine aggregate has been used.

2.1 COMPRESSIVE STRENGTH

Table 2 Details of compressive strength and % replacement by silica fume at 7 and 28 days

Silica Fume (%)	Compressive Strength (MPa)			Porosity (%)
	3 Days	7 Days	28 Days	
0	3.84	8.19	12.8	16.6
5	4.79	9.43	14.3	16.3
10	5.6	10.8	16.0	16.1
15	6.55	12.39	17.7	15.8

Compressive strength of cubes were tested in 200T capacity compression testing machine. The cubes were tested for 3, 7 and 28 Days. Cubes with 15% silica fumes showed highest strength compared to others. After 15% the strength has started decreasing. There was not much variation in the porosity compared to cubes with no silica fumes. Only there was 5% reduction in porosity when the cubes were replaced with 15% of silica fume.

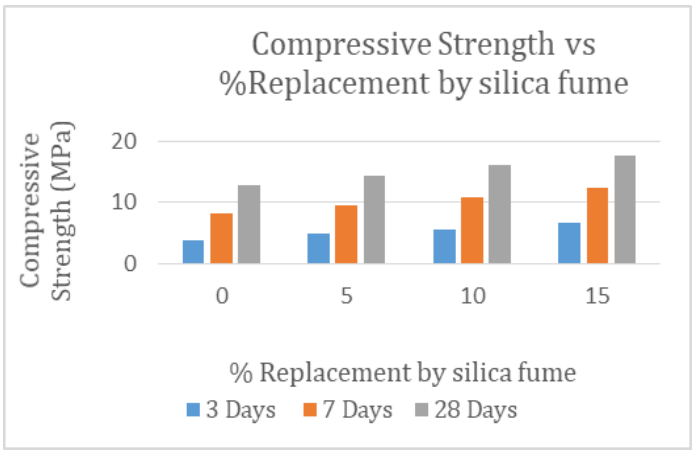

Fig 1 Compressive strength vs % replacement by silica fume

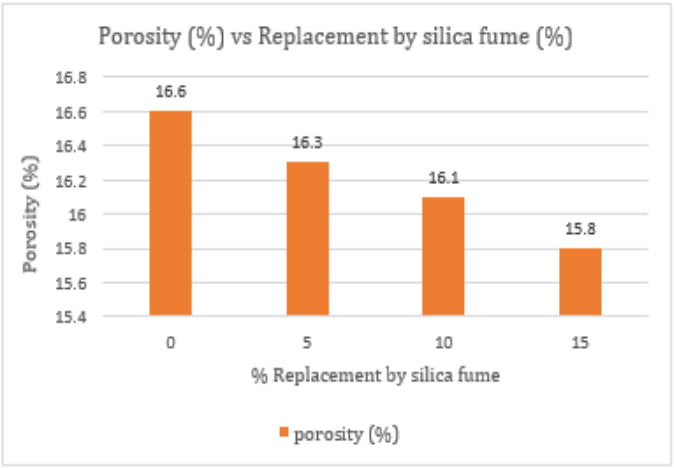

Fig 2 Porosity (%) vs Replacement by silica fume (%)

2.2 PERMEABILITY

In present study Co-efficient of permeability is determined by Falling Head Method. It can be seen that when the cement is replaced by silica fume there was not much variation in the permeability. Normal pervious concrete with 0% silica fume has 16.6% of porosity whereas cement replaced by 15% silica fume has 15.8% porosity. Since there is only 5% reduction in porosity there was no considerable variation in permeability.

Table 3 Details of Porosity (%), Replacement by silica fume (%) and Permeability (cm/sec)

Silica fume (%)	Porosity (%)	Permeability (cm/sec)
0	16.6	0.32
5	16.3	0.31
10	16.1	0.30
15	15.8	0.29

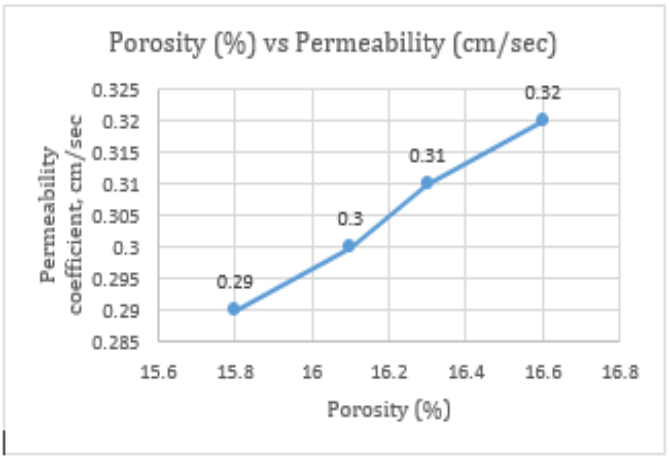

Fig 3 Porosity (%) vs Permeability coefficient (cm/sec)

3. CONCLUSION

Compressive strength was found to be highest when cement was replaced by 15% silica fume. Further addition of silica fume resulted in the decrease of strength. Compressive strength of concrete with silica fumes was better compared to previous pervious concrete with no silica fumes. There was no much variation in the permeability since the porosity percentage was not much variant

REFERENCES

[1] M Uma Maguesvari & V.L Narasimha "Studies on Characterization of Pervious Concrete for Pavement Applications" Procedia - Social and Behavioral Sciences 104(2013).

[2] K Nagababu, E.V Raghava Rao, D.Satheesh "An Experimental Study on Pervious concrete as a Pavement Layer" ISSN: 2349-6002, Vol.2, Issue 6 November 2015.

[3] Nandish SC, Ajith BT, Dr.Chandrashekar A, "Impact of Coconut Fibre & Polypropylene Fibre (Recron3S) on Concrete Mix Including Admixture" ISSN: 2278-0181, Vol.4 June2015

[4] IS 516:1959 "Methods for strength of concrete" pp-10-12

[5] Dr .B.C. Punmia "Soil mechanics and foundations" pp-189

[6] Abbott, C.L., Comino-Mateos, L., 2003. In-situ hydraulic performance of a permeable pavement sustainable urban drainage system. Water Environ. J., 17(3), 187-190.

[7] Alireza Joshaghani, Ali Akbar Ramezanianpour, Omid Ataei, et al., Optimizing pervious concrete pavement mixture design by using the Taguchi method, Constr. Build. Mater. 101 (2015) 317–325.

[8] Amde, A.M., Rogge, S., 2013. Development of High Quality Pervious Concrete Specifications for Maryland Conditions. State Highway Administration. Report number: SP009B4F.

[9] American Concrete Institute (ACI), 2010. Report on pervious concrete. ACI Committee 522. Report number: ACI 522R-10.

[10] Anthony Torres, Hu Jiong, Amy Ramos, The effect of the cementitious paste thickness on the performance of pervious concrete, Constr. Build. Mater. 95 (2015) 850–859.

[11] Bear, J., 1988. Dynamics of fluids in porous media. New York, American Elsevier Publishing Co.

[12] Betiglu Eshete Jimma, Prasada Rao Rangaraju, Chemical admixtures dose optimization in pervious concrete paste selection-A statistical approach, Constr. Build. Mater. 101 (2015) 1047–1058.

[13] Boogaard, F., Lucke, T., Beecham, S., 2014. Effect of Age of Permeable Pavements on Their Infiltration Function. Clean – Soil, Air, and Water. 42 (2), 146-152.

[14] Boving, T., Stolt, M., Augenstern, J. Brosnan, B. 2008. Potential for localized groundwater contamination in a porous pavement parking lot setting in Rhode Island, Environ. Geol. 55 (3) 571–582.

[15] Brown, C., Chu, A., van Duin, B., Valeo, C. 2009. Characteristics of sediment removal in two types of permeable pavement. Water Qual. Res. J. Can. 44 (1) 59–70.