Experimental Investigation of Pervious Concrete for Rigid Pavement

K. S. Binitha [1], M. Priyadharshini [2], M. Ragul [3]
[1, 2, 3]Assistant Professor, Department of Civil Engineering, Peri Institute of Technology, Chennai- 600048, India.

Abstract – The project aims at making and studying the different properties of pervious concrete using locally available admixtures in Chennai. Pervious concrete (or) no fineness concrete is a combination of cement and aggregate where the usage of sand is neglected. This type of concrete costs much less than normal concrete. Pervious concrete can be used in Parking areas, Side Pavements, Pedestrian path etc., where load distribution is generally low. Pervious concrete is very much important for future application on pavements for development of water conservation and to reduce water logging. An admixture known as Nano silica is used in our project to increase the strength of the concrete. This pervious concrete allows water to percolate and also this protects streams and lakes and allows local vegetation to thrive. Pervious concrete can be used as pavements or pathway in high rise apartments to increase the ground water and also it can be used in the sides of highway pavements to save run-off water. It gives high strength and permeability when no fines are used. The grade chosen for the investigation is M25.This paper attempt is made to develop the mix design for pervious concrete. The specimen results comparison for conventional concrete and pervious concrete. The graphs are plotted and it shows the variation of results.

Index Terms – Pervious Concrete, Pavement, Highway, Parking, Pathway, Pedestrian, Percolate.

1. INTRODUCTION

Water logging and depleting ground water table are the two major problems faced by the people all over the world. Even though some places have very well planned drainage facilities it becomes difficult sometimes to drain water from road surfaces. In modern times due to increasing population in developing countries like India the exposure of soil surface to the nature is highly reduced because of increased construction activities. The ground water level is also reducing due to low rate of infiltration and also the run-off water is generally high. To overcome these difficulties several measures have been taken day to day [1].

Pervious concrete is one of the modern methods which is been highly used in countries like France and USA for increasing the ground water level and also to reduce the run-off. Pervious concrete is highly capable of draining water and also has low strength characteristics. Pervious concrete or no fineness concrete is a combination of cement and aggregate where the usage of sand is neglected. This type of concrete costs much less than normal concrete. Pervious concrete can be used in Parking areas, Side Pavements, Pedestrian path etc., where load distribution is generally low. Pervious concrete is very much important for future application on pavements for development of water conservation and to reduce water logging [2].

2. PERVIOUS CONCRETE

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. Pervious concrete has a large open pore structure hence less heat storage and faster percolation [3].

Pervious concrete also finds its effective application in low loading intensity parking pavements, footpaths, walkways and highway side pavements. The pervious concrete is considered as an Environmental Protection Agent (EPA) for providing pollution control, storm management and suitable development. Due to congestion of city population there is insufficient place for draining of water and percolation of water through soil surface. Urbanisation reduced soil surface exposure on the top earth surface which is often being covered by a layer of Bitumen or Concrete for roadway. To overcome these conditions, we must generate proper draining conditions. Pervious concrete is used for draining water through concrete surface. Pervious concrete is a composition of Cement and Coarse aggregate [4].

Neetu B. Yadav, Jayesh A. Shah, Rushabh A. Shah, "Pervious concrete: Solution for Low Cost Construction", International Journal of Innovative Science and Modern Engineering. The project deals with the major properties of pervious concrete such as Density, Porosity, Permeability, Shrinkage, Durability etc., It also deals with the economic benefits of pervious concrete and its applications and Cost benefits. Pervious concrete is cost-effective and environmentally friendly.

Dania M. Abdel-Aziz, Duaa O. Al-Maani, Wael Al-Azhari, "Using pervious concrete for managing storm water run-off in urban neighborhoods: Case of Amman", American International Journal of Contemporary Research. This paper is

a study related to storm water run-off management in urban areas in a small city called 'Amman' in Jordan[5].

Figure 1 Pervious Concrete

3. EXPERIMENTAL STUDY

General pervious concrete consists of only Cement & Coarse aggregate. But when compared with conventional concrete the strength of Pervious concrete is 1/5 times of the normal concrete. To improve the strength of pervious concrete certain materials are added to it. The addition of nanosilica and polypropylene fibres increase the compressive and flexural strengths of pervious concrete. Fine aggregate is completely neglected in the project with reference to Fig.4.1 and the materials used are shown in Figure 1 to 8 [6].

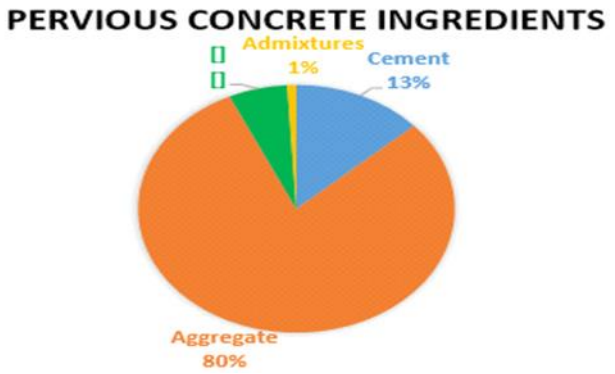

Figure 2 Pervious Concrete Ingredients

Chemical Composition	% of Composition
Lime	61.8
Silica	21.2
Alumina	5.3
Iron Oxide	3.4
Magnesium Oxide	0.6
Chloride	0.1
Loss on ignition	2.8

Table 1 Details of Mixes Considered

4. CASTING AND TESTING

Four 150mm cubes were cast for each parameter to be examined. A total 32 cubes were used in this test. Ingredients were selected and added to the mixer taking all possible precautions to avoid the balling of fibres. Mixes were designed for a high workability of slump value and fibres were added to the mix without any future modifications. All specimens were vibrated using needle vibrator. Rebound number and pulse velocity readings were taken using rebound hammer and ultrasonic concrete tester. The longitudinal pulse velocity results are presented in the Tables 2 to 4. Specimen casting and testing were shown in Figs. 3 to 8[7].

Figure 3 Mixing of the Ingredients

Figure 4 Impact test on aggregate

Figure 5 Compressive strength test on the specimen

Figure 6 Compression Test

Figure 7 Flexural Test

Figure 8 Split Tensile Test

S. No.	Mix Type	Compressive Strength		
		7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
1	Conventional Concrete (CC)	19.50	24.5	29.05
2	Pervious Concrete with Nano Silica (P.C.N)	28.52	32.94	34.12
3	Pervious Concrete with Nano Silica & Polypropylene (P.C.N.P)	15.11	17.12	20.17

Table 2 Comparison for Compressive strength

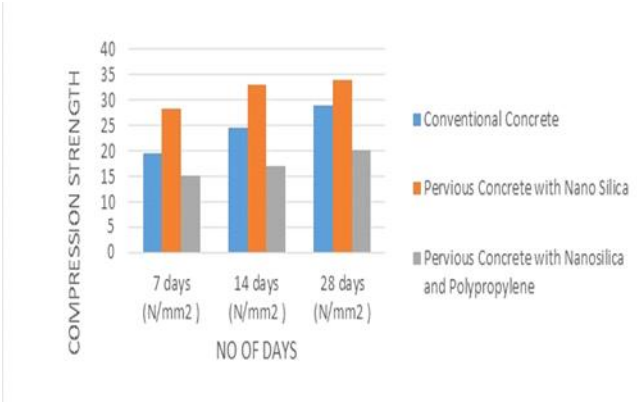

Figure 11 Results for Compressive test

S. No.	Mix Type	Flexural Strength N/mm^2		
		7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
1	Conventional Concrete (CC)	2.25	4.56	6.19
2	Pervious Concrete with Nano Silica (P.C.N)	3.45	5.16	3.4
3	Pervious Concrete with Nano Silica & Polypropylene (P.C.N.P)	2.02	3.35	4.5

Table 3 Comparison for Flexural strength

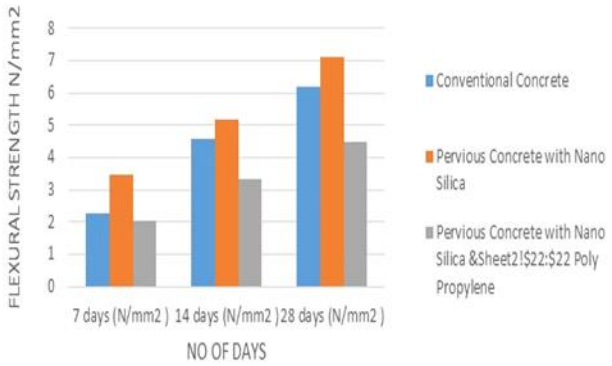

Figure 10 Results for Flexural Strength

S. No.	Mix Type	Split Tensile Strength		
		7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
1	Conventional Concrete (CC)	2.12	4.59	7.89
2	Pervious Concrete with Nano Silica (P.C.N)	3.25	5.56	8.95
3	Pervious Concrete with Nano Silica & Polypropylene (P.C.N.P)	2.12	2.00	1.86

Table 4 Comparison for Split Tensile strength

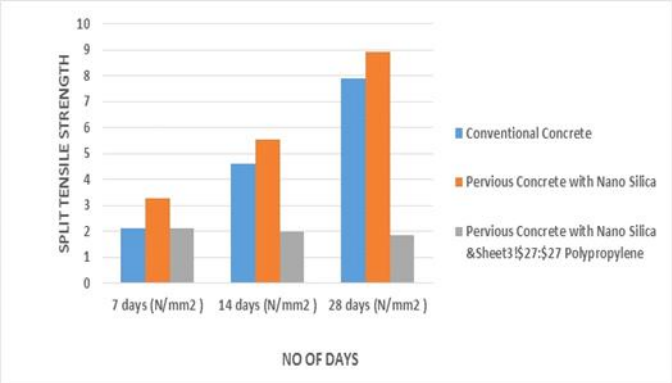

Figure 11 Results for Split Tensile Strength

5. DISCUSSION OF TEST RESULTS

The Results inferred from the Comparative Study of tests done are emphasized for the conventional pervious concrete in terms of permeability and strength characteristics. The strength is high for conventional pervious concrete. The results of the mix containing pervious concrete with nano silica have relatively high strength. The project is completely analyzed and it is clearly seen that conventional pervious concrete and pervious concrete with nano silica holds good for strength characteristics. The Permeability is high for pervious concrete. Further studies have to be done for increasing strength using Polypropylene fibers.

REFERENCES

[1] Joung. Y and Grasley.Z.C (2008) :Evaluation and Optimization of Durable pervious Concrete for use in Urban Areas" Research Rep. SWUUTC, PP 1 -117.

[2] Darshan S. Shah, Prof. Jayeshkumar Pitroda, Prof. J. J. Bhavsar "Pervious Concrete: New Era for Rural Road Pvement" ISSN: 2231-5381.

[3] Yang.J and Jiang.G, (2003), " Experimental Study on Properties of Pervious Concrete Pavement Materials", Cement and Concrete Research. V.33, p. 381-386.

[4] Amutha.R, Anitha.P. Keerthika.S "Study on Properties of Pervious Concrete Using Admixtures".

[5] Crouch, L.K., Pitt.J, and Hewitt. R, (2007). "Aggreagate Effects on Pervious Portland Cement ConcreteStatic Modulus of Elasticity" J. mater.Civ. Eng. 19(7), 561-568.

[6] Neetu B.yadav, jayesh A. shah et al, "Pervious Concrete: Solution for low cost construction" Journal of innovative science and modern engineering volume1(2013).

[7] George N. Mccain and mandar M. Dewoolkar, "Strength and Permeability characteristics of Porous Concrete Pavements" (2009).

[8] ACI 552R (2010): "Report on Pervious Concrete", American Concrete Institute, Farmington Hills, Michigan, http://www.concrete.org.