International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Studies on Mechanical Properties of the Modified Pervious Concrete

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ABSTRACT

Pervious concrete (also called Porous concrete, Permeable concrete, No-fines concrete and Porous pavement) is a special type of concrete with a high porosity used for concrete flatwork applications such as parking lots, driveways, sidewalks, road platforms etc that allows water from precipitation and other sources to pass directly through, thereby reducing the run -off from a site and allowing ground water recharge. Its void content ranges from 18 to 35% with compressive strength of 3.5 to 28Mpa. The infiltration rate of Pervious concrete will fall in to the range of 80 to 750 liters per minute per square meter. Typically, Pervious concrete has little or no fine aggregate and has just enough cementenious paste to coat the course aggregate particles by preserving the inter connectivity of the voids.

It is observed that usage of Silica Fume and Fly Ash as additives in plain Pervious concrete increases the strength in Compression, Indirect Tension and Flexural to 6.6%, 5.18%, 2.81% for Silica fume 6.14%, 3.70%, 1.40% for Fly Ash compared to plain Pervious concrete with no difference in cost of materials.Pervious concrete is a special high porosity concrete used for flatwork applications that allows water from precipitation and other sources to pass through, thereby reducing the runoff from a site and recharging ground water levels.

Keywords: Plain cement concrete, Pervious concrete, Additives, Silica Fume, Fly Ash, Compressive Strength, Indirect Tensile Strength, Flexure.

1. INTRODUCTION

As urbanization increases in India and many parts of the world the problem of water logging and requirement of drainage is also increase. This is partly due to impervious nature of the bituminous and concrete pavements. Pervious concrete which has an open cell helps significantly to provide high permeability due to its interconnected pores. Pervious concrete (also called porous concrete, permeable concrete and no fines concrete) is a special type of Concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge.

1.2 PERVIOUS CONCRETE IN INDIA

Pervious concrete can be successfully used in India in applications such as parking lots, driveways, sidewalks, road platforms, etc. over the next 15 years there is expected to be a significant amount of housing construction in India.

Massive urban migration in Indian cities is causing the ground water to go much deeper and is causing water shortages. Flooding and extended water logging in urban areas is common since all the barren land which could hold the rain water are being systematically converted into valuable real estate with a result that impervious surfaces such as roads, parking lots, roof tops are covering the natural vegetation.

Another significant advantage in India as compared to western countries is the significantly lower cost of labour. Much of the Pervious concrete construction is manual and can be done without heavy equipment and therefore Pervious concrete can be placed at a lower cost even in rural areas.

1.1 CURRENT STATUS OF PERVIOUS CONCRETE

Although there is very little documented use of no-fines concrete in Australia, it was first utilized as early as 1946. No-fines concrete was used in the construction of a residential house in Ride, New South Wales. The Department of Works and Housing undertook this project as a method of investigating new cost effective construction materials (Ghafoori 1995).

Developers and government organizations have been using no-fines concrete more readily as a method of pollution control in America. Pervious surfaces are in greater demand as planners, public works officials and developers search for methods to adequately and efficiently manage storm water in an economical and environmentally friendly method (Frentressetal 2003). This form of concrete allows the water to penetrate the soil, reducing the runoff and stopping the movement of pollutants.

1.2 ADVANTAGES OF PERVIOUS CONCRETE

- Decreasing flooding possibilities, especially in the urban areas.
- Recharging the ground water level
- Improving water quality through percolation.
- Sound absorption
- Heat absorption
- Supporting vegetation growth
- It allows more efficient land development

1.3 APPLICATIONS OF PERVIOUS CONCRETE

- Pervious pavement for parking lots.
- Green house floors
- Pavements, walls, and floors where better acoustic absorption characteristics are desired.
- Swimming pool decks
- Bridge embankments.
- Tennis courts.
- Sub base for conventional concrete pavements.
- Sidewalks and pathways.
- Residential streets.
- Slope stabilization.
- Well linings.
- Low water crossings

1.4 OBJECTIVES OF THE INVESTIGATION

1. To determine optimum Pervious concrete mix and finding of strength variations with plain cement concrete.
2. To determine optimum mix of modified Pervious concrete and compare strength parameters with plain Pervious concrete.
3. To evaluate and compare costs of studied mix proportions of plain cement concrete and Pervious concrete.

1.5 SCOPE OF THE INVESTIGATION

1. The present investigation addressed the strength and permeability aspects of pervious concrete mixes and also the influence of additives.
2. Only one mix proportion was investigated in detail i.e. (1:4)
3. In this experimental work, study of the compressive strength, indirect tensile strength and Flexural strength of Pervious concrete were discussed.

2.1 TEST METHODOLOGY

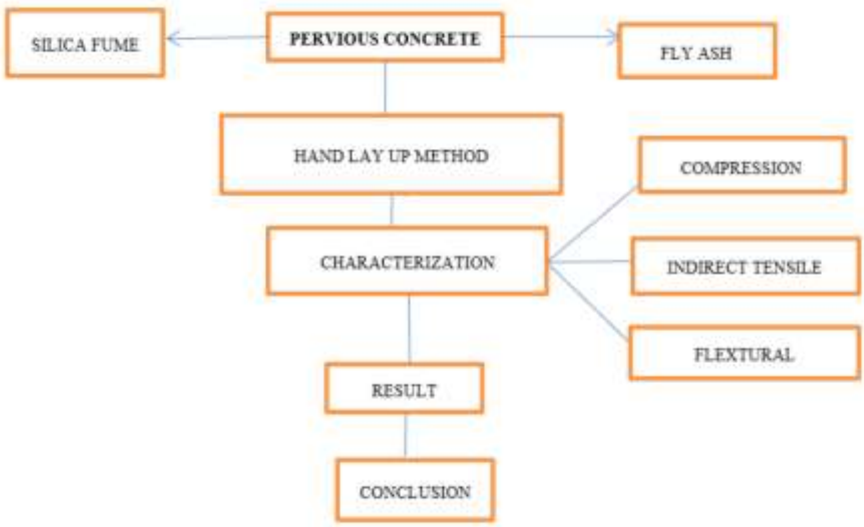
In order to develop the pervious concrete technology, trail-and-error process is implemented. The focus of the study was to identify elements that influence the mix proportions and the properties of pervious concrete. The number of aggregate ratios for the pervious concrete.

This was followed by conducting the preliminary mix design and compressive strength tests on these samples to determine the mix that performed most successfully. To determine the properties of aggregates cement and additives, laboratory investigation is carried on standard hardened concrete tests like compressive, flexure, in direct tensile, porosity and void ratio.

The proposed porous concrete design (PCD) methodology is based on fixing the target void ratio in compacted porous concrete mixtures, and dosing the raw materials focusing on the cement mortar strength and the voids in compacted mineral aggregates.It contains a content of Although porous concrete pavement design methods are mainly focused on maintaining high permeability rates in order to improve their ability to manage storm water runoff, the mixture strength is paramount for its durability and service life. The proposed porous concrete design (PCD) methodology is based on fixing the target void ratio in compacted porous concrete mixture.

Trial mixes is laid for the determination of the ratio of Aggregate, Cement and water to assess most favorable properties. For the present study, four trail mixes were designed and casted based on literature for three constituents of pervious concrete considered.

The mix designs for pervious concrete were obtained from and there were large number of different mixes that are currently being used for a whole range of applications. For this reason, four different mixes were trailed and the aggregate-cement-water ratios are as represented.



3.EXPERIMENTAL STUDIES

Trial mixes is laid for the determination of the ratio of Aggregate, Cement and water to assess most favorable properties. For the present study, four trail mixes were designed and casted based on literature for three constituents of pervious concrete considered.

Table 3.1 Compressive And Indirect Tensile Strength For Mix Proportion 1:3 (M20)

Curing Period	**Pressive Strength**	**Indirect Tensile Strength**
7 days	8.3	1.5
14 days	11.5	3.1
28 days	15.2	4.2

Fig3.1.(a) Compressive And Indirect Tensile Strength For Mix Proportion 1:3 (M20)

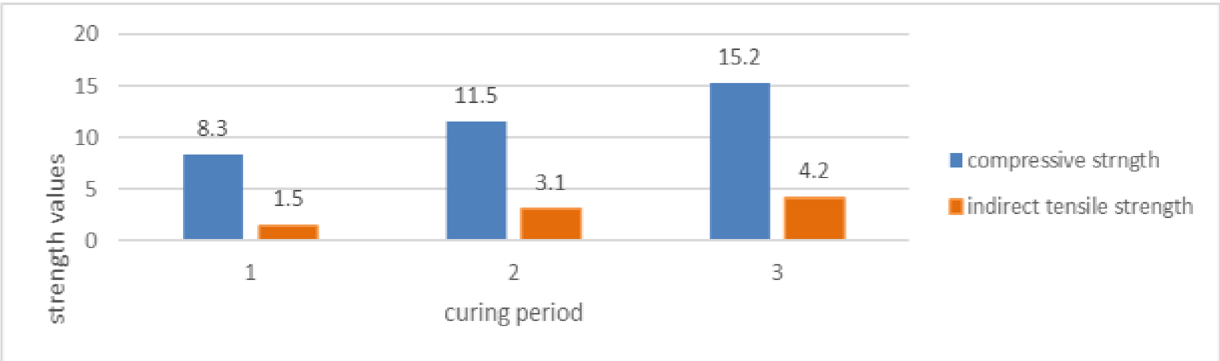


Table 3.2 Compressive Strength And Tensile Strength For Mix Proportion 1:4 (M15)

Curing Period	Compressive Strength	Indirect Tensile Strength
7 days	4.5	1.2
14 days	7.85	2.5
28 days	14.09	4

Fig 3.2 (a) Compressive Strength And Tensile Strength For Mix Proportion 1:4 (M15)

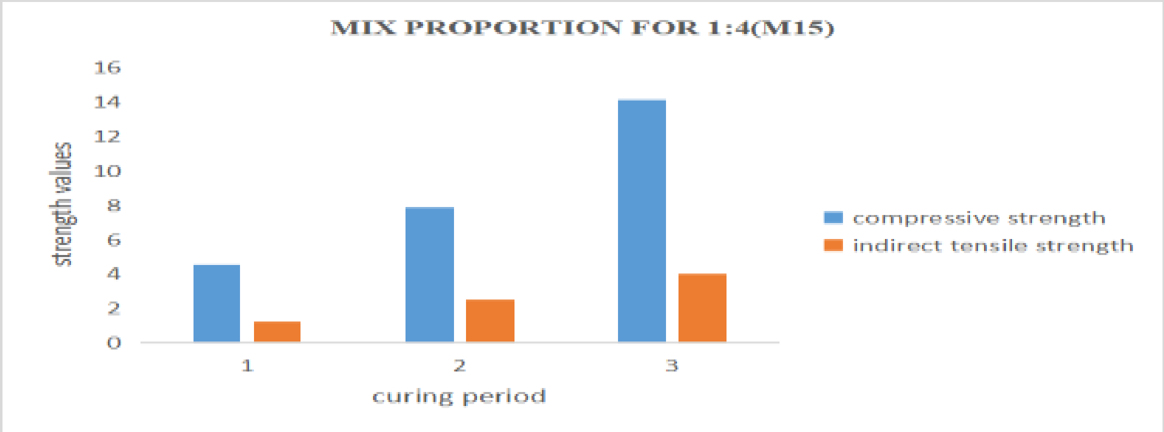


Table 3.3 Compressive Strength And Tensile Strength For Mix Proportion 1:6 (M10)

Curing Period	Compressive Strength	Indirect Tensile Strength
7 days	4.8	0.9
14 days	6.81	1.6
28 days	7.57	2.3

Fig 3.3(a)Compressive Strength And Indirect Tensile Strength For Mix Proportion 1:6(M10)

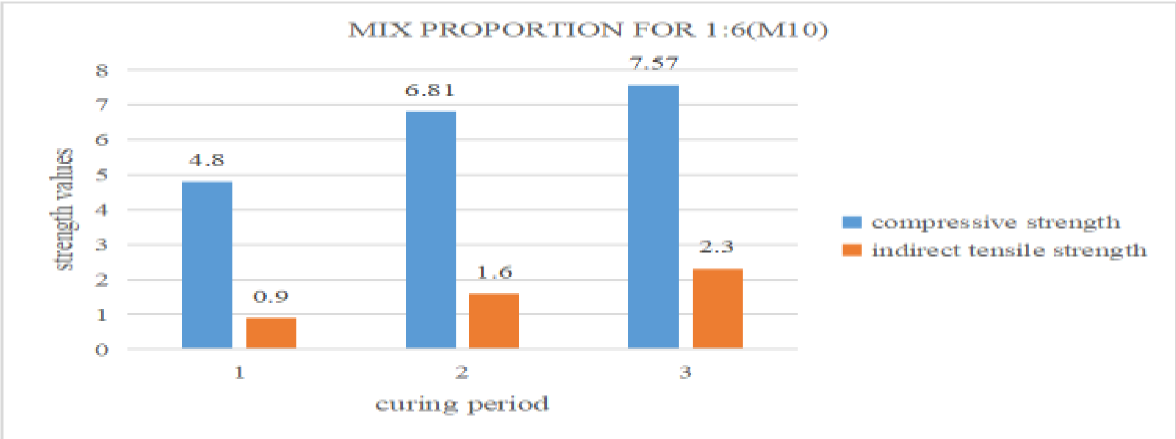
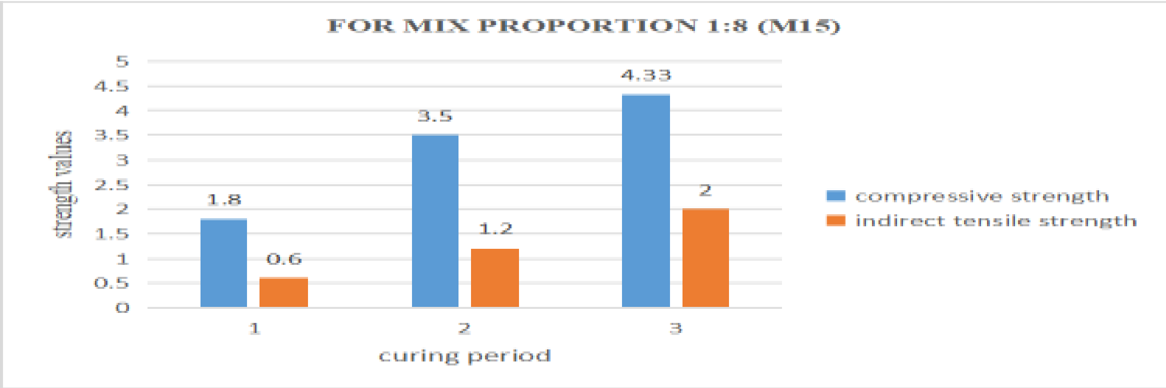


Table 3.4 Compressive Strength And Tensile Strength For Mix Proportion 1:8 (M7.5)

curing period	compressive strength	indirect tensile strength
7 days	1.8	0.6
14 days	3.5	1.2
28 days	4.33	2

fig 3.4(a) Compressive Strength And Tensile Strength For Mix Proportion 1:8 (M7.5)



The previous concrete mix design found that an aggregate- cement-water mix of 1:4,w/c of 0.3 produced the highest compressive strength and economical when compared to other mix proportions trialed. So that the **mix ratio of 1:4** and **water cement ratio of 0.3** was used for the remainder of the study.

3.2 MATERIALS USED IN THE EXPERIMENTAL WORK

The materials used in experimental work are:

- Ordinary Portland cement (OPC53)
- Coarse aggregate
- Silica fume
- Fly ash
- Water

3.3 TEST CONDUCTED FOR SAMPLES

- Compression test
- Indirect tensile test
- Flextural tests the values which are given below are modified pervious concrete with different with proportion such as 3% ,5% ,7% of silica fume and also fly ash with the percentages of 10% ,20% and 30%.

4. RESULTS AND DISCUSSION

In this, the experimental results are presented and discussed. Each of the compressive strength, indirect tensile strength and Flexural strength test data plotted in tables and figures corresponding to mean value of three samples of every test performed.

Table 4.1compressive Strength Of Modified Pervious Concrete Strength

CURING PERIOD	3% SF	5%SF	7%SF	10%FA	20%FA	30%FA
7	8.01	8.63	7.63	8.04	8.14	7.65
14	11.69	12.07	11.23	11.72	11.99	10.96
28	17.24	18.23	16.58	17.21	17.45	16.85

Fig4.1.(a)Compressive Strength Of Modified Pervious Concrete Strength

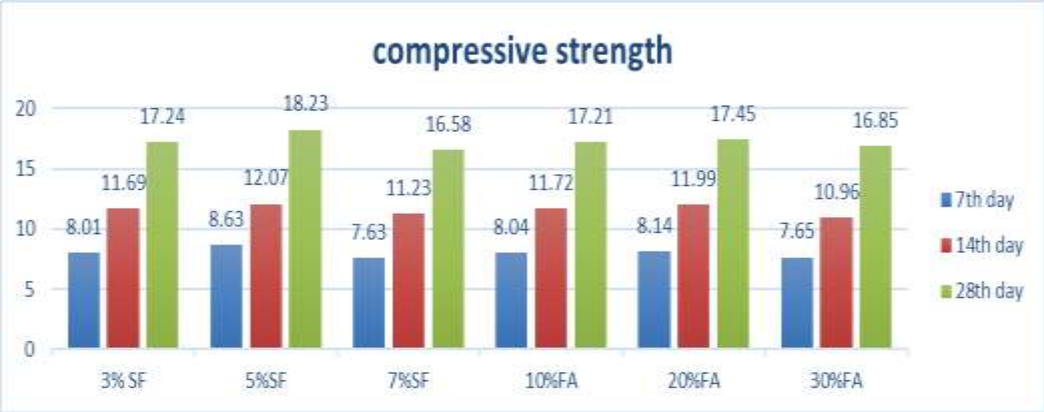


Table 4.2 .Indirect tensile Strength Of Modified Pervious Concrete Strength

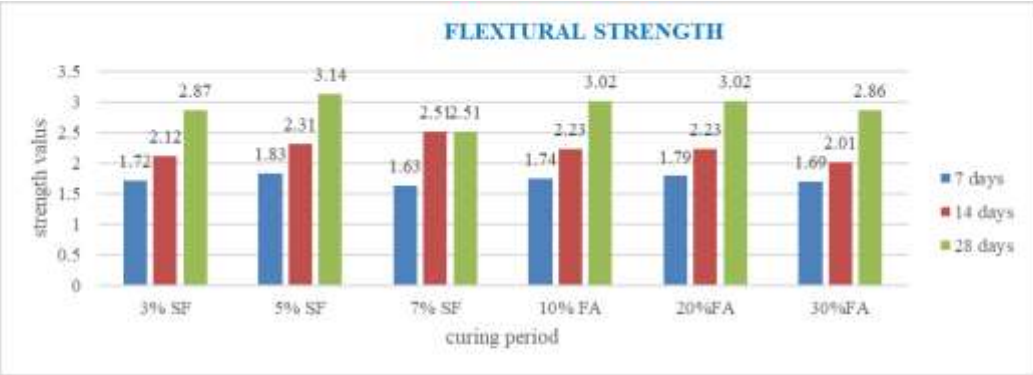
CURING PERIOD	3% SF	5% SF	7% SF	10% FA	20%FA	30%FA
7	0.76	0.95	0.67	0.83	0.89	0.79
14	0.96	1.03	0.89	1.05	1.10	1.01
28	1.27	1.42	1.25	1.37	1.40	1.31

Fig 4.2 .(a)Indirect tensile Strength Of Modified Pervious Concrete strength

Table 4.3 Flextural Strength Of Modified Pervious Concrete Strength

CURING PERIOD	3% SF	5% SF	7% SF	10% FA	20%FA	30%FA
7	1.72	1.83	1.63	1.74	1.79	1.69
14	2.12	2.31	2.51	2.23	2.23	2.01
28	2.87	3.14	2.51	3.02	3.02	2.86

Fig 4.3 (a)Flextural Strength Of Modified Pervious Concrete Strength



CONCULSION

1. A cement aggregate ratio of 1:4 is found to be optimum.
2. It is observed that compressive strength of plain pervious concrete is decreased to 7.9% than Plain Cement Concrete, whereas Plain Pervious Concrete has attained minimum strength required for desired mix proportion compared to Plain Cement Concrete.
3. Addition of 5% Silica Fume, 20% Fly Ash, is found to be optimum to cement in Plain Pervious Concrete.
4. Compressive strength on addition of optimum dosage of Silica Fume, Fly Ash, to 6.6%, 6.14%, compared to Plain Pervious Concrete mix.
5. Indirect Tensile Strength on addition of optimum dosage of Silica Fume, Fly Ash, to cement increased to 5.18%, 3.70%, %,compared to Plain Pervious Concrete mix.
6. Flexural strength on addition of optimum dosage of Silica Fume, Fly Ash, to cement increased to 2.81%, 1.40%, compared to Plain Pervious Concrete mix
7. However optimum addition (5%) of silica fume to PC exhibits higher values in terms of Compression, Indirect Tension, and Flexural as well as 3.5% increment in porosity, it is considered as the economical industrial additive used for Pervious concrete among four studied additives.

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