

AN EXPERIMENTAL STUDY ON DURABILITY AND WATER ABSORPTION PROPERTIES OF PERVIOUS CONCRETE

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Abstract

Pervious concrete is a special high porosity concrete used for flatwork applications that allows water from precipitation and other source to pass through there by Reducing the Runoff from a site and Recharging Ground Water Levels. Durability and Water Absorption are important properties of Pervious Concrete. This paper represents the experimental methodology and experimental results related to durability and water absorption. Cylinders of size 100 mm \varnothing and 200 mm height are prepared to investigate both these properties. This investigation should be carried out at the end of 28 days for water absorption and 56 days for durability in which cylinders are immersed in Sodium Chloride (NaCl) Solution after 28 days of casting. Different concrete mix proportion such as 1:6, 1:8 and 1:10 with different size of gravel such as 18.75 mm and 9.375 mm should be used to check both these properties of pervious concrete. Test results indicates that pervious concrete made by 1:6 concrete mix proportion has more durability and less water absorption and pervious concrete made by 1:10 mix proportion has more water absorption and less durability that's why durability and water absorption are inversely proportional to each other.

Keywords: Pervious concrete, porosity, durability, water absorption, sodium chloride solution

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1. INTRODUCTION

Pervious Concrete is a special type of concrete in which no fine aggregates are used and gravel has been used in place of the coarse aggregate. Pervious Concrete is a homogeneous mixture of cement, aggregate / gravel and water. Pervious Concrete is also called as “no-fines” concrete. Cylinders of size 100 mm diameter and 200 mm height are made for an experimental investigation of Water Absorption and Durability of Pervious Concrete.

Concrete Durability is one of the most important considerations in the design of new structures and when assessing the condition of existing structures. Concrete construction is becoming increasingly complex and the importance of producing structures that are both cost effective and durable has never been higher. The main purpose of durability is about minimising the rate of deterioration. Durability of Concrete is related to the design process, specification of materials, workmanship, environmental effects, accidents and repairs. In Water Absorption Test cylinders are cured in curing pond for 28 days and weighing it & % water absorption is to be determined. In Durability Test cylinders are first cured in curing pond for 28 days and then after weighing it is again immersed in “Sodium Chloride Solution” for another 28 days.

The Durability of Concrete is the resistance of concrete to weathering action, chemical attack, abrasion and other degradation processes. The Water Absorption of Concrete is the procedure that involves drying a specimen to a constant weight, weighing it, immersing it in water for specified amount of time, and weighing it again. The increase in weight as a percentage of the original weight is expressed as its absorption (in percent). The average absorption of the test samples shall not be greater than 5% with no individual unit greater than 7%.

2. EXPERIMENTAL MATERIALS

Pervious Concrete is a mixture of Cement, Coarse Aggregate / Gravel and Water. No Fine Aggregates are used for making pervious concrete. Sometimes microfibers and admixtures are used to achieve adequate strength and durability of pervious concrete. Pervious Concrete has been casted with different concrete mix proportion such as 1:6, 1:8 and 1:10 with 18.75 mm and 9.375 mm gravel size with OPC 53 Grade and PPC 53 Grade Cement.

Table 1: physical properties of ordinary portland cement 53 grade (opc) & pozzolona portland cement 53 grade (ppc)

Property	Value for Cement for OPC	Value for Cement for PPC	IS Code Recommendations IS : 12269 – 1987
Specific Gravity	3.15	2.93	3.10 - 3.15
Consistency (%)	28 %	31.5 %	30 - 35 (%)
Initial setting time (min)	35 minutes	35 minutes	30 minimum minutes
Final setting time (min)	178 minutes	230 minutes	600 maximum minutes
Compressive strength at 7 days (N/mm ²)	38.49 N/mm ²	38.49 N/mm ²	43 N/mm ²
Compressive strength at 28 days (N/mm ²)	52.31 N/mm ²	51 N/mm ²	53 N/mm ²

Source : B.V.M. Engineering College, Structural Engineering Department, V.V.Nagar, Anand

Table 2: chemical compositions of ordinary portland cement 53 grade (opc) & pozzolona portland cement 53 grade (ppc)

Oxide	Content (%) in OPC	Content (%) in PPC
Lime CaO	60-67	47.0
Silica SiO ₂	17-25	23.5
Alumina Al ₂ O ₃	3-8	12.9
Iron Oxide Fe ₂ O ₃	0.5-0.6	2.04
Magnesia MgO	0.5-4	1.74
Alkaline K ₂ O, Na ₂ O	0.3-1.2	1.05
Sulfates SO ₃	1.0-3.0	-

3. EXPERIMENTAL METHODOLOGY:

3.1 Water Absorption of Pervious Concrete: [IS: 2386 – (PART – III) 1963]

The 100 mm Ø * 200 mm height cylinder after casting will be immersed in water for 28 days curing. These specimens will then oven dried for 24 hours at the temperature 110°C until the mass became constant and again weighed. This weight was noted as the dry weight (W1) of the block. After that the specimen will be kept in hot water at 85°C for 3.5 hours. Then this weight will noted as the wet weight (W2) of the block. The percentage Water Absorption (WA) is calculated as follows.

$$\% \text{ Water Absorption} = [(W2 - W1) / W1] \times 100$$

Where,

W1 = Oven dry weight of the cylinder in grams

W2 = after 3.5 hour wet weights of cylinder in grams



Fig 1: Water Absorption of Cylinders

3.2 Durability (Sodium Chloride Solution) Test: [IS 445:2000]

For the durability test the oven dried specimens having known volume will be weighted on the digital weighing machine and calculated to the mass of specimen per unit volume.

To investigate the effect of sodium chloride solution the specimens will be tested for percentage change in weight after 28 days immersion in sodium chloride solution. Percentage change in weight determination will be carried out in the same manner as of in the water absorption test. The schedule for casting and testing are as shown in fig .

The mix proportions for preparing a pervious concrete mixture, the planning for casting the numbers of blocks and scheduling for casting and testing of pervious concrete blocks are as follows.



Fig 2: Cylinders Immersed in Sodium Chloride (NaCl) Solution

4. EXPERIMENTAL RESULTS:

4.1 Water Absorption Test: [IS: 2386 – (PART – III) 1963]

Table 3: water absorption test results for cylinder (100 mm ø * 200 mm height) with opc

SIZES OF GRAVEL	CONCRETE MIX	28 DAYS AVG % F WATER ABSORPTION
A: 3/4 inch (18.75 mm)	A1(1:6)	0.65
	A2(1:8)	0.92
	A3(1:10)	1.08
B: 3/8 inch (9.375 mm)	B1(1:6)	0.29
	B2(1:8)	0.55
	B3(1:10)	0.68

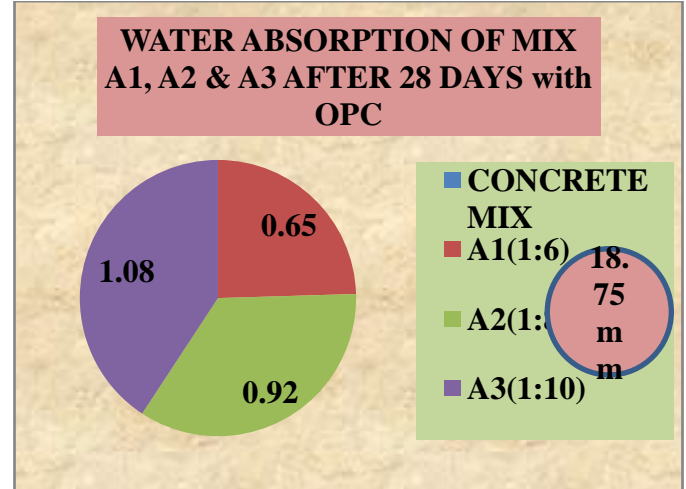


Fig 3: Water Absorption of Mix A1, A2 & A3 after 28 Days with OPC for 18.75 mm

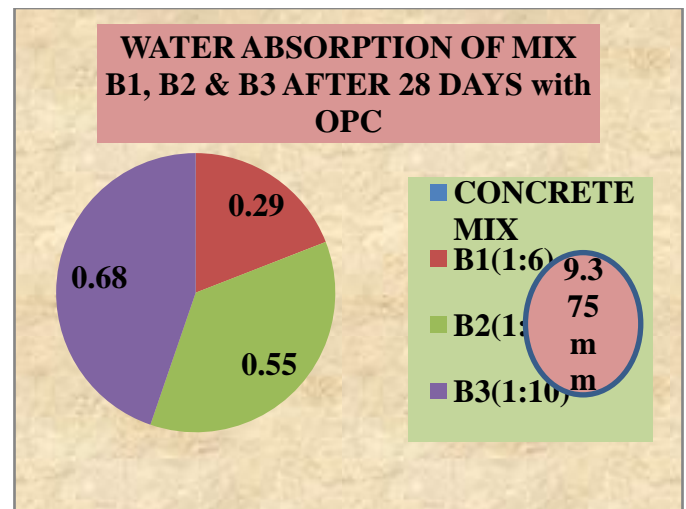


Fig 4: Water Absorption of Mix B1, B2 & B3 after 28 Days with OPC for 9.375 mm

Table 4: water absorption test results for cylinder (100 mm ø * 200 mm height) with ppc

SIZES OF GRAVEL	CONCRETE MIX	28 DAYS AVG % WATER ABSORPTION
A: 3/4 inch (18.75 mm)	A1(1:6)	0.55
	A2(1:8)	0.88
	A3(1:10)	1.04
B: 3/8 inch (9.375 mm)	B1(1:6)	0.25
	B2(1:8)	0.48
	B3(1:10)	0.56

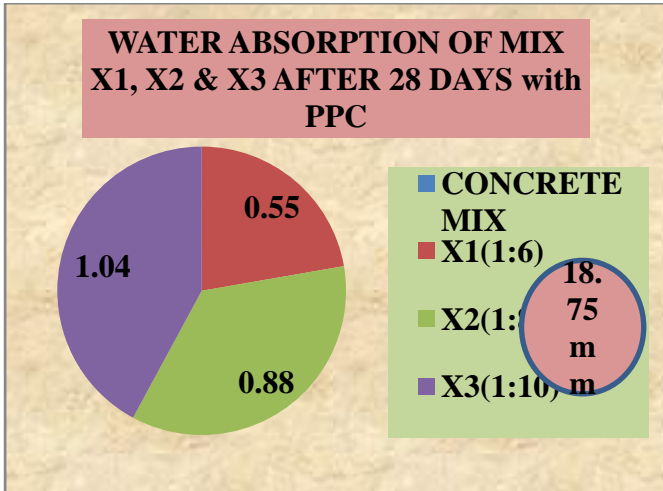


Fig 5: Water Absorption of Mix X1, X2 & X3 after 28 Days with PPC for 18.75 mm

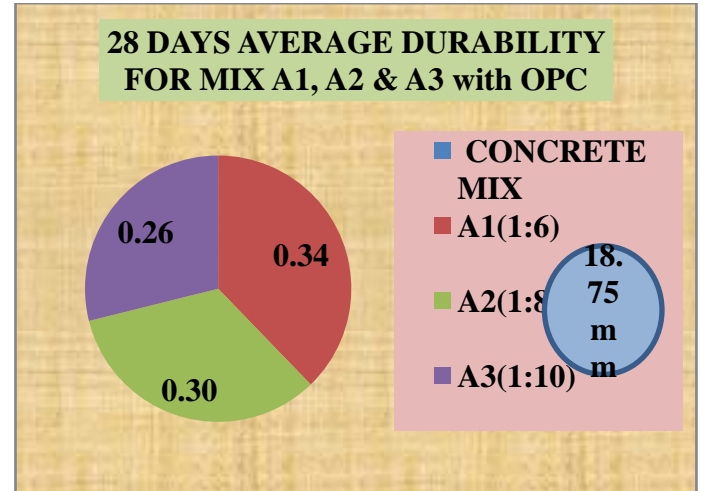


Fig 7: Durability of Mix A1, A2 & A3 after 28 Days with OPC for 18.75 mm

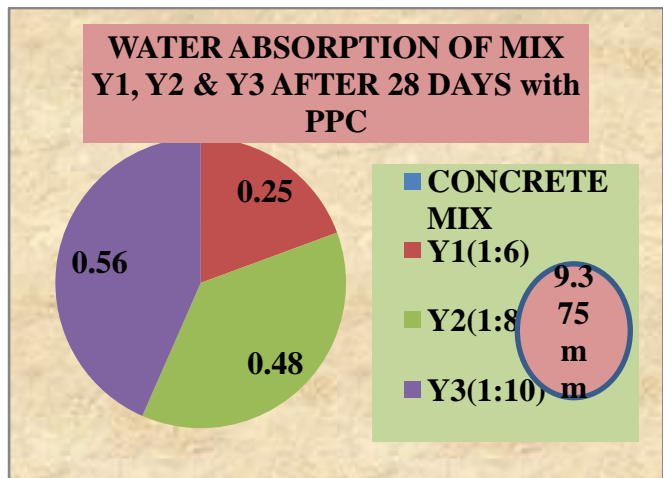


Fig 6: Water Absorption of Mix Y1, Y2 & Y3 after 28 Days with PPC for 9.375 mm

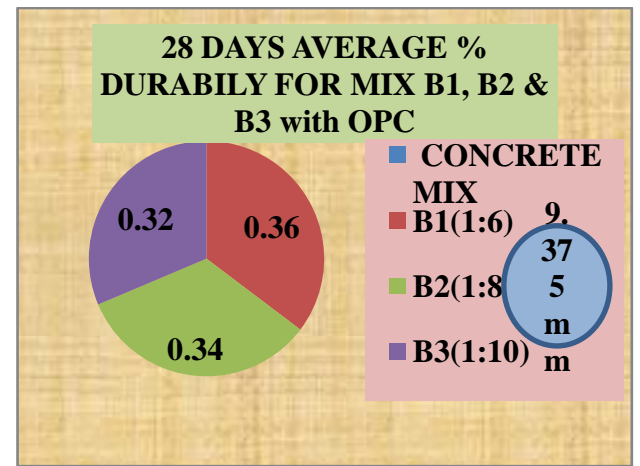


Fig 8: Durability of Mix B1, B2 & B3 after 28 Days with PPC for 9.375 mm

4.2 Durability Test: [IS 445:2000]

Table 5: durability test results for cylinder (100 mm ø * 200 mm height) with opc

SIZES OF GRAVEL	CONCRETE MIX	28 DAYS AVG % DURABILITY
A: 3/4 inch (18.75 mm)	A1(1:6)	0.34
	A2(1:8)	0.30
	A3(1:10)	0.26
B: 3/8 inch (9.375 mm)	B1(1:6)	0.36
	B2(1:8)	0.34
	B3(1:10)	0.32

Table 6: durability test results for cylinder (100 mm ø * 200 mm height) with ppc

SIZES OF GRAVEL	CONCRETE MIX	28 DAYS AVG % DURABILITY
A: 3/4 inch (18.75 mm)	A1(1:6)	0.30
	A2(1:8)	0.26
	A3(1:10)	0.25
B: 3/8 inch (9.375 mm)	B1(1:6)	0.32
	B2(1:8)	0.29
	B3(1:10)	0.27

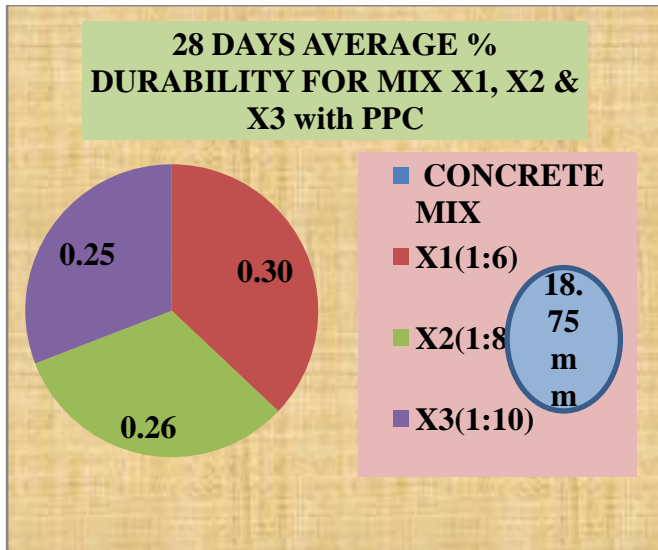


Fig 9: Durability of Mix X1, X2 & X3 after 28 Days with OPC for 18.75 mm

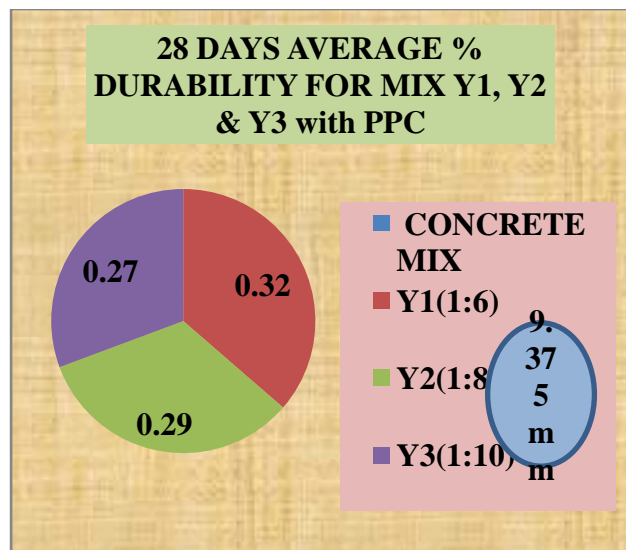


Fig 10: Durability of Mix Y1, Y2 & Y3 after 28 Days with OPC for 9.375 mm

5. CONCLUSIONS:

From the experimental result following conclusions were found out,

- 18.75 mm size gravel with 1:10 mix proportion made with OPC has more water absorption percentage value (1.08%) compared to other and similarly 9.375 mm size gravel with 1:10 mix proportion made with OPC has more water absorption percentage (0.68%) compared to other .
- 18.75 mm size gravel with 1:6 proportion made with OPC is more durable (0.34 %) compared to other and similarly 9.375 mm size gravel with 1:6 mix proportion made with OPC is more durable (0.36 %) compared to other.

- From these conclusions one main result is found out such as, water absorption and durability are inversely proportional to each other means that, concrete made by 1:6 mix proportion has more durability and less water absorption and concrete made by 1:10 mix proportion has more water absorption and less durability.

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