Experiment on Mechanical Properties of Pervious Concrete

K. S. B. Prasad, S. Lahari Anisha, N.V.L.N. Pavan Kumar

ABSTRACT--- Pervious Concrete which is also called as No-amercement Concrete is a combination of cement, water and a particular size of coarse aggregate combines to form a porous structural material. The main application of pervious concrete in pavements is for storm water control which occurs mostly in urban areas where scarcity of land is high. Permeable Pavement allows surface runoff through it and hence stops the overflow which improves ground water recharge. In this paper investigation on compressive strength, flexural strength, water permeability, density and void ratio has carried at 0.33% water cement ratio(W/C) for cement aggregate ratio (C/A)0.25 to three set of coarse aggregate(CA)sizes without fine aggregate . Summarizing that 12.5 mm (passing) to 10 mm (retained) size of aggregates has shown good results than remaining sizes for compressive strength, permeability, density and void content. Pervious cement concrete mix.

Index terms- Pervious Concrete, Permeable, high range water reducer, durability.

1. INTRODUCTION

As urbanization increases in India and also in many parts of the earthly concern there is a problem of logging of water and huge demand for drainage facility is present [1]. Pervious concrete which has feasible open spaces to provide high school permeability due to its interconnected pores allows water from precipitation and other sources to penetrate directly through and by that reduces the runoff from surface and allowing groundwater recharge. Smaller size aggregates with and without fine aggregates is used to prepare pervious concrete. Studies have been carried from past 30 years to improve ground water table and scarcity of sand.

2. EXPERIMENTAL MATERIALS AND MIX PROPORTION

2.1. Cement

In this 53 grade Deccan Cement (OPC) is used. The color of cement is gray and free from lumps. As per IS: 12269:2013. Tests are performed for cement and are according to standards.

2.2. Mix Proportion [3]

Mix	Cement (kg/cu.mt)	Aggregate (kg/cu.mt)	Water (lit/cu.mt)
Ratio	1	4	0.33
Quantity	450	1800	135

Table I: Mix proportions

Preparation of Sample and Testing:

Mechanical properties of hardened concrete are found out by performing tests of compression strength, flexural strength, porosity and permeability [1]. In order to calculate the compression strength, cylinders of dimensions 100x200 mm are used [10]. The proportions are then mixed and placed in the cylinder in two layers by giving 25 blows with a modified proctor hammer for each layer and is then kept for curing for about 7,14,28,56,91 days [3]. After the curing period, compression strength of the specimen is found out by testing it in the Compression Testing Machine ACTM.

3. FLEXURAL STRENGTH TEST

Test procedure:

The following testing procedure was undertaken during the flexural strength testing [4]:

1. The specimens for testing are prepared by molding the concrete into beams, with dimensions 500mm×15mm×15mm. support and loading has done as per IS 456-2000
2. The specimens which are cured in water are tested immediately after taking out of water; while they are still wet. The test specimen should be placed in the machine correctly by centering with the longitudinal axis of the specimen at 90^0 to the rollers. The loading direction should be normal to mould filling direction in case of molded specimens.
3. The load should be applied slowly without sudden loads at a rate so as to increase the stress at a rate of 0.06 + 0.04 N/mm^2 per second.
4. The Flexural Strength (F_b) is given by,

$$\mathbf{F_b} = P \times L/(b \times d^2)$$

Where, F_b = Flexural strength (N/mm^2),
P = maximum load in kg applied on the specimen,
L = length in cm of the span of the support.
b = width of the specimen(cm),
d = depth of the specimen(cm).

4. DENSITY AND VOID CONTENT:

Test Procedure [9] [10]:

1. Calculate the mass of each sample core to the nearest 0.1 g, and record it as "Initial Mass."
2. Initially dry the sample for 24 h ± 1 hour, and find this mass (W_D), to the nearest 0.1 g. Place the specimen in

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the oven for about one hour and note the mass again. When the difference in mass is less than 0.5 %, then constant mass is achieved. Drying in the oven should be continued until a constant mass is achieved.

3. In a bulk density tank-scale measuring system is filled completely with tap water, specimens are submerged completely, and place them straight for 30 minutes underwater.
4. After 30 minutes, keeping the specimen submerged in water, the side of the specimen is tapped 10 times with a rubber mallet. Rotate the specimen slightly after each tap so that they are equally spaced around the circumference of the core.
5. The mass of the specimen is measured to the nearest 0.1 g by submerging the specimen under water, and record it as the “Submerged Mass” (W_S)

Calculate the Porosity as follows:

$$\mathbf{P = [1 - ((W_D - W_S) / \rho_w)/V_T] \times 100}$$

5. WATER PERMEABILITY TEST:

1. Measurement of water permeability [5][9]: As pervious concrete contains large interconnected pore network, the methods that are used to evaluate the hydraulic conductivity of normal concrete are not applicable directly. In order to estimate the hydraulic conductivity of pervious concrete, a falling head permeability cell has been designed [6].
2. The permeability cell has a 300 mm long acrylic tube with an inner diameter of 110 mm. The specimen is closed in a sponge type membrane which does not absorb water. After placing the specimen in the permeability setup water will be allowed until the taken head level has filled in the graduated cylinder by closing the out let value. The head levels 22 cm difference has taken. Out valve should be released to check the time (t) taken for the water filled between head levels and measured coefficient of permeability (K)

$$K = A_1 l / A_2 * \log(h_2/h_1)$$

A1, A2 are cross-section areas of the sample and the tube. L is length of the specimen. h_1 and h_2 are initial and final heads.

Flow rate is calculated by

Q = KIA
K = permeability m/s
I = hydraluic gradient
A = cross sectional area m^2

6. RESULTS

6.1 Compressive strength:

Table II: Compressive strength of pervious concrete 06

4.75mmCA

C/A ratio	W/C ratio	CA (mm)	curing period (days)	compressive strength (N/mm^2)
1:4	0.33	6.3-4.75	28	7.96

Table III: Compressive strength of pervious concrete of 10mm CA

C/A ratio	W/C ratio	CA (mm)	curing period (days)	compressive strength (N/mm^2)
1:4	0.33	12.5-10	28	9.48

Table IV: Compressive strength of pervious concrete of 11.2mm CA

C/A ratio	W/C ratio	CA (mm)	curing period (days)	compressive strength (N/mm^2)
1:4	0.33	12.5-11.2	28	5.63

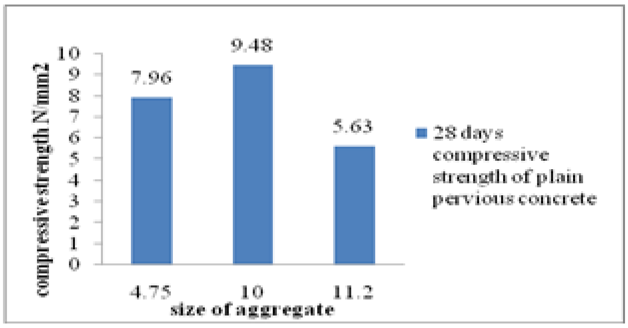

Fig 1: compressive strength of pervious Concrete of three set of aggregate sizes

6.2 Flexural strength:

Table V: shows flexural strength of 4.75 mm plain pervious concrete

Cement – aggregate ratio	Water-cement ratio	Size of aggregate (mm)	Curing period (days)	Flexural strength (N/mm^2)
1:4	0.33	4.75	28	3.03

Table VI: shows flexural strength of 10 mm plain pervious concrete

Cement – Aggregate Ratio	Water-Cement Ratio	Size Of Aggregate (mm)	Curing Period (Days)	Flexural Strength (N/mm^2)
1:4	0.33	10	28	2.44

Table VII: shows flexural strength of 11.2 mm plain pervious concrete

Cement – Aggregate Ratio	Water-Cement Ratio	Size Of Aggregate (mm)	Curing Period (Days)	Flexural Strength (N/mm^2)
1:4	0 .33	11.2	28	2.33

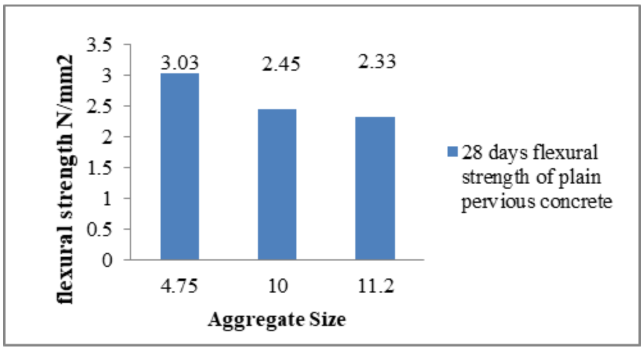

Fig 2: Flexural strength of pervious Concrete of three set of aggregate sizes

6.3 Permeability:

Table VIII: Permeability of plain pervious concrete

Size Of Aggregate (mm)	Curing Period (Days)	Permeability (m/s)	Flow Rate(m^3/s)
4.75	28	0.000796	0.00000627
10		0.00193	0.00001523
11.2		0.000842	0.0000066

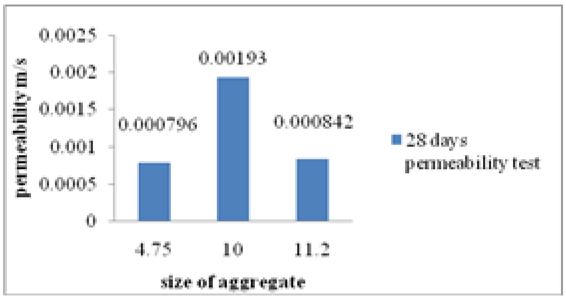

Fig 3: permeability of plain pervious concrete

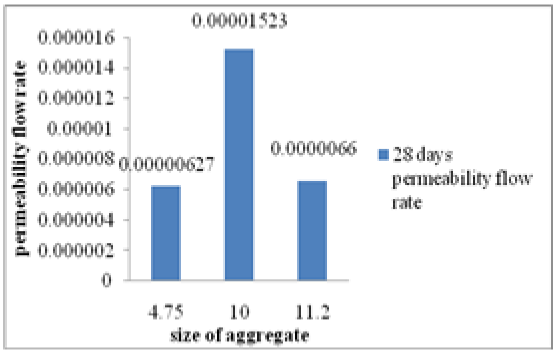

Fig 4: permeability flow rate of plain pervious Concrete

Table IX: shows 28 days' density and void ratio

Size Of Aggregate (Mm)	Initial Weight (Kg)	Oven Dried Weight (Kg)	Sub Merged Weight (Kg)	Density (Kg/m^3)	Void Ratio (%)
4.75	3.071	2.963	1.795	1886.3	23.27
10	3.23	3.118	1.915	1984.9	23.27
11.2	3.155	3.061	1.8425	1947.2	22.28

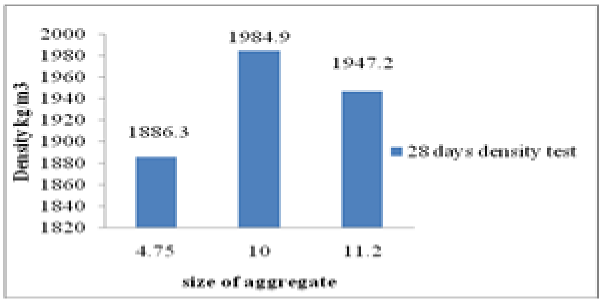

Fig 5: shows 28 days density test

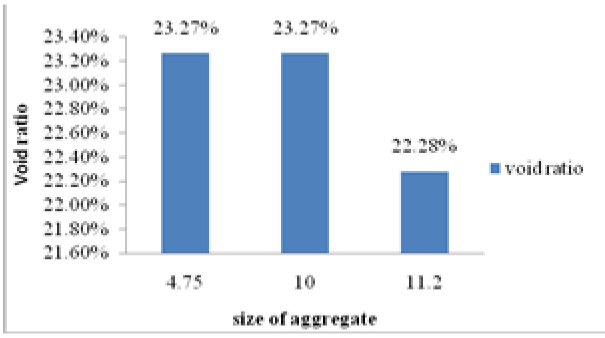

Fig 6: shows 28 days' void content

6. CONCLUSION

The compressive strength of plain pervious concrete for 10mm size is more than 4.75mm and 11.2mm. This shows that the compressive strength depends on size of aggregate. when we observe for flexural strength in the investigation above, for 4.75mm of aggregate it is higher than 10 mm and 11.2 mm.

The flexural strength is increased for 4.75 mm due to its bonding between cement and aggregates. As it is a low grade aggregate, the binding nature will be high when compared to other. In permeability test, it is observed that the permeable nature will be high in 10 mm than 4.75 and 11.2mm aggregates. For 10 mm aggregate, in the observed study the voids between the aggregates are higher than 4.75mm which is bonded packly. When coming to density and void ratio, density for 10 mm aggregate is higher than 4.75 and 11.2 mm aggregates. Density for 10mm aggregate is 1984.9 kg/m^3 which symbolizes the bonding strength between the aggregates is high when compared to other. The void ratios of 4.75mm and 10mm aggregates show similar values. As void ratio is high then the permeable nature will be high due to more void content. However, the compressive strength, flexural strength, permeability, density and void ratio of plain pervious concrete are satisfying the standards.

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