Development of Pervious Concrete For Rigid Pavement

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Abstract- *Due to Urbanization our natural surfaces are covered by impervious layer, which has led to frequent flooding and over loaded drainage systems. So to overcome such type of problems pervious concrete has attracted the attention. Pervious concrete has many more environmental benefits. Pervious concrete helps to restoring the groundwater level, control the use of storm water and also retain the pollutants on surface. Pervious concrete is also helpful to reduce the noise pollution up to some extents. Proper use of this technology will give us the best results*

Keywords- Pervious concrete, compressibility, coarse aggregate, rigid pavement.

I. INTRODUCTION

In recent times, climate change is a huge problem. Due to urbanization natural pervious layer is replaced by impervious layer. As a result, the drainage system gets overloaded causing disruption to the road transport and flooding of basement parking. While constructing any project engineer should not only consider the economics of the project but also impact on the human and natural environment. Pervious concrete has got attention in recent days because of its environmental benefits. It can be used for the construction of parking lots, low-volume roads, walkways, driveways, sidewalks and swimming pool decks. The pervious concrete pavements also serve the purpose of reducing noise pollution to some extent so they are sometimes referred to as 'low-noise road surfaces'.

The sized aggregate are bonded together by a paste formed by the cement and water. Proper volume of content should be maintained so that it should not filled the void space. Therefore a lower water-cement ratio between 0.25 and 0.5 is regulated to create channels through which water can freely flow. Coarse aggregate sizes suggested for pervious concrete range from 8 to 20 mm. The voids in the specimen should account for only 15 to 35 percent. And water cement ratio is suggested between 0.26 to 0.50.

II. OBJECTIVES

- To cast pervious concrete cubes using different aggregate sizes.
- Effect of aggregate size on compressive strength.
- Effect of aggregate size on coefficient of permeability.
- To compare pervious concrete with conventional concrete on the basis of permeability and compressive strength.

III. MATERIALS AND PROPERTIES

1. Coarse Aggregate

For the casting of pervious concrete cubes and slabs standard coarse aggregate used on regular construction size is used. The aggregates of sizes 10 mm, 13 mm and 16 mm are used in this study. The aggregates of 13 mm and 16 mm were further refined by sieving the large and medium size aggregates available. Aggregates of size 10 mm were made available from the crushing company at Yewlewadi, Pune. Specific gravity of each of the aggregates specimen is 2.97.

2. Cement

Cement is a binder material that sets and hardens. It is made up of calcareous and argillaceous materials. An early version of cement made with lime, sand and gravels was used in Mesopotamia in third millennium B.C. The technical knowledge of cement was later formulized by French and British engineers in Portland named placed in 18th century.
Birla Super cement was used for construction of pervious concrete in this project. Ordinary Portland cement of grade 53 confirming to I.S. 8112 was used. Specific gravity of cement is 3.15.

3. Water

Potable and clean drinking water available in college campus is utilised for casting and curing of pervious concrete.

IV. EXPERIMENTAL WORK

1. Mix Design:

The main aim of mix design is to enable concrete technologist to design a concrete mix for a particular strength. The concrete mix design procedure is covered in IS 10262: 2019. Here the mix design for M30 grade plain cement concrete was prepared and the mix proportion is 1: 0: 2.9.

Table 01 Per cubic meters quantities and mix proportions.

Cement	394 Kg/m^3
Water	197 Kg/m^3
Coarse Aggregate	1142 Kg/m^3
Water Cement Ratio	0.45
Ratio (C:S:A)	(1 : 0 : 2.9)

2. Workability:

Workability is that property of fresh concrete which determines the ease and homogeneity with which concrete can be mixed, placed, compacted and finished. Here the workability was observed through slump cone test. The workability test was conducted on concrete on the Mix prepared for different aggregate sizes.

Table 02: Slump values of PC mixes

	Pervious Concrete Mix Having Aggregate Size		
	10 mm (S)	13 mm (M)	16 mm (L)
Height of mould	300 mm	300 mm	300 mm
Height of slumped concrete	294 mm	296 mm	296 mm
Slump value	6 mm	4 mm	4 mm
Slump	Low	Low	Low

3. Compressive strength test:

Compression test is easy to perform and done on hardened concrete. In this test we have used the cube specimen is of the size 15 × 15 × 15 cm. The universal testing machine (UTM 1000KN) available in college laboratory was used to perform compressive strength test. All the tests were performed according to IS 516:1959.

For each of the three mixes of pervious concrete six number of readings for compressive tests are taken. Loads taken by individual cubes and averages are stated in Table 03.

Table 03: Individual loads and average load

	Pervious Concrete Mix Having Aggregate Size		
	10 mm (S)	13 mm (M)	16 mm (L)
Sample 1	612.00	663.55	582.15
Sample 2	619.25	664.55	580.30
Sample 3	625.55	640.70	611.45
Sample 4	618.10	646.00	480.90
Sample 5	609.90	635.30	471.30
Sample 6	591.80	638.00	518.50
Average Load (KN)	612.77	648.02	550.43

4. Permeability test:

Permeability test is also known as infiltration test. This test is performed on 27th day of curing of pervious cubes. The apparatus is prepared of cardboard material for measuring the coefficient of permeability of the cubes. Makings at every centimetre of the cardboard are marked. The whole tower is sealed with sticky tape for water insulation. The height of tower is 130 cm. While performing the tests the tower is placed on the concrete cube. The vertical walls of the cubes are sealed. Then water is filled inside to tower with high discharge outlet of water. The time required for water to flow from predetermined upper level of tower to lower lever in the tower is recorded.

Coefficient of permeability can be calculated by the formula stated below.

$$k = \frac{a.L}{A.t}.log_e\left(\frac{h_1}{h_2}\right)$$

where, $a \rightarrow$ cross-sectional area of standpipe
$L \rightarrow$ length of the sample
$A \rightarrow$ cross-sectional area of the specimen
$t \rightarrow$ time for water to drop from h_1 to h_2

For each of the three mixes of pervious concrete six number of readings for compressive tests are taken on two number of cubes each sample. Coefficients of permeability are mentioned in Table 04

Table 04: Observations of Permeability test.

		h_2	h_1	T
Pervious Concrete Mix Having Aggregate Size 10 mm	Sample 1	7	107	24.32
	Sample 2	9	109	20.65
	Sample 3	11	111	21.12
	Sample 4	13	113	18.41
	Sample 5	8	108	21.79
	Sample 6	10	110	21.13
Pervious Concrete Mix Having Aggregate Size 13 mm	Sample 1	7	107	20.64
	Sample 2	9	109	19.46
	Sample 3	11	111	16.90
	Sample 4	13	113	17.14
	Sample 5	8	108	20.97
	Sample 6	10	110	19.53
Pervious Concrete Mix Having Aggregate Size 16 mm	Sample 1	7	107	22.21
	Sample 2	9	109	21.48
	Sample 3	11	111	18.72
	Sample 4	13	113	19.06
	Sample 5	8	108	20.97
	Sample 6	10	110	18.24

V. CONCLUSION

The above experimental work included the compressive strength tests and permeability tests for varying size of aggregate. Here we got the maximum compressive strength for 13mm aggregate size. 10 mm aggregate has a slightly less compressive strength but greater than 16 mm due to its aggregate size. The compressive strength of aggregate size 16 mm has the least compressive strength among the 3 samples, as the compressive strength of aggregate depends on the size of aggregate.

The permeability of the concrete with 13 mm aggregate is found to be highest due to the optimum balance between number and size of voids and the aggregate size. The coefficient of permeability in this case was found to be 1.92 cm/sec. The concrete sample with larger 16 mm aggregate develops the slurry of cement at the bottom which slightlyreduces the permeability. Due to smaller size aggregates the pores will be of smaller size and lesser interconnectivity, as a result the concrete mix with 10 mm size aggregate has the least coefficient of permeability. Pervious concrete pavements are extensively used worldwide these days because of their environmental benefits, hydraulic and durability properties.

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