Experimental Study on Pervious Concrete Slabs

Shaik Niyazuddin Guntakal, Akhil Kommi, S. Senthil Selvan

ABSTRACT: ***Pervious concrete is an environmental friendly composite material which consists of cement, coarse aggregate and water. In pervious concrete, voids ratio is more compare to the conventional concrete which will helps to percolates the water through pores present in it. It is otherwise called as no fine open evaluated solid which energies ground water and further more diminish the surface water spillover. In this paper experimental investigation carried out to find out the ultimate load carrying capacity, deflection and stiffness of pervious concrete slabs. The coefficient of permeability was determined by utilizing the falling head strategy. The pervious blend is comprised of coarse aggregate size 20 mm. The axial test on slab 590 X 590 X 150 mm is used to find the load carrying capacity of slab, deflection and stiffness. The results indicate that the ultimate load carrying capacity of conventional concrete is 112 kN and the pervious concrete with 5% of M-Sand is 84 kN, where as the ultimate load carrying capacity of pervious concrete is 5% of river sand is 72kN only. This indicates that the strength of pervious concrete slab with 5% M-Sand is more with compared to River sand.***

Key words: permeability, load, deflection and stiffness.

1. INTRODUCTION

Pervious concrete which consists of no fine aggregate or some amount of fine aggregate is one of the most promising sustainable material now a days it has a zero slump value. This concrete has high void content and it is becoming popular as a storm water drainage management system. This is a natural choice in the age of green buildings. It improves ground water level and helps in reducing water lagging and water scarcity. It is a mixture of port land cement, water, coarse aggregate and chemical admixtures etc..

It helps to protect our environment by reducing the heat on the pavements, it helps to restore natural ecosystems in the world this can be a great choice in urban areas.

2. MATERIALS USED

2.1 Cement

The cement that is used is of OPC grade 53 as per the standard specifications [8]. The cement according to the Indian specification must satisfy the [IS code 12269 - 2013]. Specific gravity of cement tests were conducted and it is found to be 3.15.The results have been found confirming to IS 12269 - 2013.

2.2 Coarse aggregate

The aggregates used here are granite and the size of aggregate IS383-970[7,13] is 20mm. the specific gravity of the coarse aggregate used in this experimental investigation is 2.75. The aggregates are tested as per IS2386-1963(I,II,III)[14] specifications.

2.3 M-Sand

Manufactured sand is created from hard rock stone by squashing. The squashed sand is of cubical shape with grounded edges, washed and assessed to as an important material. Specific gravity of the M-sand 2.75.

2.4 River sand

The river sand is product of natural weathering of rock from many million years. It is present in the river beds. It is used for the construction purposes. The specific gravity of the river sand is 2.60[8].

2.5 Water

Water is essential element of concrete as it really taken an interest in the substance response with bond. Water utilized for blending and relieving like oils, acids, soluble bases, salt, sugar, natural materials or different materials that might be destructive to cement or steel. pH estimation of the water utilized in cementing will not be under 6 – 8 [9]. Henceforth common clean consumable water free from suspended particles was utilized both for blending and relieving of the solid examples.

3. NEED OF STUDY

Pervious concrete is one of the successful techniques to decrease storm water spillover and to energize ground water. This research in unique in a way by testing on axial test and using M-sand to it, M-sand is less of cost and the availability is more. The Experimental result shows the difference between the strength and permeability of conventional, M-sand and River sand. The main aim is to know the strength of the conventional slab and pervious slabs with replacing of fine aggregate and permeability of pervious concrete simultaneously.

4. EXPERIMENTAL PROCESS

The materials used are OPC 53 grade coarse aggregate of 20 mm size,5% of River sand and 5% of M-sand as fine aggregate the mix ratio is 1:2.5.

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Table 1 Specific gravity Properties of material used

Properties	Values
coarse aggregate	2.75
cement	3.15
River sand	2.60
M-sand	2.75
Initial setting time	45 minutes
Final	60 minutes

4.1 Mix proportions

To achieve the target strength of the concrete structure it is recommended to use the mix design processor for finding the right properties of cement, sand and aggregate, the mix design stated as Concrete Mix = Cement: Sand: Aggregates.

The pervious concrete was designed with conventional, river sand and M-Sand and different test were carried out. Slabs dimensions are (590 X 590 X 150 mm) done for the axial test. The variations during compaction, like high compaction and light compaction with hand, the slabs are made with only 5% of fine aggregate and water cement ratio is 0.30 it should not exceed from 0.38 in pervious concrete [1].

The thickness of the slab was referred from the code IRC-21(Road bridges section code) and from a paper [10, 4].

Table 2 Pervious concrete mix proportions

Mix name	OPC 53 grade cement	Coarse aggregate	Fine aggregate	Water content
C	1	2.83	1.283	0.3
M1	1	1.68	0.83	0.3
M2	1	1.68	0.83	0.3

*size of the coarse aggregate is 20mm

The above table shows the mix proportions of different fine aggregates and used for conventional and pervious slabs. The quantity of Conventional and pervious are different.

Where,

C Conventional concrete.

M1 Pervious concrete with 5% M-Sand + 0.3 water cement ratio.

M2 Pervious concrete with 5% River sand + 0.3 w/c ratio.

4.2 LOAD

The load test was done for 7 days test on slab and the dimensions of the specimen is 590 X 590 X 150 mm [10, 4].

4.3 Deflection

The deflection of a uniform loaded flat slab where bottom is fixed and applied the load on the top and by using the dial gauge on the bottom, so that we can know how much deflection we are getting.

4.4 Permeability

The permeability test was done by using falling head method. Permeability is calculated by taking time as a varying factor. The size of slab is taken as 590 X 590 X 150 mm, were casted and tested for 28 days [10,4].

4.5 Properties of mix

The quantities of all the required ingredients were taken by batching, with the appropriate fractions and the casting of slabs is done, and checked the permeability test with the help of Falling head method [6].

Figure 1 Conventional slab

Figure 2 Pervious slab

Figure 3 Axial load test

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Figure 4 Deflected shape of slab

4.6 Testing of specimens

After casting of the slabs they were kept in curing tank for 7 days and 28 days, after 7 days and took the specimens out for allowing the surface moisture to drain and done axial test on slab to find the load, deflection and stiffness, after 28 days the permeability test on the slabs was done by using the falling head method.

Stiffness = Load/ deflection

Permeability K $\frac{A_1 l}{A_2 t} log \frac{h_2}{h_1}$

Where, K Permeability of water

A_1 Cross section area of the specimen (590 mm)

A_2 cross section area of the tube (590 mm)

l length of the specimen (590 mm)

t time 30, 60, 120, 150s

h_1 initial water head (300 mm)

h_2 final water head (1 mm)

$$K = \frac{590 \times 590}{590 \times 30} log \frac{1}{300} = 48.7\ mm/s$$

5. RESULTS AND DISCUSSION

5.1 Strength characteristics

The load, deflection, permeability and stiffness done with different materials. The specimen's size is same for the three tests. The percentage of fine aggregate used is 5% and water cement ratio 0.3% and compared with conventional slab in terms of strength and permeability.

S. No	Coding	Axial test		
		Load (KN)	Deflection (mm)	Stiffness (KN/mm)
		7 days	7days	7 days
1	C	112	6.18	18.122
2	M1	84	8.03	13.45
3	M2	72	6.25	11.52

Table 3 Axial test on the slab

The table shows the load, deflection and stiffness values for conventional concrete and for pervious concrete with River sand and M-Sand. Result shows that conventional concrete is having more strength.

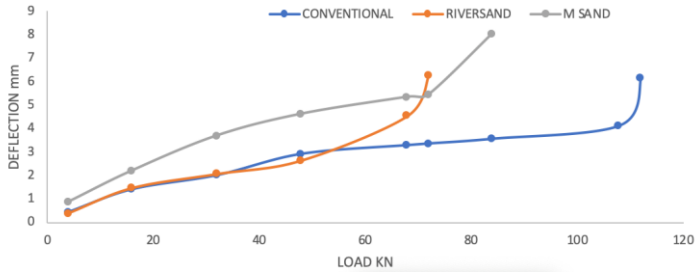

Figure 1 Axial test

The figure shows the load and deflection of the conventional concrete slab, pervious concrete with 5% of River sand as fine aggregate and 5% of M-sand.

Trials	Time (sec)	w/c	Permeability (mm/s)	Conventional (mm/s)
1	30	0.3	48.7	5
2	60		24.3	0
3	120		12.17	0
4	150		9.74	0

Table 4 Permeability test for the pervious concrete slab by using Falling head method

The above table shows the permeability of the pervious concrete slab with 5% of M-sand and water cement ratio as 0.3. The experiment shows that when the time increases the permeability increases.

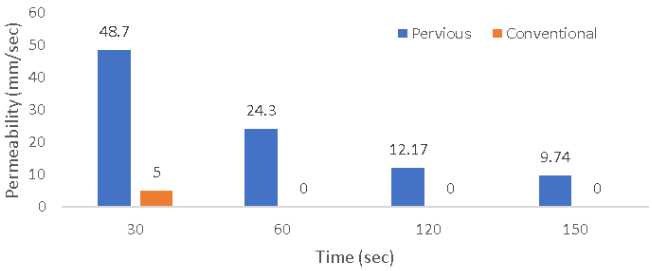

Figure 2 Permeability test for the pervious and conventional concrete slab by falling head method

The figure shows the falling head method of the pervious concrete and conventional concrete slab. The pervious concrete has porosity so it will have permeability and conventional concrete absorb water initially and after some time period, permeability of conventional concrete becomes zero.

6. CONCLUSION

Having gone through the testing of various samples of pervious concrete with percentage variation of fine aggregate, the following points were drawn,

- The conventional concrete slab is having more strength than the Pervious concrete slab.
- The pervious concrete will get more permeability and in the conventional we will not have permeability.

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- When compared to M-sand and River sand, the M-sand is more strengthen than River sand.
- The availability of M-sand is more than River sand and the strength also will be more.
- It is able to capture the storm water and recharge the ground water
- It is having the required void ratio for the water seepage.
- If the voids increases the load and deflection decreases.
- The above result shows the replacing of 5% fine aggregates has more permeability compared to conventional concrete.

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