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Performance of pervious concrete pavement

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Abstract
Pervious concrete (also called porous concrete, permeable concrete and no fine concrete) is a special type of concrete with a high porosity used for concrete flat work applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing the ground water recharge. Pervious concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab, pervious concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways and green houses. It is an important application for sustainable construction and is of many low impact development techniques used by builders to protect the water quality. Pervious concrete has been increasingly used to several sustainability-relative benefits offered by this material. Pervious concrete includes other environmental benefits such as reduced noise generated by tire-pavement interaction, reduced urban heat, minimized road splash, improve skid resistance, recharge of ground water table, reduced storm water runoff, limited pollutant penetration into the ground water and preservation of native eco system. In this paper it is discussed about the properties of pervious concrete like compressive strength, split tensile strength, permeability factor and Comparison between pervious concrete and normal concrete.

Keywords: pervious, between, comparison, environmental, strength

1. Introduction

1.1 General: Pervious concrete (also called porous concrete, permeable concrete and no fine concrete) is a special type of concrete with a high porosity used for concrete flat work applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing the ground water recharge. Pervious concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab, pervious concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways and green houses. It is an important application for sustainable construction and is of many low impact development techniques used by builders to protect the water quality. Pervious concrete has been increasingly used to several sustainability- relative benefits offered by this material. Pervious concrete includes other environmental benefits such as reduced noise generated by tire-pavement interaction, reduced urban heat, minimized road splash, improve skid resistance, recharge of ground water table, reduced storm water runoff, limited pollutant penetration into the ground water and preservation of native eco system. Despite these benefits, the potential for lower compressive strength, clogging, raveling and sustainability to freezing and thawing damage, have limited use of pervious pavements in cold climatic conditions when compared to conventional concrete pervious concrete exhibits sustainability, because of its properties. Some notable characteristics of pervious concrete are lower unit weight and drying shrinkage, higher permeability, higher thermal insulation, lower compressive, tensile and bond strength, lower pressure on frame work during construction sand long curing time required prior to form removal, elimination of capillary attraction and economic in materials.

Pervious concrete is a unique cement based product whose porous structure permits free passage of water to the concrete and into the soil without compromising the concretes durability or integrity. Pervious concrete is a composite material consisting of coarse aggregate, Portland cement and water. It is different from conventional concrete in that it contains no fines in the initial mixture, recognizing however, that fines are introduced during the compaction process. The aggregate usually consists of single size and is bounded together at a point of contact by a paste formed by the cement and water.

Fig 1

Fig 2: Pervious concrete

2. Objectives

- To develop a strong and durable pervious cement concrete mix using different types of aggregates with varying the quality of fine aggregates.
- In the present investigation M sand is used. The percentage of fine aggregates used in PCC mix is 15%. The properties of PCC mixes investigated are compressive strength, flexural strength, permeability and clogging potential.
- The effects of varying the components of pervious concrete on its compressive strength are investigated. The goal is to achieve a maximum compressive strength without inhibiting the permeability characteristics of pervious concrete pavement.
- This will be accomplished through extensive experiments on the test cubes created for this purpose. Experiments include specific gravity test, permeability, compressive test and infiltration test.
- To determine the influence of fine aggregate and coarse aggregate quantities and properties of pervious concrete.
- To evaluate the performance characteristics of the pervious concrete such as porosity, compressive strength, infiltration and density.

3. Advantages

- Reduces the size and sometimes the need for storm water runoffs.
- Recharges the ground water level.
- Allows for the natural treatment of polluted water by soil filtration.
- Does not create heat islands due to its light color.
- Reduces risk of flooding and top soil wash away.
- Improves the quality of landscaping and reduces the need for watering Safety.
- Reduces tire noise.
- Due to open interconnected air void structure, pervious concrete has been found to act as an effective acoustic absorbent. The tire noise generated between tire and pavement is lower with pervious concrete as compared to conventional concrete or blacktop.
- Prevents glare.
- Pervious concrete allows the water to flow freely through the surface which reduces glare, especially at night when the road is wet.
- Reduces hydroplaning and flooding.
- When pervious concrete is designed correctly all the precipitation should be absorbed by sub-grade or diverted away from pavement by a drainage system (in case of low absorption sub-grade). This results in reduced flooding and a puddle- free surface, eliminating hydroplaning.
- Reduces or eliminates the need for storm sewers or retention ponds.
- Increases facilities for parking by reducing water retention areas.
- Increases permeable area and may qualify for permeable area credit.
- Recognized by Leadership in Energy and Environmental Development (LEED).
- Requires less costly repairs than black top.
- Longer service life and lower life cycle.

4. Methodology

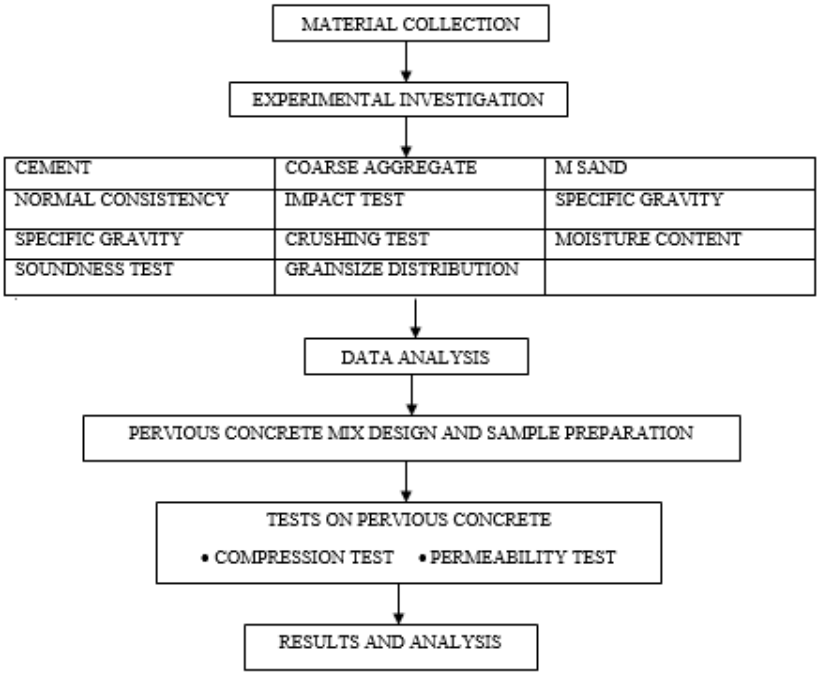

Fig 3

5. Materials, its properties and mix design

Materials: Ordinary Portland Cement (OPC), Coarse Aggregate, Fine Aggregate, water.
Mix Proportioning: Mix design is done as per IS 10262:2009 and mix portions are tabulated.

Table 1

Cement	Water	Fine Aggregate	Coarse Aggregate
1	0.4	0.5	3

6. Experimental investigation and result

6.1 Slump TEST

Table 2: Slump test results

Water/Cement ratio	Slump in mm
0.4	80

6.2 Compressive Strength: Compressive test were carried to specimen of 150x150x150 after 3,7,14,21,28 days of curing with both water and carbon curing method. The compressive strength of the cube is calculated as:
Compressive strength=[P/(150x150)] N/mm^2

Table 3: Compressive strength results

No of Days	Compressive Strength C= L/A in N/mm^2
7	8.58
14	9.2
28	11.28

6.3 Split Tensile Test: The split tensile strength of the cylinders is calculated as follows
Split Tensile Strength = [2P/(π*r*h)] N/mm^2

Table 4: Split Tensile strength results

No of Days	Split Tensile Strength T=L/A in N/mm^2
7	1.2
14	1.5
28	1.8

6.4 Permeability test: Quantity of water that flows under a given hydraulic gradient through a concrete block of a known dimensions and cross sectional area in a given time. water is allowed to flow through cylindrical sample of a concrete block under a constant head.
Procedure

1. For the constant head arrangement, the specimen shall be connected through the top inlet to the constant head reservoir.
2. Open the bottom outlet.
3. Establish steady flow of water.
4. The quantity of flow for a convenient time interval may be collected.
5. Repeat three times for same interval.

Table 5: Permeability Test Results

Sl.no	Water in ml	Infiltration rate
1	100ml	12.9sec
2	100ml	12.3sec
3	100ml	12.1sec

7. Comparisons and results

- The percentage decreases in compressive strength in pervious concrete is 50 - 75% compared with conventional concrete.
- The percentage decreases in split tensile test in pervious concrete is 45-50% compared with conventional concrete.
- The percentage of void ratio is increased to 4% in pervious concrete as compared with conventional concrete. So that the permeability is also high.

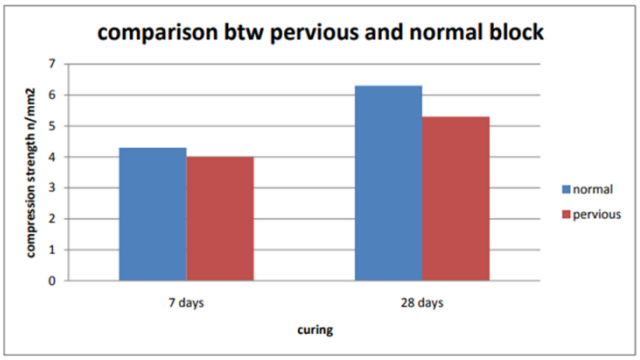

Fig 4: Comparison between compressive strength of pervious and normal Concrete.

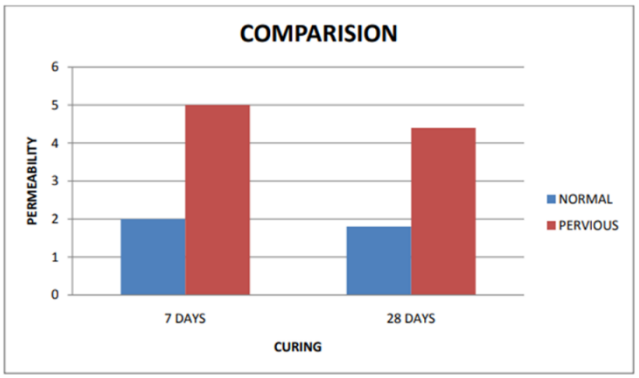

Fig 5: Comparison between permeability of pervious and normal concrete.

8. Conclusion and summary

8.1 Specific Conclusion: The following conclusions are drawn based on the experimental investigation on compressive strength, split tensile and permeability considering the environmental aspects also.

- Pervious concrete has less strength than conventional concrete by 14.5% for M20.
- Similarly the split tensile strength values are also comparatively lower than the conventional concrete by 30%.
- The smaller size of the coarse aggregate should be able to produce a higher compressive strength and at the same time produce a higher permeability rate.
- The mixtures with higher aggregate/cement ratio are considered to be useful for pavement that requires low compressive strength and high permeability rate.

8.2 General conclusions

- It is evident from the project that no fines concrete has more coefficient of permeability. Hence, it is capable of capturing storm water and recharging the ground water. As a result, it can be ideally used at parking areas and at

residential areas where the movement of vehicles is very moderate.

- Further, no fines concrete is an environmental friendly solution to support sustainable construction. In this project, fine aggregate as an ingredient has not been used presently.
- Use of this concrete can effectively control the run off as well as savings the finances invested on the construction of drainage system.

8.3 Summary

Pervious concrete pavement was investigated in laboratory environments to study infiltration rates of pervious concrete after years in service and to determine the effectiveness of various pervious concrete maintenance methods. In addition, construction specifications for use in the placement of pervious concrete were developed. A literature search was conducted and data collected from the laboratory explorations.

In addition to the data collection we conducted Basic tests and tests on Pervious concrete. Compression test was conducted to analyze the property of materials used in our project. For the Permeability test apparatus was not available, we have conducted the percolation rate by ourselves.

Pervious pavement layers can be adopted everywhere in all the cities, where the traffic flow is less. It maintains storm water to percolate and recharges ground water table. It is very useful in the cities like Bangalore to adopt these techniques to generate the water to the locality. Helps in maintaining the pavement clean and do not clogs.

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