

Permeable Concrete-An Innovative Solution for Groundwater Replenishment

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ABSTRACT: Impervious surfaces are the surface covered with impermeable materials and doesn't allow water to infiltrate the ground. When rainwater falls on such surfaces either it directly gets discharged into streams or gets flooded if no proper drainage is provided. This rainwater carries dust particles on impervious surface along with it and causes pollution in stream and affects aquatic life. Such surfaces also result in increased water scarcity and surface temperature. Permeable concrete is a cost effective and quick solution to make a surface pervious. A permeable concrete membrane is laid on the top surface and drainage pipes are provided within the sub-base layer. The water which is collected in outlet pipe can either be used for non-potable application or else discharged to streams. Permeable concrete pavements can be provided in light traffic areas, parking lots and pedestrian walkways. This paper deals with effectiveness of using permeable concrete as an innovative solution for groundwater replenishment on basis of certain experiments conducted. This is an application for sustainable construction.

KEYWORDS: Impervious surfaces, Permeable concrete, Drainage, Sustainable.

I. INTRODUCTION

Environmental issues like water scarcity and increase in temperature are mainly due to poor rainwater infiltration and collection of solar heat by pavement surfaces. These issues are correlated with impermeable surfaces. Such surfaces are covered with impenetrable materials. It restricts rainwater infiltration and groundwater replenishment and collects a large amount of solar heat.

Permeable concrete is a quick and effective solution to convert impervious surfaces to pervious. It is composed of coarse aggregate, cement, water and no fines. Since no fines are used it is highly porous and on the other hand it is of low strength. It cannot be provided in areas with heavy traffic instead it can be used in light traffic areas, parking lots, pedestrian walkways etc. A permeable concrete membrane is laid on the top surface and drainage pipes are provided within the sub-base layer.

This paper deals with effectiveness of using permeable concrete as an innovative solution for ground water replenishment. Some important properties of the permeable concrete were studied on basis of certain experiments conducted. For the investigation, size of aggregate used is 10-20mm. Three sets of w/c ratios were used 0.3, 0.35 and 0.4. Aggregate cement ratio used was 4:1.

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II. EXPERIMENTAL PROCEDURE

1. Workability

Workability is defined as the ease with which concrete can be mixed, transported, placed and cured. The workability of permeable concrete can be found by slump test.

2. Compressive strength

Compressive strength is the strength by which a gradually applied load can be resisted without failure. The compressive strength is calculated by testing the cubes for 7 days and 28 days curing.

3. Permeability test

Permeability is the property which allows water to flow through. Permeability can be determined by falling head method for 150 x 150 mm cylinder casted in PVC pipe.

4. Void content

Void content is defined as the percentage of air voids present in a specimen by volume.

$$\text{Void content} = \frac{\text{Theoretical density} - \text{Density}}{\text{Theoretical density}}$$

5. Density

Density of permeable concrete has been evaluated by ratio of weight of cube to the volume.

$$\text{Density} = \text{Mass/Volume}$$

III. RESULTS AND DISCUSSION

Table.1. 28 days results for various properties

Sl. No.	Water cement ratio	compressive strength at 28 days curing (N/mm ²)	permeability (mm/s)	Void content (%)	density (kg/m ³)
1.	0.4	6.67	21.74	18.62	1925.33
2.	0.35	4.22	22.12	19.80	1669.19
3.	0.3	2.44	23.14	22.11	1606.52

1. Compressive strength

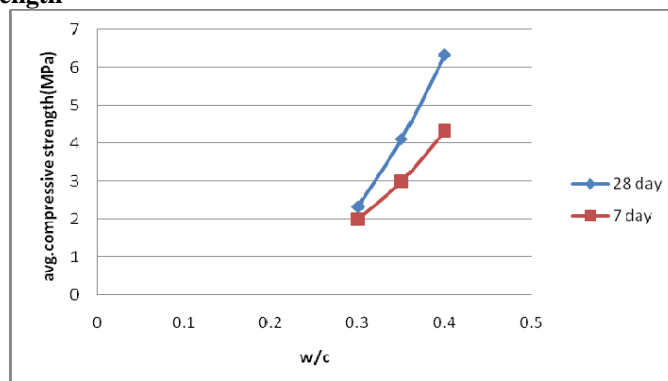


Fig.1. Compressive strength vs w/c ratio

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Compressive strength of permeable concrete is more for w/c ratio 0.4. As per ACI 522R-10 compressive strength of permeable concrete ranges from 2.8 MPa to 28 MPa. Compressive strength increases with increase in size of aggregate and w/c ratio.

2. Permeability

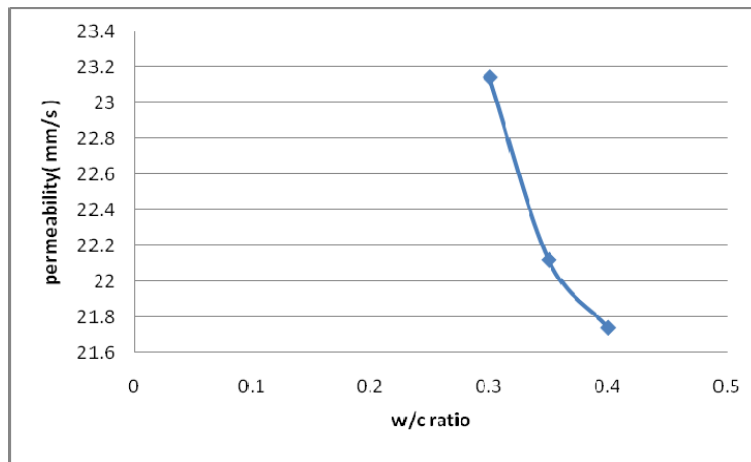


Fig.2. Permeability vs w/c ratio

Permeability of permeable concrete is more for w/c ratio 0.3. Permeability of permeable concrete is within the range 2 to 30 mm/s. Permeability reduces with increase in size of aggregate and w/c ratio.

3. Void content

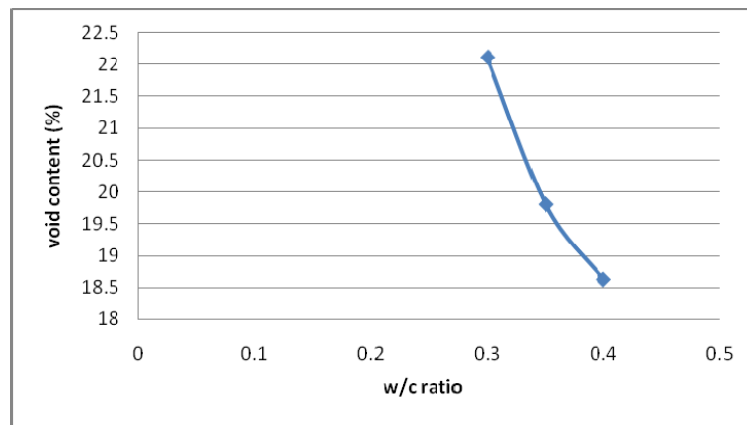


Fig.3. Void content vs w/c ratio

Void content of permeable concrete is more for w/c ratio 0.3. As per ACI 522R-10 void content of permeable concrete lies in the range 15 to 35%. Void content reduces with increase in size of aggregate and w/c ratio.

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4. Density

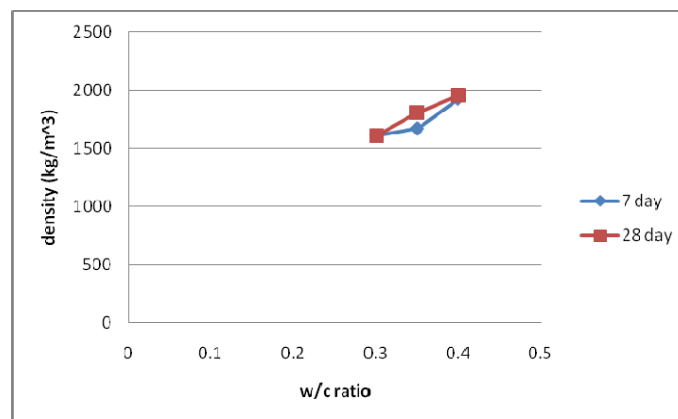


Fig.4. Density vs w/c ratio

Density of permeable concrete is more for w/c ratio 0.4. Density of permeable concrete is within the range 1600-2000 kg/m³. Density increases with increase in size of aggregate and w/c ratio.

IV. CONCLUSION

The following conclusions are obtained from experimental investigations.

- Compressive strength of permeable concrete increases with increases with increase in water cement ratio.
- Permeability of permeable concrete increases with reduction in water cement ratio.
- Void content of permeable concrete increases with reduction in water cement ratio.
- Density of permeable concrete increases with increase in water cement ratio.
- Permeable concrete increases infiltration rate and thus it is an innovative solution for groundwater replenishment.

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