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RECHARGE OF GROUND WATER THROUGH PERMEABLE PAVEMENT

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Abstract— Permeable pavement typically consist of pervious concrete, porous asphalt, permeable interlocking concrete paving units or grid type systems over an open – graded base sub-base layers. Permeable pavements infiltrates storm water reduces peak flow, filter and clean contaminants and promote ground water recharge.

Pervious concrete is a porous type of concrete which is widely used nowadays for construction work and for permeable pavement. Since authors noticed that less quantum of research is carried out on this topic hence out of motivation this work under consideration is carried out. In many developed countries, the use of pervious concrete for the construction of pavement, car parks and driveways is becoming popular. In order to develop material specification for pervious concrete, it is necessary to conduct testing to evaluate its performance. Pervious concrete is a zero-slump, open graded material consisting of hydraulic cement, coarse aggregate and water. Because pervious concrete contain little or no fine aggregates such as sand, it is some time referred to as "no-fine" concrete. To achieve the porous concrete ordinary Portland cement is used.

Keywords— Pervious concrete, no-fine concrete, Groundwater Recharge, Permeable pavement, Infiltration

I. INTRODUCTION

.Permeable concrete is a homogenous mixture of cement, aggregate, water and little or no sand which create an open cell structure that's allow the flow the water to pass through it. Pervious concrete is a mixture of 10mm to 12.5mm average size of aggregate, cement, other cementitious material and water. Conventional normal weight Portland cement is generally used for pavement construction. The impervious nature of concrete pavement contributes to increase water runoff into drainage system overburdening the infrastructure and causing excessive flooding in a built up areas.

II. LITERATURE REVIEW

David Thorpe, Yan Zhuge, 8 September 2010

To determine the performance of different pervious concrete mixtures to achieve an optimized mix with adequate tensile strength and porosity. The mix design included the study of aggregate cement ratio, aggregate gradation and cementing materials blends were examined. Single and hybrid fiber systems were also calculated. These included wollastonite natural fibers and polypropylene macro-fibers. Modifications to the permeability test proposed by AC1522R, pervious concrete were made to evaluate permeability of the specimens.

A.K. Jain, Dr. J.S. Chouhan, S.S. Goliya, Dec 2011
This paper presents the laboratory results of the study undertaken to determine the effect of shapes and size of aggregate on permeability of pervious concrete. Shape of aggregate is measured in terms of their angularity number. Angularity or absence of rounding of the particles of an aggregate is an important property because it affects the porosity, surface area in contact with each other in the matrix of ingredients and ease of handling of a mixture of aggregate and binder. The result indicates that permeability of pervious concrete vary as a function of angularity number of aggregate used. It is also found that for all sizes of course aggregate used in the study, aggregate with less angularity number produce mix having less permeability.

Darshan S. Shah, Prof.JayeshkumarPitroda, Prof.J.J.Bhavsar, Aug 2013
Pervious concrete is a relatively new concept for rural road pavement, with increase into the problems in rural areas related to the low ground water level, agricultural problem. Pervious concrete has introduced in rural roads as a road pavement material. Pervious concrete as a paving material has seen renewed interest due to its ability to allow water to flow through itself to recharge ground water level and minimize storm water runoff. This introduction to pervious concrete pavements reviews its applications and engineering properties, including environmental benefits, structural properties and durability. In rural area cost consideration is a primary factor which must be kept in mind. So that in rural areas costly storm water management practices is not applicable. Pervious concrete pavement is a unique and effective means to meet growing environmental demands. By capturing rain water and allowing it to seep into the ground. This pavement technology creates more efficient land use by eliminating the need for retention ponds, swell, and other costly storm water management devices

III.EXPERIMENTAL PROGRAMME

3.1 Materials used

In this experimental study, cement, Coarse aggregate, water are used.

Cement

Ordinary Portland Cement (OPC) of 53 grade with specific gravity of 3.15 was used in this experiment.

Coarse aggregate

Coarse aggregate of specific gravity 2.73 .The size of aggregate is commonly used as 12.5mm passing and 10mm retained are used.

Water

Potable water free from impurities was used.

IV.EXPERIMENTAL METHODOLOGY

4.1 Mix Design : The mix design of cement and the coarse aggregate ratio are 1:3, 1:5 and 1:6.Water cement ratio used is of two different sets i.e., 0.32 and 0.4. Proportion for casting the cubes was taken by weight.
Mixing of concrete was done with hand mixing method.
Cubes are prepared by using 150mm in length, 150mm in width and 150mm in depth sizes of mould to cast the cubes. The cement used was OPC with 53 grade. Before casting the cubes the course aggregates was washed thoroughly and oven dried at 100^{o}C in laboratory.
The coarse aggregate used was 12.5mm and down size.18 cubes were casted with different water cement ratio 0.32 and 0.4 respectively.

4.2 Compressive strength test

In this test, the specimens of 150 X 150 X 150 mm were casted. Cubes were demoulded after 24 hours of casting. The cubes were kept for curing under water immersion at temperature 35^{o} to 42^{o}C
After the curing period the cubes were tested in UTM. The compressive strength is noted. In each category 3 cubes were tested and their average value is reported.

4.3 Water infiltration test

It should be done usually on permeable pavement. it consists of four main components;
1. Installing the infiltration ring
2. Pre wetting the concrete
3. Testing the concrete
4. Calculating the result

To install the infiltration ring, clean the surface and the ring should be of specified size, mark 1cm from bottom on the ring. The ring is placed over the cleaned surface and secured in place with polished putty. Some amount of water is added into the ring up to the marked line and the time for infiltration is recorded. It is given as,

$I = (km)/(d2) \times (t)$

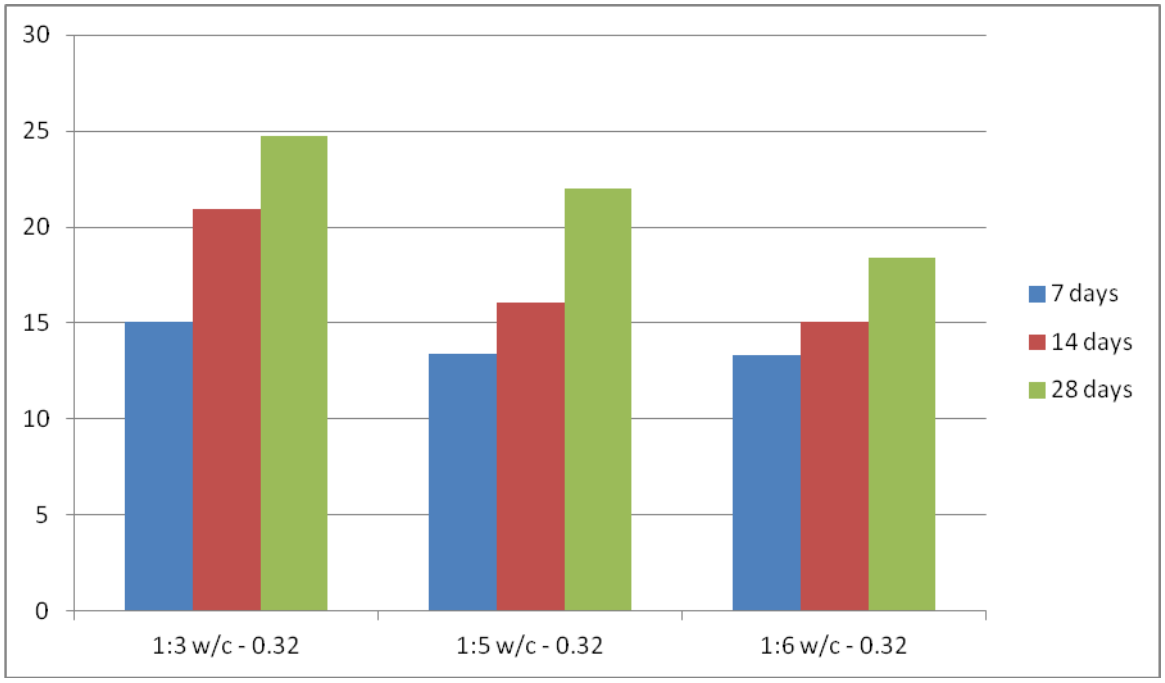
Where,
m = mass of water
k = constant (126870)
d = ring diameter (12inches)
t = time for infiltration
I = infiltration rate (inch/hr)

V. Results and Discussions

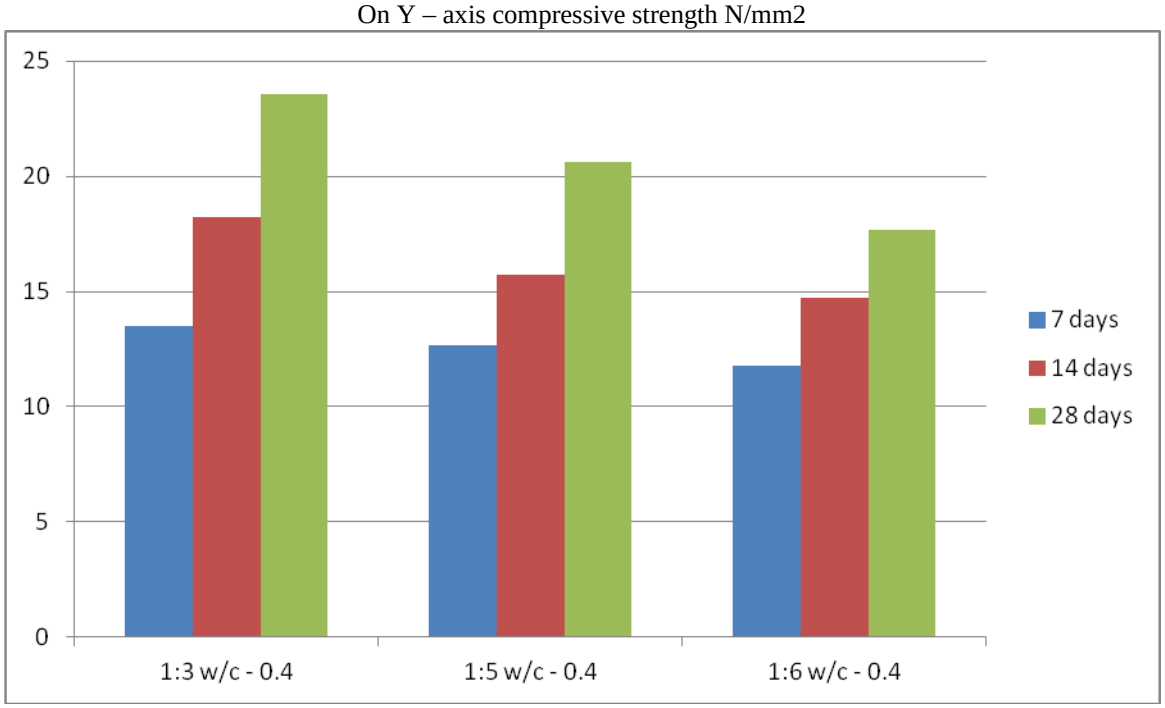
5.1 TEST RESULTS ON HARDENED CONCRETE:

5.1.1COMPRESSIVE STRENGTH TEST RESULTS

Sl. no	Mix ratio	w/c ratio	7 days strength N/mm2	14 days strength N/mm2	28 days strength N/mm2
1	1:3	0.32	15.08	20.93	24.72
2	1:3	0.4	13.52	18.22	23.55
3	1:5	0.32	13.42	16.80	16.80
4	1:5	0.4	12.68	15.7	20.6
5	1:6	0.32	13.32	15.07	18.42
6	1:6	0.4	11.79	14.72	17.66



On X – axis mix ratio for w/c – 0.32
On Y – axis compressive strength N/mm2

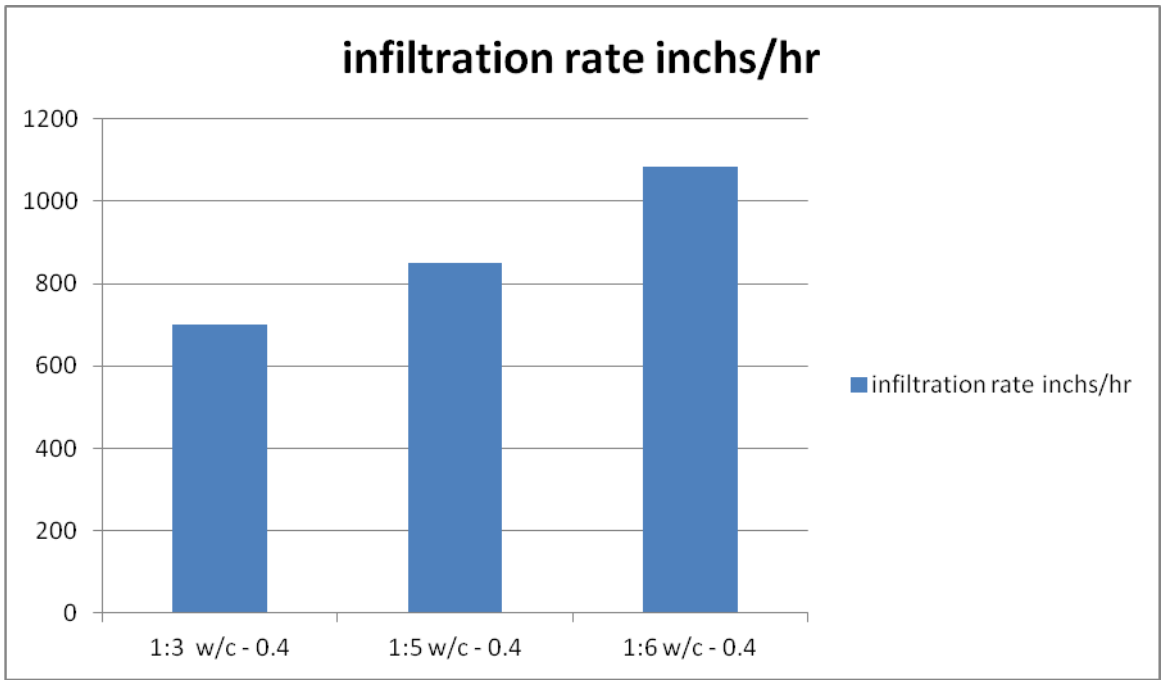


On X – axis mix ratio for w/c – 0.4
On Y – axis compressive strength N/mm2

5.1.2 WATER INFILTRATION TEST:

Observations: for 1:6 mix and w/c – 0.4
Mass of the water (m) = 22.04lb (10 liters)
Diameter of the ring (d) =12inch
Constant (k) =126870
Time of infiltration=17.94secs

Calculations:
I= (km)/ (d2) x (t)
I= (126870×22.04) ÷ (122×17.94)
I=1083.9 inch/hr
Note: Infiltration rate should be more than 900 inch/hr



VI. Conclusions

The following conclusions can be drawn from the studies and experimental investigation carried out;

- The permeable pavement installed has the runoff volume discharge less than 5%, which proves to be an effective measure in reduction of runoff volume over a pavement.
- This permeable pavement can withstand a load up to 18N/mm2; hence it can be used in a low traffic roadway or as a pavement of parking lot.
- The infiltration rate of the permeable pavement is 1083.9ich/hr, which shows a high permeable structure with zero runoff in a small lapse of time.
- By construction of this pavement a large amount of water can be recharged into the ground which solves the problem of ground water depletion.
- Permeable pavement also has less amount of runoff which reduces the soil erosion, reduces the wastage of water and keeps the pavement in a good condition.
- The advantages of construction of Permeable pavement system are mostly of a hydrological nature; Strom-water (runoff) reduction, an increase in infiltration, and a reduction of ground water depletion.

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