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Understanding the Porous Pavement Properties Examining the Viability of Pervious Pavement

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Abstract: ***Porous pavement design and drainage facility***

Keywords: Pavement; porous; design; drainage

1. Introduction

Urbanization gaining more importance and connectivity between regions becoming a significant part of economic development has made roadways an essential part of the growth story for any country or location. Better quality road means efficient transportation, easy mobility and freight management. All these factors boost up the local trade making the place easy to access & establish businesses or factories.

Such demand for roadways has lead to an organized planning strategy & design methodology for road construction. When we describe the road design, as a layman we observe the pavement. If there's any water logging or poor drainage then it impacts the road surface & hence leads to many troubles for the travelers using that road for daily work.

To eradicate such issues related with water logging on roads, there are certain drainage structure systems which are further being designed to improve their efficiency of working. In the study of water management and distribution in an area , there are different layouts of pipeline which enables the efficient supply of water , similarly a road drainage system could be facilitate to imitate a similar pattern for collecting the water that gets on road & leads to various obstacles hampering the road quality and easy movement on it. The road network itself is a broad & versatile connection of many areas which could be used for waste water treatment.

2. Ease of Use

a) Objective

The design of pavement drainage with the consideration of water flowing below the surface in order to utilize the collected water is made by focusing on the following objectives:

- Proper road drainage facility
- Standard quality of road
- Waste water treatment
- Establishing a network where collected could be transported
- Promoting the eco- friendly development of constructions
- Protecting the environment & helping to reduce unwanted traffic congestion.

From the mentioned objectives we have to design a system that works on various conditions with good resistive qualities against the highly demanding environment to give the desired output.

3. Methodology

We focus on the procedures utilized for creating and testing pervious concrete. To draw reasonable conclusions in regards to choosing appropriate mixture ratios for pervious concrete, testing and experimentation must be conducted. Compressive strength is best determined by creating pervious concrete and subjecting it to loadings until failure

a) Units

- The A/C ratio is by volume and not by weight. The unit weight of the aggregate was required for calculating correct volumes for the ratio. Unit weight was obtained by conducting two experiments in accordance with ASTM C29/29M-97. A quantity of aggregate was obtained, oven dried, and its weight recorded (W3). A container was then filled with water up to a certain level, weighed, and its weight recorded (W1).
- The water was then emptied from the container and replaced by the aggregate. Water was then reintroduced into the container until the previous level was reached. The container with the water and the aggregate was then weighed (W2). The mass of aggregate equal to the volume of water removed from the container (W4) is then determined by adding W1 and W3 and subtracting W2. Specific gravity is then calculated by dividing W3 by W4.

b) Cuboid for testing

Although much research has been conducted in the past on its compressive strength, testing must still be accomplished in order to understand the nature of pervious concrete. Prior research is an excellent source, however, to develop parameters for that testing. Based on prior readings, 3 test cuboids would provide a representative sample of varying mixture ratios (i.e. A/C ratio and W/C ratio). The cuboids used for testing were one time use only. These cuboids are 30cm length, 30cm width and 15cm thickness. The pervious concrete & impervious concrete was made from 8mm aggregate retained and Type I Portland Cement. The test cuboids used and the pervious concrete mixed are in accordance with ASTM C31/C31M-03a. Eight separate batches with 3 different A/C ratios and two methods of compaction (Standard Proctor and Modified

Proctor) were created. The Standard Proctor compaction test requires test cuboids be filled in three layers.

Each layer receives 25 blows with a hammer weighing 5.5lbs through a distance of 12 inches. The Modified Proctor compaction test requires test cylinders be filled in five layers. Each layer also receives 25 blows with a hammer, however, this hammer weighs 10 lbs and is dropped a distance of 18 inches. The Standard Proctor compaction test provided 341 kN-m/m3 of energy or 50 psi of vertical force while the Modified Proctor compaction test provided 1544 kN-m/m3 of energy or 223 psi of vertical force. for calculations. The W/C ratio is not required for the mixture parameters and is calculated after completion of the mixture. Since water is added to the aggregate and cement until a sheen is developed throughout the mix, it is impossible to have this value prior to mixing. The amount of water utilized is converted to weight and divided by the amount of cement used by weight to calculate the W/C ratio used for each mixture. Once the unit weight of the aggregate is calculated, correct volumes of aggregate and cement are determined for mixing. Each mixture provided enough pervious concrete for three cuboids with the exception of Mixture 3. In this batch, an incorrect amount of aggregate was used thereby affecting the amount of pervious concrete produced. The amount of pervious concrete created was yielded enough for the three cuboids. Three cuboids per mixture allowed for two cuboids with identical parameters (A/C ratio, W/C ratio, and compaction energy).

c) Infiltration, Specific Gravity, and Compressive Strength of Pervious Concrete

Each of the 3 cuboids was suspended above the ground surface. Once a constant flow was established, a container below the cylinder was able to capture the amount of water flowing through the concrete for a period of one minute. After completion of the permeability tests, specific gravity experiments were conducted on each cylinder in a manner similar to those previously performed on the aggregate in order to determine unit weight, void ratio, and porosity. Lastly, the 30 day compressive strength was determined on each of the above cuboid using the compression testing Machine with 250 kip capacity. Each cuboid was equipped with a neoprene cap on its top and base and was loaded at a rate of 50 psi/sec until failure. Data was recorded in the form of load in pounds and displacement in inches. This data was then interpreted in the form of graphs.

Total loads on slab

1) Dead load of the slab
2) Live load of the slab
3) Floor finish load

Dead load = self weight of slab= mass/(weight of slab)*density*area

Live load:
According to IRC class AA loading live load on road, rail, bridges etc is 4.25KN/m
Total load=D.L+L.L+F.L KN/m
Factored load= 1.5*total load KN/m

According to ACI 318-08 section 8.5,
Modulus of elasticity for concrete
$E_c=W_c^{1.15}*0.043\sqrt{f'c}$ Mpa
This formula is valid for value of W_c b/w 1440 and 2560kg/m^3.
For normal weight concrete
$E_c=4700\sqrt{f'c}$ Mpa
According to ACI 318-08 section 8.5,
Modulus of elasticity for concrete
$E_c=W_c^{1.15}*0.043\sqrt{f'c}$ Mpa

The Poisson's ratio of the, cc pavement μ=0.15
Thermal coefficient of cc per o_C, of $=1*10^{-5}$

Modulus of sub-grade reaction

Modulus of Subgrade reaction, k may be defined as the pressure sustained per unit deformation of sub-grade at specified deformation or pressure level using specified plate size the diameter of the standard plate for finding k-value of the sub-grade is 750mm(75cm) but for highway pavement, a smaller plate of 300mm diameter is also used.

The pressure corresponding to a settlement of 0.125(cm0 is read and the k-value is calculated by relation

$$K=\frac{P}{0.125}\ \text{kg/cm}^3;\quad K=15.525\ \text{kg/cm}^3$$

Westergaard defined this term as the' radius of relative stiffness ' L' which is expressed by the equation.

$$L=\left[\frac{Eh^3}{12k(1-\mu^2)}\right]^{\frac{1}{4}}$$

Here

- L = radius of relative stiffness, cm
- H = slab thickness, cm
- E = modulus of elasticity of cement concrete kg/cm^2
- μ = Poisson's ratio for concrete=0.15
- K = sub grade modulus or modulus of subgrade reaction Kg/cm^3
- Factor of safety = (flexural strength)/(total flexural stress)

$$\text{Void content (\%)} = \frac{T-D}{T} * 100$$

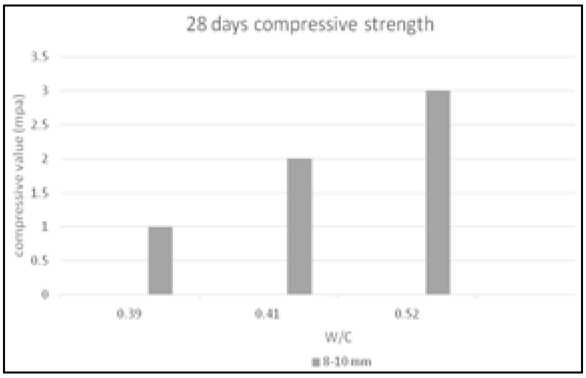
- Here D = (Mc-Mm)/Vm (Density)
- Mc = mass of measure filled with concrete
- Mm = net mass of concrete by subtracting mass of measure
- Vm = volume of measure
- T = Ms/Vs (Theoretical Density)
- Ms = total mass of materials batched
- Vs = total absolute volume of materials

Density:

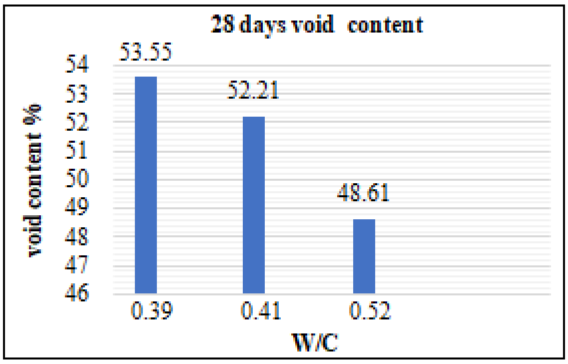
Density of pervious concrete pavement has been evaluated by ratio of weight of cube to the volume of cubes.

D = weight of cube/ volume of cube

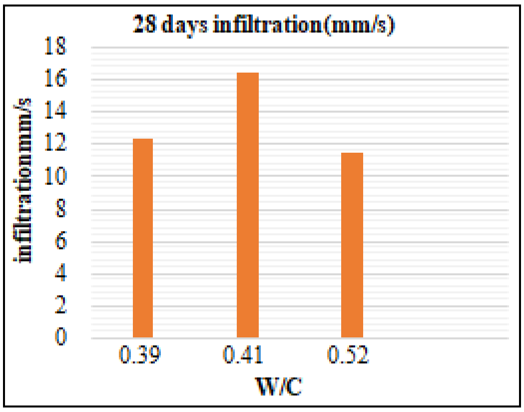
4. Result and Discussions



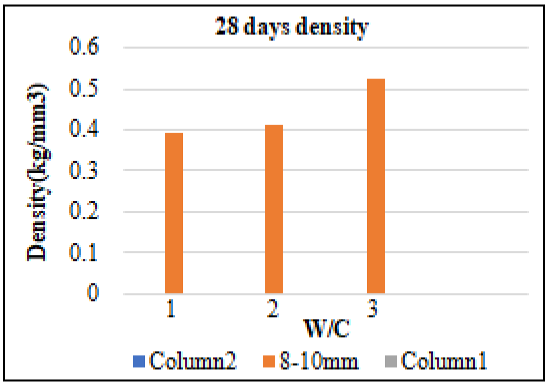
Effect of w/c ratio on compressive strength of pervious concrete pavement:



Effect of w/c ratio on void content of pervious concrete (28 days)



Effect of w/c on infiltration for Pervious Concrete pavement (28days):



Effect of w/c on Density of Pervious Concrete

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References

[1] http://www.engineeringenotes.com/transportation-engineering/highway-pavement/how-to-design-plain-jointed-rigid-pavements-for-highways-with-irc-method/48697
[2] https://www.scribd.com/doc/68468204/IRC-58-2002-Guidline-for-the-Design-of-Plain-Jointed-Rigid-Pavements-Design-for-Highways
[3] https://www.vrmca.com/wp-content/uploads/2016/05/2016-Pervious-Concrete-In-Place-Durability-and-Infiltration.pdf
[4] T.C. Nwofor and D.B. Eme, Appraisal on The Strength of Concrete Produced
[5] with Varying Aggregate Size, International Journal of Civil Engineering and
[6] Technology, 7(3), 2016, pp. 233–240.