Pervious Pavement

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Abstract- *Water logging and depleting ground water table are the two major problems faced by the people all over the world. Even though some places have very well planned drainage facilities it becomes difficult sometimes to drain water from road surfaces. Urbanization reduced soil surface exposure on the top earth surface which is often being covered by a layer of Tar or Concrete for roadway. The ground water level is also reducing due to low rate of infiltration and also the run-off water is generally high. Pervious concrete is one of the modern methods which is highly capable of draining water and also has low strength characteristics. Implementation of pervious concrete roads for Indian conditions is very essential for a beneficial town planning with efficient collection system for run-off water.*

I. INTRODUCTION

Pervious concrete is a specialty concrete used to allow to intentionally pass through surface of pavement and allow storm water to eventually absorb back into the surrounding soils. Pervious concrete acts as both pavement and storm water management tool. In pervious concrete, fine aggregate fraction has been omitted. This concrete is made up of coarse aggregate of 12.5 and 20 mm size, cement, water and admixture if preferred. Unlike the conventional concrete, in which the strength is primarily controlled by water-cement ratio, the strength of pervious concrete is dependent on aggregate-cement ratio. Pervious concrete can be used in wide range of applications like residential roads, driveways, low volume pavements, sidewalks and parking areas. We have used Interlocking Concrete Pavement Institute (ICPI) – Permeable Design Pro to analyze structural and hydrological design of a pavement in Chennai considering of its precipitation and traffic.

II. OBJECTIVE

The main objective of this project is to increase pervious concrete strength by increasing aggregate cement ratio and size of aggregate. Nano silica is also used to attain required standard strength. Also, we have analyzed its hydrological and structural elements by using ICPI software. The project also includes study of clogging and maintenance methods.

III. MATERIALS AND PROPERTIES

Cement

Ordinary Portland cement, 53Grade conforming to IS: 269 – 1976 is used, the selected choice of brand and type of cement is the most important to produce a good quality of concrete. A total of nearly 25 kg of cement is used in developing the project.

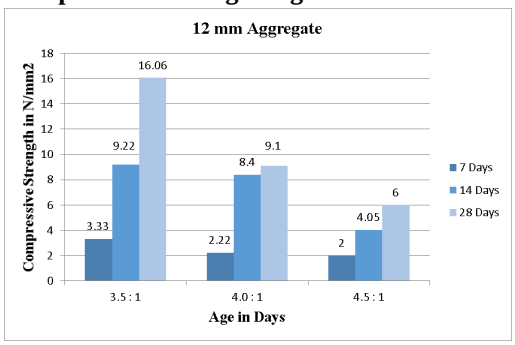
Water

Casting and curing of specimens were done with the potable water that is available in the college premises. Pervious concrete should be proportioned with a relatively low water-cement ratio typically 0.26 to 0.40 because an excess amount of water will lead to the drainage of the paste and subsequent clogging of the pore system. The addition of water therefore has to be monitored closely in the field.

Aggregates

Locally available crushed stones conforming to graded aggregate of nominal size 12.5 mm and 20mm as per IS: 383 – 1970 is used in addition to cement paste – aggregate ratio, aggregate type has a great influence on concrete dimensional stability. Fine aggregate content is null in pervious concrete mixtures because it tends to compromise the connectedness of the pore system. The addition of fine aggregate may increase compressive strengths and density but correspondingly reduce the flow rate of water through the pervious concrete mass.

Compression Testing Images



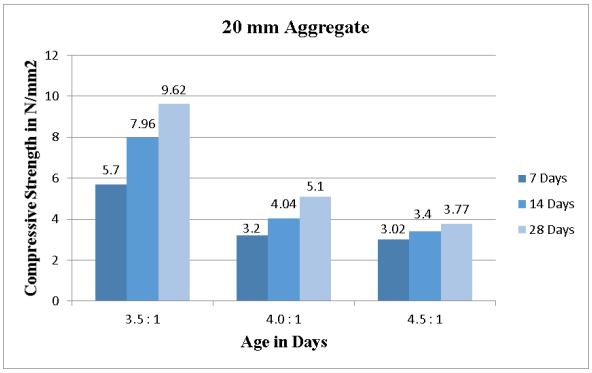
Compressive Strength comparison for 12 mm aggregate
Compressive Strength comparison for 20 mm aggregate

IV. RESULT

The maximum compressive strength of a cube is attained by cube which has 12 mm aggregates is – 17.95N/mm2.

Hydrological Design Results

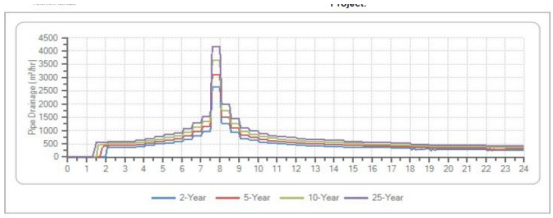
Equivalent Design Storm



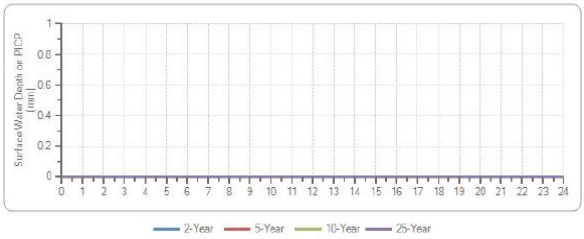
Storage Goal = 25 year storm
Storage Capacity - 25 year storm
Pavement Water Storage Capacity = 839 m³

Combined Site Hydrological Characteristics for Permeable and Non-Permeable Areas

Catchment Area = 10,000 m²
Average Curve Number - 0
Average Rational C Value



Pipe Drainage VS Storm Return Period



Surface water depth VS Storm Return Period

Schedule, Tasks and Milestones

Our Project mainly had three milestones

- Literature Review and Problem Identification which consisted of finding the appropriate aggregate/cement ratio as well as the aggregate sizes to achieve the standard strength
- Finding the appropriate admixture that helped us in achieving the landmark strength for a pavement

- Software analysis using ICPI Permeable design pro consisting of hydrological and structural analysis of a sample Pervious pavement

V. PROJECT MODEL DEMONSTRATION

Materials Used:

- 1. Synthetic Wood
- 2. Glass
- 3. Soil and Gravel
- 4. Pervious Concrete Slab

VI. MODEL OF PERVIOUS PAVEMENT

Soil Layers

1. Pervious paving Layer
2. Bedding Course
3. Granular layer: a) Base b) Sub Base
4. Sub grade Layer

VII. MAINTENANCE METHODS

Permeability maintenance:

Permeable pavements are similar to filters. These filters remove particles from fluids, as more particles are removed the flow rate is reduced and maintenance is required to restore the flow rate. The rate of clogging of a filter is based on the initial permeability and pore size, type and amount of material to be filtered, rate of the fluid carrying the material, and the level of service requiring regeneration of the filter. It has been observed that the permeability of typical pervious concrete placements is maintained with semi-annual cleaning. Clogging most often occurs when large amounts of soil wash onto the pavement surface during daily activities. Consequently, permeability maintenance considers both routine cleaning and clogging restoration. Research has shown that sand-sized particles are more likely to be retained on the surface, while silt and clay sized particles are more likely to become deposited at the bottom of the aggregate layer. As more and more particles become filtered out, there is a progressive failure of permeability from the top. Fortunately, then the top layer clogs protecting the middle and bottom of the concrete from clogging. The progressive clogging at the surface is highly desirable because surface cleaning is both relatively easy and effective at restoring lost permeability.

Permeability on clogged OGFC sections can be restored using a combination of high pressure water ranging from 860 kPa to 3,450 kPa (125 psi to 500 psi) with a vacuum to remove the debris. Routine maintenance (maintenance performed before clogging occurs) was more effective at maintaining permeability for longer periods of time. Pressure washing is commonly used for permeability maintenance on sidewalks.

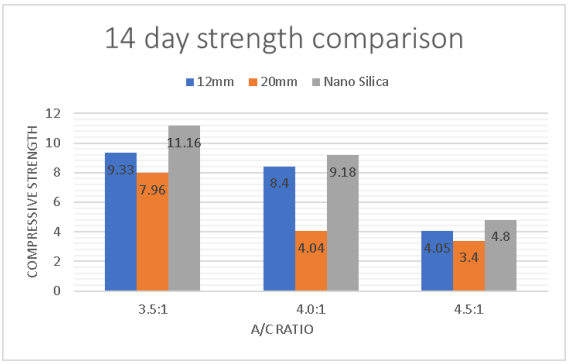
Cleaning Operations for maintaining permeability

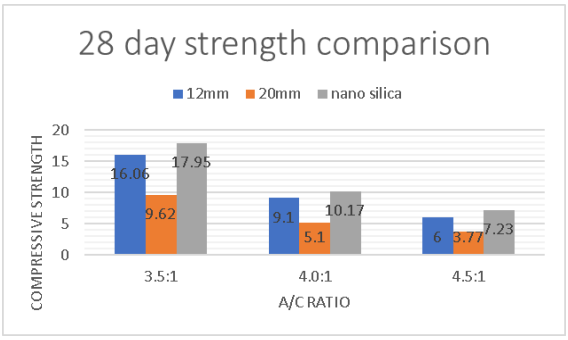
Conclusion

Pervious concrete or No fineness concrete can be used as pavement generally and the usage of admixture with conventional Nano silica increases the strength and the mix attained its maximum strength in 28 days itself. Nano silica mix reached a strength of 17.95 N/mm^2 compared to the highest strength of 16.06 N/mm^2 we attained with varying aggregate size and A/C ratio. So can be used for low road bearing roads. It is also an Environment Friendly system where the ground water is recharged simultaneously.

The project is completely analyzed and it is clearly seen that Conventional pervious concrete and Pervious concrete with Nano silica holds good for strength characteristics. The Permeability is high for Pervious concrete and low for other two mix. The Cost analysis has revealed that Pervious concrete has lesser costs compared to conventional concrete and laying such pavements can considerably reduce costs which can be used for rainwater harvesting and other green sustainable practices.

Further Software analysis for the Hydrological and Structural factors of the Pavement has been done in Permeable Design Pro.





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