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Green Pervious Concrete

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ABSTRACT: Zero-slump, open graded material consisting of hydraulic cement, coarse aggregate, admixtures and water constitutes pervious concrete. As it does not contains fine aggregates such as sand, it is also referred to as "no-fines" concrete. It has a high void content of about 25 -30% and it has potential to reduce the runoff to the drainage systems which can provide a water flow rate around 0.30 cm/second.

Heat storage is less due to large open pore structure. Other effective applications are in low loading intensity parking pavements, footpaths, walkways and highways. The pervious concrete is considered as an Environmental Protection Agency (EPA) for providing pollution control and storm management.
The aim of this project is to lay the green concrete in platform and car parking enable water to be transmitted to the underground surface very easily for enhancing the ground water table even in all the places.
KEYWORDS: Pervious, Air Voids, Drainage, Porosity, Ground Water

I. INTRODUCTION

Pervious concrete (also called porous concrete, permeable concrete, no fines concrete and porous pavement) is a special type of concrete with a high porosity used for concrete flat applications allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater 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 one of many low impact development techniques used by builders to protect water quality.
The basic ingredients of pervious cement concrete mix are not very different from the conventional cement concrete mix, except in the proportion of ingredients. The main ingredients are cementations material, water, aggregate and if required, admixtures. The initial use of porous concrete was in the United Kingdom in 1852 with the construction of two residential houses and a sea groaned. Cost efficiency seems to have been the primary reason for its earliest usage due to the limited amount of cement used. It was not until 1923 when porous concrete re surfaced as a viable construction material.

This time it was limited to the construction of 2-story homes in areas such as Scotland, Liverpool, London and Manchester. Use of porous concrete in Europe increased steadily, especially in the World War II era. Since porous concrete use less cement than conventional concrete and cement was scare at that time.It seemed that porous concrete was the best material for that period. Porous concrete continued to gain popularity and its use spread to areas such as Venezuela, West Africa, Australia, Russia and the Middle East. After World War II, porous concrete became wide spread for applications such as cast-in-place load-bearing walls of single and multistorey houses and, in some instances in high-rise buildings, prefabricated panels, and stem-cured blocks. Also applications include walls for two-story houses, load-bearing walls for high-rise buildings (up to 10 stories) and infill panels for high-rise buildings

FEATURES OF PERVIOUS PAVEMENT

- Deformation in the subgrade is not transferred to subsequent layers.
- Design is based on flexural strength or slab action.
- High flexural strength
- Grain to grain load transfer exists
- Have low repair cost but completion cost is high
- Life span is more when compared to the flexible pavements (low maintenance cost)

- Surfacing can be directly laid on the subgrade
- Thermal stresses are more vulnerable to be induced as the ability to contract and expand is

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very less in concrete. That's why expansion joints are needed
- Strength of the road is less dependent on the strength of the subgrade
- Rolling of the surfacing is not needed
- Road cannot be used until 14 days of curing
- Force of friction is high
- No damage by oils and greases

WATER PURIFYING PERFORMANCE

Pollution of urban lakes, rivers and wet lands and enclosed coastal waters near large citied has been serious in recent years due to runoff containing waste water from homes and plants, posing problems of environmental disruption. Water purification by pervious concrete is a sort of inter-gravel contact oxidation, in which the biota formed on the internal surfaces of continuous voids provides an additional bio-purification function. It is therefore anticipate that the porous concrete applied to revetment and coastal areas would contribute to water purification by the biota consisting of various organisms including microbes.

PERVIOUS CONCRETE AS NOISE ABSORPTION

Pervious concrete is applied for sound barriers or pavements to absorb traffic noise and reduce sound wave reflection. In terms of acoustic engineering porous concrete can be considered as a rigid frame porous medium. Theoretically the sound absorption properties of a rigid frame porous medium are mainly influenced by void texture and thus the main focus of modelling is to determine the generalized void texture. Since porous sound absorbing materials, such as polyurethane, fabrics, formed metal, etc., The main concern of the present study is the absorption characteristics of porous concrete in case the vertical incidence acoustic wave has occurred. Many other type of noise including the rolling noise of vehicles or impact noise with high sound pressure considering random incidence acoustic waves, also need to be considered when designing porous concrete used as an acoustic wall. However, this issue is beyond the scope of present work, nevertheless, it should be subject of future work for developing more versatile acoustic absorption models for porous concrete.

PERVIOUS CONCRETE REDUCES PROBLEMS

It may reduce or eliminate the need for sub terrain storm sewer drains. Pervious concrete not only eliminates much of the runoff from pavements, but may also catch the runoff from the roofs and return it to the aquifer. Trees are great tools in fighting greenhouse effect. Unlike impervious pavements, pervious concrete lets water and oxygen and enter the soil below. This allows tree roots to perform their tasks efficiently. Those tasks include cooling the surrounding air by the evaporation of the captured ground water.This helps reduce air conditioning cost.

The light colour of concrete pavements absorbs less heat from solar radiation than darker pavements, and the relatively open pore structure of pervious concrete stores less heat, helping to lower heat island effects in urban areas.

Pervious concrete because of its solar reflectivity index of about 29 absorbs much less heat than asphalt and with its water retention it reduces the load on air conditioning.

Finally for the developer or engineer, it makes possible maximum land use for parking lots, roads and structures. With certified engineering it can reduce the size of retention areas. Storm drains may be eliminated and some curbing as well. For watershed and estuary areas it's an environmental tool to keep these water clean and cooler. These are ecological as well as dollars and cent issues.

Trees thrive as pervious concrete allows rain water to reach their roots. As the water is drawn up to the leaves or blades of grass the miracle of transpiration converts it back to vapour it back to vapour which helps create more rain while cooling surrounding air.

NEED FOR PERVIOUS CONCRETE IN RURAL ROAD PAVEMENT

In rural areas larger amount of rainwater ends up falling on impervious surfaces such as parking lots, driveways, sidewalks, and streets rather than soaking into the soil. This creates an imbalance in the natural ecosystem and leads to a host of problems including erosion, floods, ground water level depletion and pollution of rivers, as rainwater rushing across pavement surfaces picks up everything from oil and grease spills to de-icing salts and chemical fertilizers.

A simple solution to avoid these problems is to stop constructing impervious surfaces that block natural water infiltration into the soil. Rather than building them with conventional concrete, we should be switching to Pervious Concrete or Porous Pavement, a material that offers the inherent durability and low life-cycle costs of a typical concrete pavement while retaining storm water runoff and replenishing local watershed systems. Instead of preventing infiltration of water into the soil, pervious pavement assists the process by capturing rainwater in a network of voids and allowing it to percolate into the underlying soil.

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II. MATERIAL COLLECTION

CEMENT

Ordinary Portland cement, 53Grade conforming to IS: 269 – 1976.Ordinary Portland cement, 53Gradewas used for casting all the Specimens. Different types of cement have different water requirements to produce pastes of standard consistence. Different types of cement also will produce concrete have a different rates of strength development. The choice of brand and type of cement is the most important to produce a good quality of concrete. The type of cement affects the rate of hydration, so that the strengths at early ages can be considerably influenced by the particular cement used. It is also important to ensure compatibility of the chemical and mineral admixtures with cement.

COARSE AGGREGATE

Locally available crushed blue granite stones conforming to graded aggregate of nominal size 12.5 mm as per IS: 383 – 1970. Crushed granite aggregate with specific gravity of 2.77 and passing through 4.75 mm sieve and will be used for casting all specimens. Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite. In addition to cement paste – aggregate ratio, aggregate type has a great influence on concrete dimensional stability.

SILICA FUME

Obtained from ELKEM India (P) Ltd., Navi Mumbai conforming to ASTM C 1240 as mineral admixture in dry form. Silica fume is one of the artificial pozzolanas, commonly used as mineral admixture. Silica fume is very fine non- crystalline silica, produced in electric arc furnaces, as a by-product of the production of elemental silicon or alloys containing silicon also known as condensed silica fume or micro silica.

There are two reactions in the silica fume, Pozzolanic reactions are, Silica fume reacts with the calcium hydroxide, which is liberated during process of Hydration, about 22-24 percent and produces calcium-silicate-hydrate (C-S-H). The following are the chemical reactions that are taking place.

The second function silica fume performs in cementitious compounds is a physical one. Because silica fume is 100 to 150 times smaller than cement particle it can fill the voids created by free water in the matrix. This function, called particle packing, refines the microstructure of concrete, creating a much denser pore structure. Impermeability is dramatically increased, because silica fume reduces the number and size of capillaries that would normally enable contaminants to infiltrate the concrete. Thus silica fume modified concrete is not only stronger, it lasts longer, because it's more resistant to aggressive environments. As a filler and pozzolana, silica fume's dual actions in cementitious compounds are evident throughout the entire hydration process.

WATER

Casting and curing of specimens were done with the potable water that is available in the college premises.

III. MIX DESIGN

NEED FOR PERVIOUS PAVEMENT DESIGN

- Joints are designed to take care of the environmental stresses
- Thickness of the pervious pavement slab is decided based on the following two points:
- The maximum bending tensile stress resulting out of maximum wheel load stress and critical environmental stress should be less than the flexural strength of concrete
- The Pervious Concrete pavement should withstand the expected number of repetitions of axle loads during its design life

SECTIONAL PLAN

PERVIOUS PAVEMENT CATEGORIES

For the cross-section of pervious concrete pavement we have to adopt the following details from California Department of Transportation For pervious concrete use the following minimum thicknesses for the Class 4 AB layer:

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Table 1

CATEGORY	EXAMPLES	LOADING	SPEED	RISK
A	Landscaped areas, sidewalks and bike paths (with no vehicular access), miscellaneous pavement to accept run-on from adjacent impervious areas (e.g. roofs)	No vehicular loads	N/A	Low risk
B	Parking lots, park & ride areas, maintenanceaccessroads, scenic overview areas, sidewalks and bike paths (with maintenance/vehicular)	Few heavy loads	Low speed(less than 30mph)	Low
C	Rest areas , maintenance stations	Moderate heavy loads	Low speed	Low
D	Shoulders, some low volume roads, areas in front of noise barriers (beyond the traveled way)	Moderate heavy loads	High speed	Medium
E	Highways, weigh stations	High heavy loads	High speed	High

PERVIOUS PAVEMENT CATEGORIES
Zero for Category A (non-auto locations) 0.50 feet for Category B auto areas
0.70 feet for Category B truck areas 0.70 feet for Category C truck areas

Hence we have to use 0.50 feet depth of pervious concrete layer that means 16cm in which it will give higher amount of porosity that allows water to percolate in to ground water and also it can withstand the load given by the parking vehicles.

DETAILED DRAWING

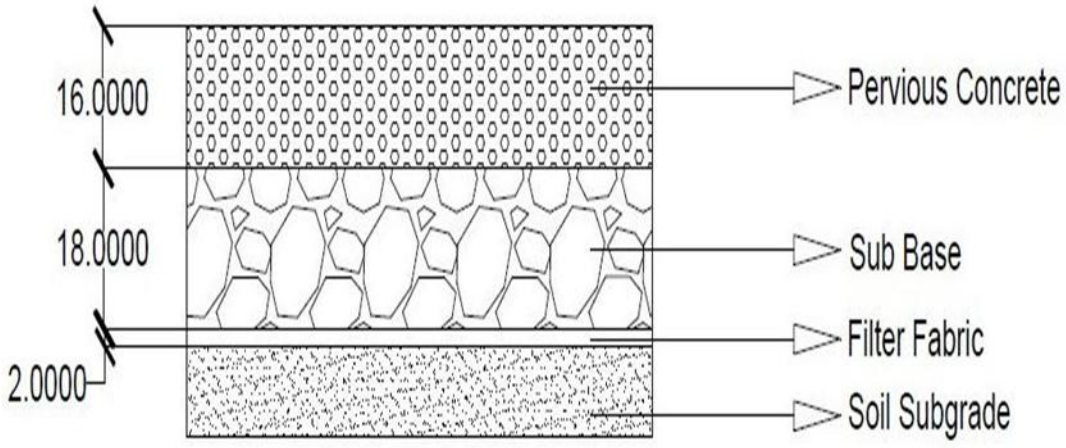

Figure 1: Cross Section of Pervious Concrete

MIX DESIGN

Based on ACI 522R-06
Pervious concrete of strength 20Mpa
Design average cube strength at 28 days
A/C = 3
Optimum W/C ratio = 0.31
Bulk Density of coarse aggregate:
12.5 mm = 1650 Kg/m3
A/C ratio by weight = 3x 1650/ 1700 = 2.91
Cement: Aggregate: Water
1: 2.91: 0.31
Quantities of materials per m3 concrete:
Cement: 540 Kg/m3
C.A: 1746 Kg/m3
Water: 186 Kg/m3
Silica fume: 60 Kg/m3

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IV. OBESERVATIONS

Cube size in mm	3 days Strength	7 days Strength	14 days Strength	21 days Strength	28 days Strength
150x150x150	7.32	17.16	23.4	24.57	25.73

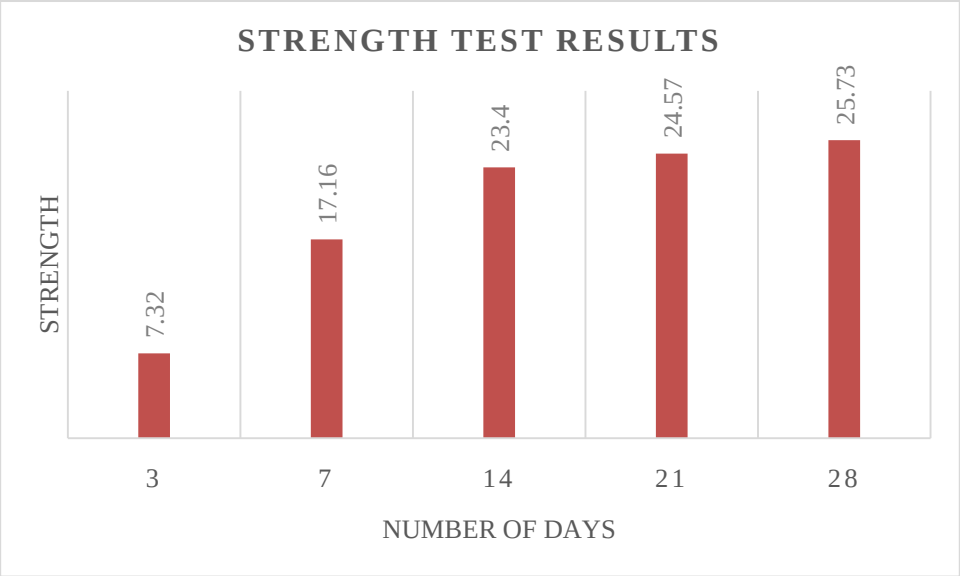

Figure 2: Comparison of compressive strength values

V. CONCLUSION

- The mix design with aggregate and cement ratio of 3 has the maximum strength
- This mix design gives us the required strength of M20grade concrete.
- This mix design has the required void ratio for the water seepage.
- So we can choose this mix design for the application purpose.
- The pervious concrete is laid at the top layer up to 16cm.
- Then below that a layer of sub base of 18cm is provided.
- Then below it a 2cm layer of filter fabric is laid.
- Thus the pervious concrete will have its complete usage as the pavements.

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