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STORMWATER RUNOFF SOLUTION: PERMEABLE PAVEMENT CONCRETE BLOCK

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Abstract: *Nowadays the major issue is to reduce surface runoff and enhance the ground water level, this is the problem wherein areas having concrete pavements. So, the pervious concrete is adopted as one of the best alternative to avoid this. Pervious concrete pavement is an environmentally friendly paving material that allows water to percolate directly through the surface and recharge groundwater. Among several type of concrete pervious concrete includes cement, coarse aggregate, admixture, water. Pervious concrete pavement is unique and effective means to meet growing environmental demands. By capturing rainwater 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 stormwater management devices*

Keyword: Pervious concrete, recharge groundwater, admixture.

1. INTRODUCTION

Due to heavy rain the major and serious problem we all are facing is stormwater management. The best solution for this problem is to construct pervious concrete pavement. Pervious concrete pavement is an alternative paving surfaces that capture and temporarily store the Stormwater Retention Volume (SWRv) by filtering runoff through voids in the pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system, or allowed to partially infiltrate into the soil. Pervious concrete is a zero-slump, open-graded material consisting of cement, coarse aggregate, admixtures and water. Pervious concrete contains little or no fine aggregates such as sand, it is sometimes referred to as "no-fines" concrete. Pervious concrete is the special type of concrete which contains interconnected voids and these voids or pores allows storm water to percolate underground. 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 permeable pavement concrete contains 15% to 30% air voids by limiting the fine aggregate content helps to reduce surface stormwater runoff, its filtrates rainwater, decreases urban heating, replenish groundwater etc. These permeable pavement systems are changing the way human development interacts with the natural environment.

1.1 BENEFITS OF PERVIOUS CONCRETE:

- It reduces the storm water runoff
- Eliminates the need for detention ponds and other costly storm water management practices
- Mitigates surface runoff
- Replenishes the aquifers and water table
- Allows more efficient land development
- Prevents water from entering into the stream and also prevents it from being polluted

1.2 SCOPE OF WORK

1. Calculation for concrete mix design
2. Testing on pervious concrete
3. Design of layer
4. Preparation of model

1.3 APPLICATIONS OF PERVIOUS CONCRETE:

- Pervious Concrete as a Road pavement
- Low-volume pavements
- Sidewalks and pathways
- Residential roads and driveways
- Parking lots
- Noise barriers
- Slope stabilization
- Hydraulic structures
- Tennis courts

2. METHODOLOGY

1) Study about topic
2) Collection of material
3) Testing of material
4) Cube casting
5) Testing of cube
6) Sub grade design
7) Prepare the model of permeable concrete block

2.1 Materials:

1. Cement:

Ordinary Portland cement of 53 grade manufacture by Birla Company confirming to IS: 12269 was used. The specific gravity of the cement was 3.15. The initial and final setting time was found as 40 min. and 340 min. respectively.

Table 1: Physical Properties of Cement

PROPERTIES	Average Value For Opc Used In The Present Investigation	Standard Value Of Opc As Per IS:12269(1997)
Specific Gravity	3.15	-
Consistency (%)	17	-
Initial setting time (min.)	36	>30
Final setting time (min.)	570	<600
Soundness (mm)	0	<10
Compressive strength (Mpa) 28 days	69	>30

2. Coarse Aggregate

Crushed granite aggregate from local source has been used. To obtain a reasonable good grading, 60% of aggregate passing through 20mm IS sieve and retained on 10mm IS sieve and 40% of aggregate passing through 10mm IS sieve and retained on 4.56mm IS sieve was used in pervious concrete.

Table 2: Physical properties of coarse aggregates

Properties	Average Value
Fineness Modulus	6.77
Specific Gravity	2.84
Water Absorption (%)	1.2

3.Silica fumes

Silica fume is an amorphous polymorphic substance composed of SiO2 i.e silica. Silica fume is an ultrafine powder formed as a by-product of the production of silicon and ferrosilicon alloy and contains spherical shaped particles with an average diameter of 150 nm

Table 3: Chemical and Physical Characteristics of Silica fume

SiO2 (in %)	90.90
Al2O3 (in %)	1.12
Fe2O3 (in %)	1.46
CaO (in %)	0.69
SO3 (in %)	0.38
Loss on ignition(in %)	3.00
Density (in kg/m3)	2260
Insoluble residue (in %)	62.85

Compressive strength test

The compressive strength test is the most important test conducted to determine the load carrying capacity of the concrete. The was conducted on compression testing machine of 2000 KN capacity after curing period of 28 days under normal room temperature

Spilt tensile strength test

This is an indirect test to determine the tensile strength of cylindrical specimens. Splitting tensile strength tests were carried out at 28 days for the cylinder specimens of size 150mm diameter and 300mm length, using compression testing machine of 2000KN capacity. The load was applied gradually till the specimen's splits and readings are noted.

Permeability test

Permeability, or hydraulic conductivity, tests were performed using a falling head permeameter. The permeameter consisted of a 4 in. diameter upstream polyvinyl chloride (PVC) pipe with a U-shaped assembly. The U-shaped assembly was mounted with a scale to record the change in head. To prepare the specimen for testing, the side of the specimen was covered with silicone sealant and wrapped with Saran wrap plastic film before placing in a plastic mold. Permeability test was conducted to calculate filtration rate of cube blocks.

Calculation For 1 Cube

- Ratio:Admixture to cement 1:9 silica fumes to cement
- W/C ratio =0.48
- Cement Content =(8.5÷(1+7))x 7=7.45
- 12.5=4.458mm
- 10mm=2.942mm
- Silica fumes=0.118 kg
- Water Content=0.425 kg

Test on cube blocks

Sr. No	Wt. of block (Kg)	App. Load (KN)	C/S Area (mm)	$\sigma_c = F/A$ N/mm^2
1	7.00	330	150*150	14.67
2	7.22	340	150*150	15.11
3	7.35	300	150*150	13.33
Average	7.19	323.33	150*150	14.37

Table no 4: compression strength for 14 days

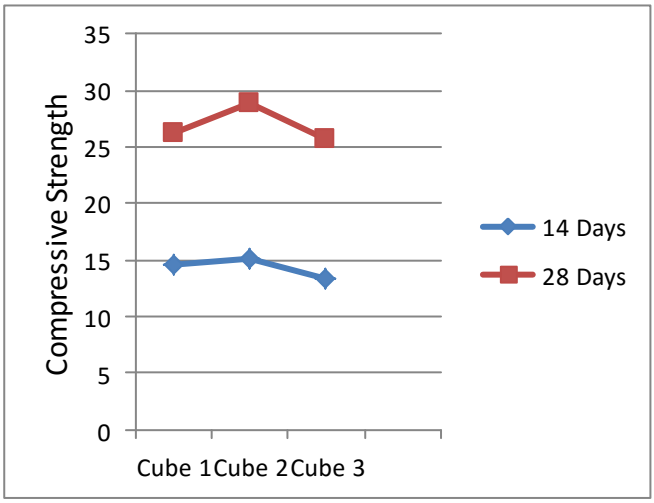
Compressive Strength for cubes

Table no 5: compression strength for 28 day

Sr. No	Wt. of block (Kg)	App. Load (KN)	C/S Area (mm)	σ_c = F/A N/mm^2
1	7.94	590	150*150	26.22
2	7.98	650	150*150	28.89
3	7.98	580	150*150	25.78
Average	7.96	606.66	150*150	26.96

Graph for Compressive Strength Test

In X axis steel fibers percentage and in Y axis average comp strength.



Graph no 1

D= diameter of sample (10.5cm)

1) Testing of cube

d= diameter of standpipe (1.1cm)

Time (sec)	Heights (cm)	Co-efficient of Permeability K (cm/sec)×10^{-3}
0.0	100.0	-
5.0	89.8	2.36
10.0	79.8	2.51
15.0	68.3	3.42
20.0	58.3	3.48
25.0	48.0	4.27
		Average K= 3.224

CONCLUSIONS

- The permeability of pervious concrete decrease to some extent with the addition of silica fumes, but the strength increases to great extent.
- If the ratio of silica to cement if taken 1:9 than permeability as well as strength can be achieved.
- It is clearly seen from the experimental result that pervious concrete has very low compressive strength, so it cannot be used for structural application but it can be significantly used for sidewalks, parking lots, sports surfaces, driveways, etc.
- Pervious concrete is considered as ecofriendly system.

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