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An Assessment of Groundwater Development Using Pervious Concrete-A Case Study in JSSATE Campus Bangalore

Dr. P. Nagabhushana[1], Mahendra C[2], Shrishail[3], Sunilkumar Borannavar[4], Vinay Kumar M[5]
Faculty, Department of Civil Engineering[1]
Students, Department of Civil Engineering, JSSATE, Bangalore, India[2,3,4,5]
JSS Academy of Technical Education, Bengaluru, India
drpnagabhushan@jssateb.ac.in[1]; mahendra.rc2000@gmail.com[2]; sbshrishail111@gmail.com[3];
sunilkumarb951@gmail.com[4]; vinaykumar2k1406@gmail.com[5]

Abstract: *Pervious concrete is a special kind of concrete with a high porosity that is used for concrete flatwork applications to lessen runoff from a site and facilitate groundwater recharging. Water from precipitation and other sources can directly pass through pervious concrete. Other names for it include porous pavement, permeable concrete, no-fines concrete, and porous concrete. Pervious concrete is made with large particles and minimal to no tiny Aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab. In order to reduce runoff from a site and enable groundwater recharge, pervious concrete is a specific variety of concrete with a high porosity that is used for concrete flatwork applications. Pervious concrete allows water from precipitation and other sources to pass through directly. Porous concrete, permeable concrete, no-fine concrete, and porous pavement are other names for it. Pervious concrete is made with large aggregates with little or no small aggregates. The Environmental Protection Agency (EPA) regards pervious concrete as a means of providing storm water management, pollution reduction, and appropriate development. The development of trees is also enhanced by pervious concrete. The behaviour of pervious concrete has been experimentally explored in the current work. The ratio of water to cement was 0.45. The ratio of coarse aggregate to cement was maintained at varying ratios of 1:4 and 1:6. Half of cement is made of fly ash. Experimental research has been done on a variety of pervious concrete qualities, such as workability and compressive strength tests after 7 and 14 days.*

Keywords: Pervious concrete, Compressive strength, Groundwater development

I. INTRODUCTION

A reliable storm water management tool is pervious concrete, sometimes referred to as no fines, porous, gap graded, and permeable concrete, and improved porosity concrete. Pervious concrete is, by definition, a combination of gravel or granite stone, cement, water, and little to no sand (fine aggregate). Storm water can seep through pervious concrete paving and into the soil beneath thanks to the open cell architecture. The basic components of pervious concrete are the same as those of conventional concrete, which are interconnected voids that make up 15% to 30% of the volume and permit water to pass through the concrete. In order to increase the strength and workability of the concrete, high-range water reducers and thickening agents are added. In comparison to typical rain events, it can enable the passage of 0.014–0.023 m^3 of water per minute through its open cells for each square foot (0.0929 m^2). On intensively trafficked roads, pervious concrete develops a moderate amount of surface ravelling and has a rough texture with a honeycombed surface. A paste is made using a measured amount of water and cementation components. In order to prevent the paste from flowing off during mixing and placement, the paste subsequently develops a thick layer around the aggregate particles. By applying enough paste to coat the particles, a network of connected gaps that allows water and air to move through is maintained. Pervious concrete is a highly hard mix as a result of the lack of sand, which has an adverse effect on mixing, delivery, and installation. Additionally, pervious concrete is lightweight (between 1600 and 1900 kg/m^3) because of the large void content. Pollutants are captured by pervious concrete void structures, which also significantly increase structural strength. Additionally, it produces concrete that is highly permeable and quickly drains.

With regard to managing runoff from paved surfaces, preventing run-off water contamination, and recharging aquifers, pervious concrete systems have advantages over impervious concrete. They also repel salt water intrusion, control pollution in water seepage to ground water recharge, which prevents subterranean storm water sewer drains, and absorb less heat than conventional concrete and asphalt, which lowers the need for air conditioning. Increased site optimization is possible with pervious concrete because, in most circumstances, its use should completely eliminate the need for it for imprisonment and On commercial sites of one acre or more, retention ponds, swales, and other more conventional storm water management tools are otherwise necessary for compliance with the Federal storm water rules.

II. MATERIALS

2.1. Cement

Ordinary Portland Cement (OPC) confirming Indian standard code IS: 12269-2013.

2.2. Fly Ash

It is used as 50% replacement of cement.

2.3. Coarse Aggregate

Locally available crushed granite aggregate, confirming to IS: 383-1970 is used as coarse aggregate.

2.4. Water:

The water used in the study was clean and clear. It was free from bacteria and other impurities. There was no acid content in it. The water cement ratio for the concrete mix is 0.45.

III. MIX PROPORTIONING

Pervious concrete mixture proportioning
As per ACI (American Concrete Institute) 211.3R-02
(Guide for Selecting Properties for No-slump Concrete)

Materials	Ratio of cement and coarse aggregate. (1:4)	Ratio of cement and coarse aggregate. (1:6)
Cement	5.2 Kg	4 Kg
Coarse Aggregate	41.6 Kg	24 Kg
Fly ash Class F	5.2 Kg	4 Kg
Water Cement ratio	0.45	0.45
Number of Cubes	6	3

IV. JSS ACADEMY OF TECHNICAL EDUCATION

The JSS Academy of Technical Education (JSSATE) was founded in Bengaluru in 1997 and is a branch of the JSS Mahavidyapeetha in Mysuru. The campus is situated on a vast 21.17 acres of land on the southern edge of Bengaluru City, surrounded by a verdant plantation.

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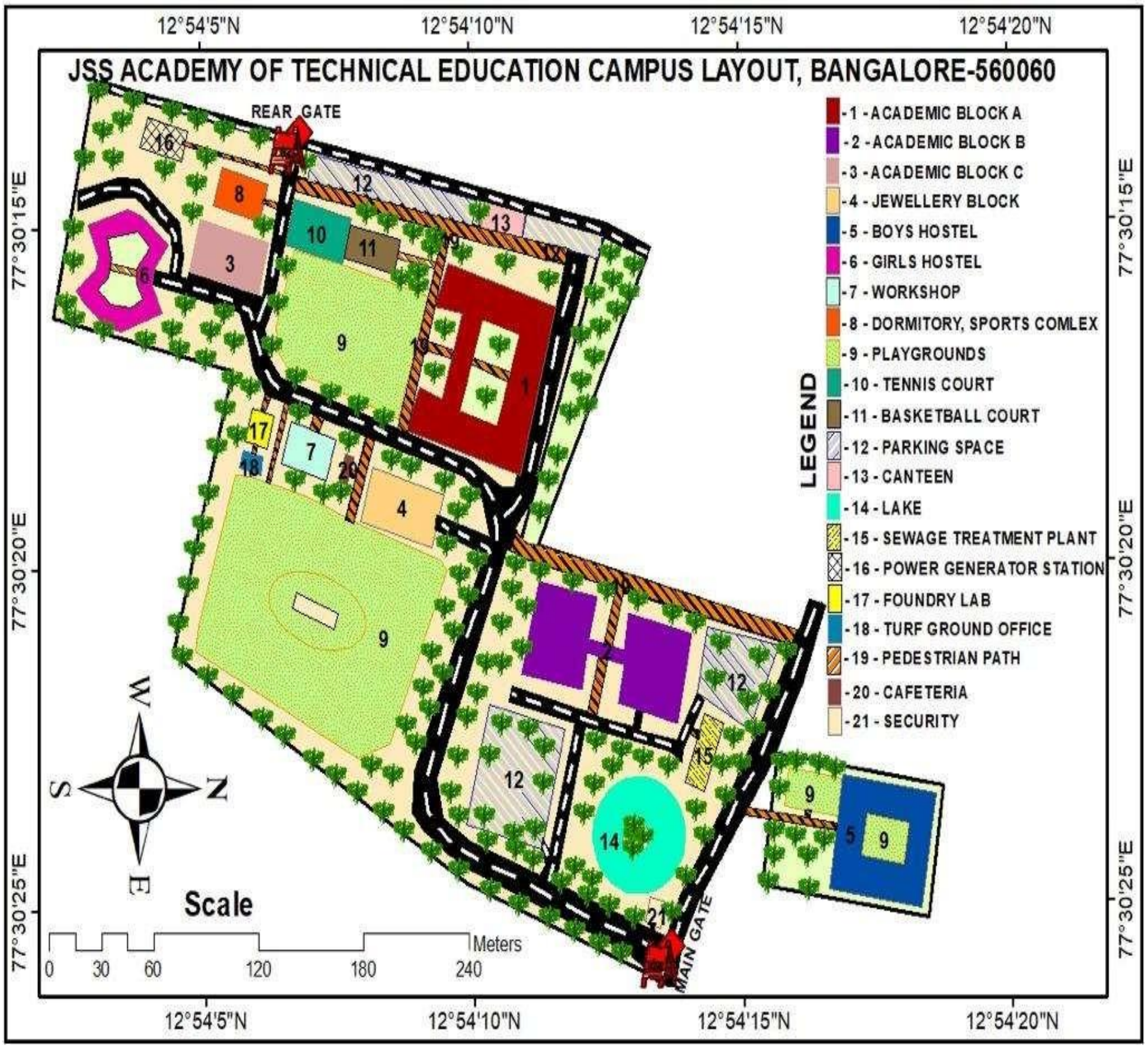

Fig.4. JSSATEB campus layout

Description	Length(m)	Width(m)
Block-C garden area	22	4
Block-C entrance	22.5	4
Girls hostel entrance	42.5	5
Block-C. back yard	18.5	3
Dormitory block entrance	16	3.5
Parking near canteen	25	3
Parking near back gate	105	14
Parking near main block	35	13
Block-A entrance from front gate	374	10
Block-B entrance (vertical)	88	9.5

Block-B entrance (horizontal)	86	7
Jewelry block entrance	60	4
Block-A back yard	80	3
Back gate to T-section	209	7
Total	1183.5	90

Table 4: Dimensions of Roads of JSSATEB Campus

Total length: 1183.5m
Total width: 90m
Total area: 1183.5*90=106515m^2

V. RESULTS

5.1 Material Test Results

The test done on the materials for the mix design:

Table 5.1: Properties of Cement

Sl. No.	Tests	Observedvalues	Acceptance Criteria
1	Standard consistency	32%	
2	Setting Time Initial settingtime Final settingtime	 35min 660min	Confirm IS requirement as per IS 12269-2013
3	Specific Gravity	3.15	

Table 5.2: Properties of Coarse Aggregate

Sl. No.	Tests	Observed Values	Acceptance Criteria
1	Specific Gravity	2.68	IS:2386-1963
2	Water absorption	1%	IS:2386-1963

Table 5.3: Properties of Fly Ash (Class F)

Properties	Values
SiO_2%	65.65
CaO%	0.98
$Al2O_3$%	17.69
Fe_2O_3	5.98
Specific Gravity	2.12
Bulk Density g/cm^3	1.6
Surface area m^2/Kg	430

Table 5.4: Comparison of compressive strength with respect to the different ratios ofcement and coarse aggregate.

Ratio of cement andcoarse aggregate	Compressive Strength(KN)	
	7days	14Days
1:4	111.11	128.27
1:6	66.6	81.57

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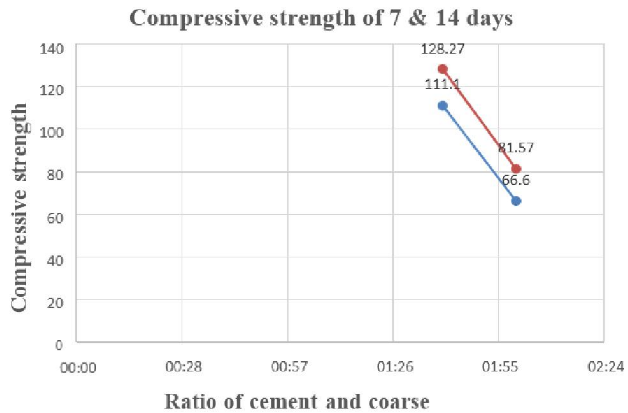

VI. CONCLUSION

- When compare to normal concrete, pervious concrete has a 50% to 75% reduction in compressive strength.
- Compare to normal concrete, its density is 30% lower.
- The void ratio increases with coarse aggregate size.
- As aggregate size grows, the compressive strength of the cube decreases.
- Fly ash increases mechanical strength while lowering permeability.
- As the aggregate size grows, permeability rises.
- The compressive strength of the mix is normally lower when the water cement ratio is lower or greater than the ideal value.
- Aggregate size, shape and water cement ratio all are affect. The permeable porous concrete

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