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An Experimental Paper on Compressive Strength of Pervious Concrete

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ABSTRACT

Pervious concrete has been in use in many countries over more than a century. Its higher porosity helps in percolating rain water directly to ground and thereby helps in recharging groundwater aquifer. In this study, pervious concrete of sizes of 6.3mm size aggregate were prepared with different water cement ratios to find the compressive strength. The purpose of this project is to analyze the feasibility of producing highly sustainable no-fine concrete mixtures and evaluating the effect of W/c ratio on the properties of pervious concrete. Porous concrete is produced by using ordinary Portland cement, coarse aggregates, and water. This concrete is tested for its property compressive strength. The results showed that the water cement ratio showed significant effect on compressive strength of Pervious concrete.

KEYWORDS: *Pervious concrete, Compressive strength.*

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I. INTRODUCTION

With population growth, continual urbanization has led to an increase of impervious surface areas, which block the percolation of precipitation from rainfall through the ground. This increases the potential for excess surface runoff, which can lead to downstream flooding, bank erosion and possibly transport of pollutants into potable water supplies. On the other hand, permeable pavements have the ability to reduce runoff volume and improve water quality. Indeed, they can store storm water runoff until infiltrating into soil or conveyed downstream in the storm water management system by a drain. For this reason, many communities are now exploring their use as an alternative low impact development design for storm water control measures. Such permeable pavement systems can contribute to solving drainage problems and reducing the risk of flash flooding, resulting from continuous urban developments. Portland cement pervious concrete (PCPC) is a special type of concrete characterized by an interconnected pore structure. The use of pervious concrete may reduce loading risk, recharge ground water, reduce storm water runoff, reduce noise when in contact with vehicle tires, and prevent glare and skidding during rainy season by allowing water to infiltrate freely through its pores [2,3]. In addition, pervious concrete is produced at low cost, thus it can be considered among the most attractive sustainable urban drainage systems (SUDS). PCPC requires, however, regular maintenance to prevent any clogging of the pores by sediments and vegetation which might change its high permeability.

While its constituent materials are similar to that of normal concrete, PCPC contains little or no fine aggregate. It is also known as no-fines concrete, permeable concrete, porous concrete and enhanced porosity concrete. Pervious concrete has been used in a variety of applications, notable among which are low-traffic pavements such as parking lots and sidewalks, around buildings, and on highway shoulders and medians.

This study is an attempt to reduce sand in the consecutive order proportion till 100% reduction of sand from the previous concrete to determine the compressive strength and infiltration rate; also find the optimum sand proportion to produce pervious concrete. The comparison of pervious concrete with standard concrete is shown in Figure 1 and the application of pervious concrete in sidewalks is shown in Figure 2. Correct paste viscosity allows complete coating of the coarse aggregate without paste draining away and clogging the pore space. Desired paste viscosity is achieved by balancing water content, fine aggregate, and admixtures. Workability of the mixture is influenced by the paste consistency, thickness of cementous paste between coarse aggregate particles, and surface characteristics of the coarse aggregate. While many mixtures are possible, typical

mixtures contain 300 to 360 kg/m3 of cement. Water-to-cement ratios (w/c) 0.5-0.6

Figure1. Comparison of pervious and conventional concrete

Figure2. Pervious concrete application in sidewalks

II. EXPERIMENTAL PROGRAM AND APPROACH

MATERIAL PROPERTIES

2.1. AGRREGATES:-

In pervious concrete generally singular size of coarse aggregates are used. For design of pervious concrete we used 6.3 mm of coarse aggregates as per the IS code 10262:2009 for mix design and also if coarse aggregate size decreases compressive strength increases.

2.2 CEMENTITIOUS MATERIAL:-

we used ordinary Portland cement of o.p.c grade-53(Deccan cement) as per the is code IS code 12269-1987. The fineness is used to quantify the surface area of cement. The surface area provides a direct indication of the cement fineness. The typical fineness of cement ranges from 350 to 500 sq.m/kg. The type of cement used all throughout the experiment was Ordinary Portland Cement of grade 53 (OPC-53). This is the most common type of cement used in general concrete construction where there is no exposure to sulfates in the soil or in the ground water.

Table1: physical properties of cement

S. No.	Properties	Experimental values
1	Fineness of cement	6.50%
2	Specific gravity	3.10
3	Nominal consistency	29%
4	Initial setting time	30 min
5	Final setting time	320 min

Water: This is the least expensive but most important ingredient of concrete. The water, which is used for making concrete, should be clean and free from harmful impurities such as oil, alkali, acid, etc.; In general, the water, which is fit for drinking, should be used for making concrete. The results of various tests on water are given below.

Table2: physical properties of water

S. No	Parameter	Values
1.	pH	7.10
2.	Taste	Agreeable
3.	Appearance	Clear
4.	Turbidity (NT Units)	1.75
5.	Hardness (mg/l)	250

MIX DESIGN:

Pervious concrete uses the same material as a conventional concrete, except that there is usually no or little fine aggregate. The size of the coarse aggregate used to keep fairly uniform in size to minimize surface roughness and for a better aesthetic. Water to cement ratio should be within 0.5-0.6Ordinary Portland cement and blended cement can be used in pervious concrete. Admixtures can be used in pervious concrete. Generally, A/C ratios is 1:4 by mass. These A/C ratios lead to aggregate contents of between about 1300 kg/m^3 to 1800 kg/m^3. Higher A/C ratios (greater than 4.5:1) have been used in laboratory studies, but significant reductions in strength result. However, mix design implemented based on literature study and trial mixes is given in Table.3.

Table3: mix proportions

Type	Proportions kg/m^3
Cement	450
Aggregate	1800
Water: cement ratio (by mass)	0.5-0.6
Aggregate: cement ratio (by mass)	4:1
Fine: coarse aggregate ratio (by mass)	0

Methodology

In order to develop the pervious concrete technology, trail-and-error process is implemented. The focus of the study was to identify elements that influence the mix proportions and the properties of pervious concrete. The test procedure includes the initial steps of deciding the tests to be conducted and choosing a number of aggregate ratios for the pervious concrete. This was followed by conducting the preliminary mix design and compressive strength tests on these samples to determine the mix that performed most successfully. To investigate the properties of cement and water, laboratory investigations are carried out. Standard hardened concrete tests compression test performed on pervious concrete samples to determine the strengths at different water cement ratios of 6.3mm size aggregate. Compressive strength determined by compression test through compressive testing machine

Compression strength= P/A

Where, P = maximum load (in kn) applied to the specimen,
A = cross-sectional area of the cylinder on which load is applied

In general compressive strength is dependent on size of coarse aggregate, void ratio, bond between mortar and coarse aggregate. In 7 days cubes of permeable concrete gain 30% of its strength, in 21 days of permeable concrete gain 70% of its strength, and for 28 days it gains 95% strength.

Figure3. Testing of cylinder for Compressive strength

III. RESULTS AND CONCLUSION

After the curing period of 28days the cylindrical samples are taken out and surface dried in room temperature without exposure to direct sunlight. Then the capping is done with gypsum on both top and bottom of cylinder to get even surface for equal distribution of load throughout the area of cylinder. All the compressive strength values are average of 3 samples. The test results are given below

Tabel4. Compressive strength of 6.3mm-9.5mm size of aggregate for 28 days curing

Cement aggregate ratio	Water Cement ratio	Load (P) (kn)	Compressive strength (N/mm^2)
1:4	0.53	85.16	10.79705
	0.56	78.46	9.990663
	0.6	53.46	6.807572

Figure4: Graph showing compressive strength of 28Days cured cylinders

The following are the conclusions made by this study. According to the Experimental results, it has been observed that The compressive strength of pervious concrete of 6.3mm-9.5mm size aggregate is greater for 0.53 compared to 0.57, 0.60 water cement ratios.

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