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Study on Compressive Strength and permeability of Pervious Concrete

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***Abstract*— Pervious concrete is a relatively new concept for rural road pavement, with increase into the problems in rural areas related to the low ground water level, agricultural problem. Pervious concrete has introduced in rural road as a road pavement material. Pervious concrete as a paving material has seen renewed interest due to its ability to allow water to flow through itself to recharge groundwater level and minimize storm water runoff. This introduction to pervious concrete pavements reviews its applications and engineering properties, including environmental benefits, structural properties, and durability. In rural area cost consideration is the primary factor which must be kept in mind. So that in rural areas costly storm water management practices is not applicable. 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 storm water management devices.**

This paper discuss the art of pervious concrete; materials and possible mix proportions, properties such as compressive strength, permeability with initial tests done at college.

Keywords—pervious concrete; Compressive strength; permeability; cement ; silica fume; Ground-granulated blast-furnace slag; aggregates;

I. INTRODUCTION

Pervious concrete can be used for a number of applications, but its primary use is in road pavement such as in rural areas. This report will focus on the pavement applications of the concrete, which also has been referred to as porous concrete, permeable concrete, no-fines concrete, gap-graded concrete, and enhanced-porosity concrete.

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 pavement in rural areas is a unique and effective means to achieve important environmental issues and support green, sustainable growth. By capturing storm water and allowing it to seep into the ground, porous concrete is instrumental in recharging groundwater, reducing storm water runoff.

. In the absence of fine aggregates, pervious concrete has connected pores size range from 2 to 8 mm, and the void content usually ranges from 15% to 25% with compressive strength of 2.8MPa to 28MPa (however strength of 2.8 to 10 MPa are common). The draining rate of pervious concrete pavement will vary with aggregate size and density of the mixture, but will generally fall within the range of 81 to 730 L/Min/m2.

The objectives of the study presented here were to determine the compressive strength and permeability properties of a particular porous concrete mix design. Each type of test was performed on samples with diameters of 150 mm, 150 mm, and 150 mm to determine what role, if any, the sample size has on reported results. For a given sample size, each test was conducted on at least three different “identical” specimens.

II. EXPERIMENTS

A. *Objective of the investigation*

Experiments were conducted to form pervious concrete using coarse aggregates and cement with admixture named as GGBFS and silica fume. These particles are replacing the volume of the cement by percentage. The following is considered while conducting the experiments and casting.

- Comparing the results with the standard values of compressive strengths and permeability of the concrete that are obtained by testing of concrete with no using admixture at 28thth day.

III. MATERIALS AND EXPERIMENT

A. *material used*

1. GGBFS- Ground-granulated blast-furnace slag
2. Ordinary Portland cement- 53 grade cement was used for the experiment
3. Coarse aggregate- standard crushed stones available for regular construction works were used.
4. Silica fume
5. No plasticizers were added.

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B. Procedure

- Initially 3 cubes and of standard sizes were cast for M15 grade of concrete for reference, defined as RF.
- 5 sets of cubes and were cast for different proportion of replacement of cement in concrete for the same mix design, defined as M1 to M5.
- The proportion of the GGBFS and silica fume in designated grade are as follows:

Table 2: Admixture proportion in respective concrete mix.

Name	% Of GGBFS	% of silica fume
M1	05	05
M2	10	10
M3	15	15
M4	20	20
M5	25	25

- Cube specimens of size 150mm X 150mm X 150mm were prepared for every concrete mix with different proportion of GGBFS and silica fume and were tested on 28th day.

C. Mix Design

The mix design was prepared for M15 grade concrete. For the calculation of the quantities and mix design different research paper and literature review were used.

The quantities required for M15 grade are given in the table below. This concrete mix will be referred as "RF".

***Table 3:** Mix design for RF (Per m3)*

Name	Quantity (kg)
Cement	326
Water	145.58
Course aggregate	1277.49

The quantities for other mix that contains GGBFS and silica fume content are given in the table below.
Cement/Water ratio: 0.44

Aggregate/Cement ratio: 4

Table 3: Mix design for M1 to M5 (Per m3)

Mix name	Cement (kg)	GGBFS (kg)	Silica fume (kg)	Course aggregate (kg)
M1	293.86	16.32	16.32	1135.54
M2	261.21	32.65	32.65	1135.54
M3	228.56	48.97	48.97	1135.54
M4	195.91	64.99	64.99	1135.54
M5	163.26	81.63	81.63	1135.54

D. Tests

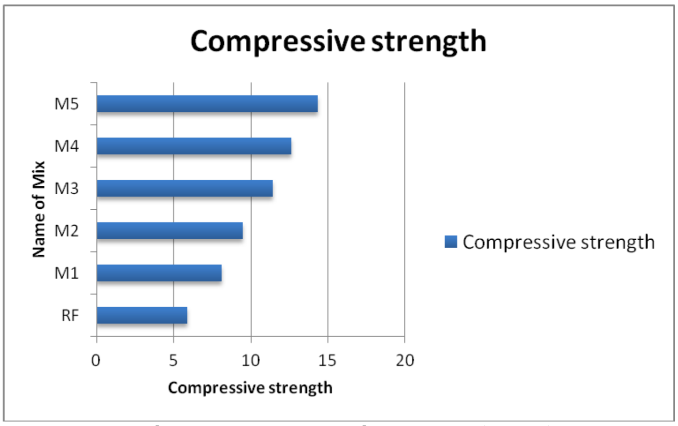
(A) Compressive strength:

3 cubes of each type of concrete mix were tested for compressive strength. The table below shows the value of average compressive strength of various type of mix. All the tests were performed according to IS 516-1959.

Table 4: Compressive strength of various mix at 28th day

Name Of Mix	Compressive Strength
RF	5.86
M1	8.13
M2	9.45
M3	11.44
M4	12.62
M5	14.35

Graph 1: comparison between increment of strength and mix proportion various mix at 28th day referred to Table no.4



Graph 1 Compressive strength comparison(in MPa)

fig. 1 Compression test

(B) Permeability:

3 cubes of each type of concrete mix were tested for permeability. The table below shows the value of average permeability of various type of mix. All the tests were performed according to IS 516-1959.

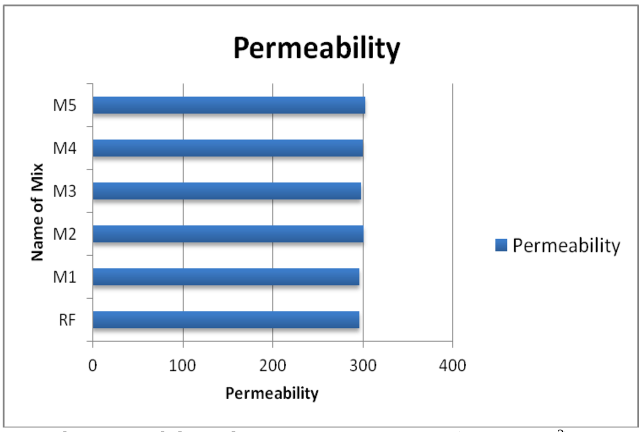
Table 5: permeability of various mix at 28th day

Name Of Mix	Permeability in L/min/m^2
RF	296
M1	296
M2	301
M3	298
M4	300
M5	303

Graph 2: Comparison between various mix design and permeability at 28th day referred to Table no. 4

Has been made a setup for the permeability test of the pervious concrete

Fig.2 Permeability test setup



Graph-2 Permeability value comparison (in L/min/m^2)

Average permeability is 299liter/minute/m^2

IV. RESULTS AND DISCUSSIONS

- It is evident that GGBFS and silica fume can be used as a partial replacement for in cement for increment of strength.
- Ideally 50% of replacement of cement should be done as it is observed in the tests that compressive strength of M15 is increase where permeability remains nearly constant.

V. CONCLUSIONS

The following conclusion comes through the study of the pervious concrete pavement becomes more suitable reduce the storm water runoff, to increase the ground water level, to eliminate the costly storm water management practices. From the above case study we conclude that there is an average permeability of tested concrete is 299 liters per minute per meter square and strength of it is 95% of M15 grade concrete. Pervious concrete is the relatively new concrete for the pavement construction. Pervious concrete extensively used worldwide because of their environmental benefits, hydraulic and durability properties.

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