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An Experimental Study on Pervious Concrete

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ABSTRACT

Pervious concrete is a type of concrete with high porosity. It is used for concrete flatworks application that allows the water to pass through it, thereby reducing the runoff from a site and allowing ground water recharge. The high porosity is attained by highly interconnected voids content. Pervious concrete has water to cementicious material ratio of 0.36. The mixture is composed of cementicious materials, coarse aggregates and water with no fine aggregates. In this paper works porous concrete with fly ash as a blended material is tested for strength and permeability for assessing the adaptability of fly ash as a substitute material to cement. The percentage of fly ash is varied from 10% and 20%. Various tests like compressive strength, tensile strength and water permeability are done on the specimens and results are discussed.

Keywords: Fly ash, Compressive strength, Tensile strength, Permeability test.

1. INTRODUCTION

Environmental change, global warming and manage of industrial wastages is the matter of concern of the hour. At present, eco concern is huge responsive and much vital due to the population explosion, massive constructions and extensive use of industry materials like cement. Since researches are going on across the world to find a replacement of cement. As fly ash is a industrial waste product and its disposal is a head ache towards the industries and government but it has cementitious property, so its use in civil engineering industry can solve both the problems. Titanium oxide is used in pervious concrete for cleaning the air pollutants and volatile organic compounds by oxidizing them1. As a result, the dust particles clogged in the pores of concrete are easily washed down during rains by maintaining the infiltration rate in pervious concrete. In this report, the effects of varying the components of pervious concrete on its compressive strength are investigated. The goal is to achieve a maximum compressive strength without inhibiting the permeability characteristics of the pervious concrete. This will be accomplished through extensive experiments on test cylinders and cubes.

II.PROJECT WORK

Materials used and its Properties:

2.1. Cement:

The Cement used in this study was Ordinary Portland cement (OPC) which is the most important type of cement. OPC cement of 53grade of cement use in this experimental work. Conforming weight of each cement bag was 50kg.The property of cement is shown in Table 1.

Table 1: Properties of Cement

Physical Properties	Value observed in investigation
Specific gravity	2.86
Consistency (%)	31
Initial setting time (minutes)	32
Final setting time (hours)	11.2
Fineness test (%)	7

2.2 Coarse Aggregate:

The coarse aggregate are the blue granite stone of which particles passes through 20mm sieve and retained 16mm sieve they should be hard, strong, dense, durable and clean. It should be conical shape. Flaky pieces should be avoided. It creates much better bond between cement paste and the Aggregates. The properties of Coarse aggregate are shown below in Table 2.

Table 2: Properties of Coarse Aggregate

S.NO	PROPERTY	VALUE
1	Sieve analysis	Passes through 20mm and retained on 16mm sieves
2	Specific gravity	2.53
3	Water absorption	2.71%
4	Impact test	11.11%
5	Dorry attrition test	29.2%

2.3 Fly Ash

Fly ash is a silt like powdery particles that are spherical in shape, either solid or hollow and mostly glassy (amorphous) in nature, having similar physical characteristic with silt. The property of fly ash is shown below in Table 3.

Table 3: Properties of Fly Ash

S.No	Property	Value
1	Specific gravity	2.42
2	Consistency (%)	29
3	Initial setting time (minutes)	150

Table 4: Physical Properties of Fly Ash

S.No	Properies	Fly Ash
1	Density	2.17g/cm^3
2	Specific gravity	1.66-2.55
3	Color	Grey
4	Bulk density	1.26g/cm^3
5	Particle shape	Irregular
6	Porosity	45%-55%
7	Fineness modulus	2.50-3.50

III.OBJECTIVES

The objective of this study is to investigate the effects onthe important engineering properties of pervious concrete additive to fly ash. The physical properties are examined inclusive with compressive strength, split tensile strength and permeability of pervious concrete.

IV.MIXING AND DESIGNING

While pervious concrete contains the same basic ingredients as the more common conventional concrete (ie. aggregate, Portland cement, water, and a variety of admixtures), the proportioning of ingredients is quite different. One major difference is the requirement of increased void space within the pervious concrete. With low water to cement ratio, the need for void space within the mix design, and little to no fine aggregates, the conventional design of concrete needs to be adjusted accordingly. Ratio of mixture materials commonly associated with pervious concrete are listed below. These ranges are based on previous researches.

Compositions:

1. Cement + Coarse aggregates + water (No substitution)
2. Cement + Coarse aggregates + water + fly Ash (10% substitution) + titanium dioxide (2%)
3. Cement + Coarse aggregates + water + fly ash (20% substitution) + titanium dioxide (2%)

Table 5: Mixing details

Material	Proportion range	Selected Proportion
Fly ash	5-20%	10% and 20%
w/c ratio	0.27 to0.34 (without admixture)	0.34
Aggregate: cement ratio	4 to 4.5 : 1	4:1
Fine:coarse aggregate ratio	0 to 1.1	0

Table 6: Quantity of material

S.No	Description	Value	Kg/Lit
1	Total quantity of cement	36	Kg
2	Total quantity of coarse aggregate	180	Kg
3	Total quantity of Fly Ash	9	Kg
4	Total quantity of water	16.2	Lit
5	Total quantity of Titanium Dioxide	0.5	Kg

V. RESULT AND DISCUSSION

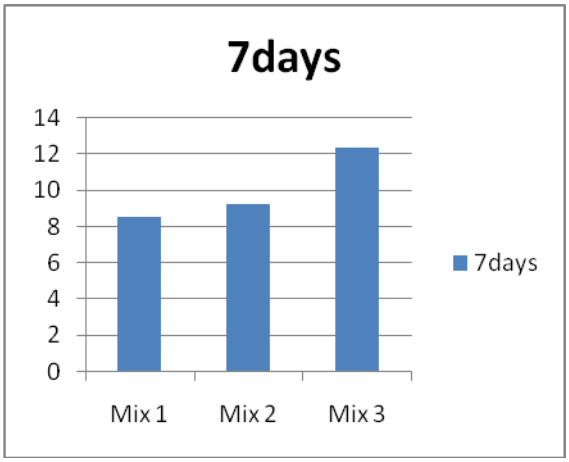
5.1 Compressive Strength Test

Compression test is the usual test conducted on hard concrete, partly because it is an easy test to perform and partly because most of the desirable properties of concrete are qualitatively related to its compressive strength. The strength of concrete is usually defined and determined by the crushing strength of 150mm x 150mmx150mm, at an age of 7 and 28 days. The mould and its base rigidly clamped together so as to reduce leakages during casting. The sides of the mould and base plates were made sticky oiled before casting to prevent bonding between the mould and concrete. The cube was set to store for 24 hours undisturbed.

Compressive strength was calculated as follows:
Compressive strength = P/A
Where,
P = Load (N)
A = Area (mm^2)
Area(150mm x 150mm)
The testing of cube under compression was shown in figure

Table 7. Test results for compression strength

Mix	Compression Strength N/Mm^2
	7DAYS
Mix 1(0%)	8.55
Mix 2(10%)	9.23
Mix 3(20%)	12.35



Graph 1 : Compression strength Test

5.2 Split Tensile Strength Test

For tensile strength test, cylindrical specimens of dimension 150 mm diameter and 300 mm length were cast. In this test three cylinders were tested and their average value was reported.

The split tension test was conducted by using digital compression machine having 2000 kN capacity.

Split tensile strength was calculated as follows:

Spilt Tensile strength (MPa) = $2P / \pi DL$

Where,

P = Failure Load (kN)

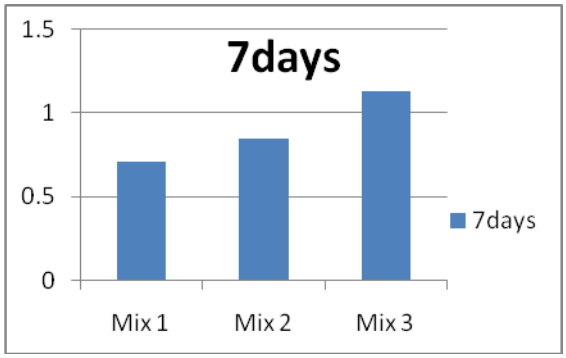
D = Diameter of Specimen (150 mm)

L = Length of Specimen (300 mm)

Three cylinder specimens were casted in each percentage, in order to find the average value of split tensile strength. These cylinder specimens were left for 7 and 28 days curing in a curing tank. After the course of curing, the specimens were ready for testing. All the cylinders were tested.

Table 8. Test results for Split Tensile strength test

Mix	Split Tensile Strength Test N/Mm^2
	7DAYS
Mix 1 (0%)	0.707
Mix 2 (10%)	0.848
Mix 3(20%)	1.13



Graph 2: Split Tensile Strength Test

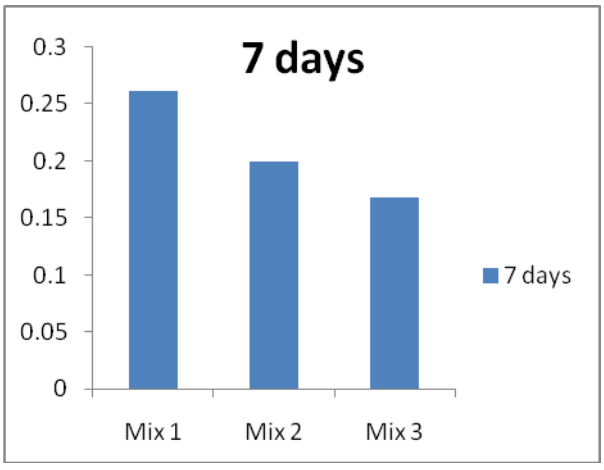
5.3 Permeability test

The constant head permeability test method has been adopted. The time required for the flow of 1000 ml of water through the Cubical mould was noted. Table below shows time and coefficient of permeability for the different specimens.

K = qL/AH
Where,
K = Coefficient of permeability cm/sec
q = Discharge cm^3/sec
L = Length of specimen in cm
A = Cross-sectional area in cm^2
H = Constant head causing flow in cm

Table 9. Test results for Permeability test

Mix	Permeability Test Cm/Sec
	7DAYS
Mix 1(0%)	0.26116
Mix 2(10%)	0.19981
Mix 3 (20%)	0.16788



Graph 3. Permeability test

VI. CONCLUSIONS

In summary of the above investigations, the following conclusions are made from the experimental results indicated following:

- The compressive strength and split tensile strength of concrete with 10% and 20% replacement results in increased strength compared to the pervious concrete without fly ash.
- By the use of cementicious material fly ash, the usage of cement can be reduced which will reduce the cost of concrete to certain extent.
- The permeability of concrete with 10% and 20% replacement results in decreased coefficient of permeability compared to the pervious concrete without fly ash.
- As the pervious concrete with 10% and 20% replacement of fly ash gives slight increase in compressive strength, split tensile strength and decrease coefficient of permeability. Hence this material can be used for road pavement at the places of low volume of traffic road, parking lots, play grounds etc which helps in recharging.

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