STUDY ON STRENGTH PROPERTIES OF PERVIOUS CONCRETE USING FLYASH

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Abstract— Concrete is a homogeneous mixture of cement, aggregate (fine and coarse aggregate) and water. Now a day's special concrete is more preferred in the construction industry. Some of the special concretes are pervious concrete, high strength concrete, transparent concrete, self compacting concrete because of their special properties which is better compared to convectional concrete.

Pervious concrete is a special concrete in which no fine aggregate is used. It is a zero slump concrete, open graded material consisting of cement, coarse aggregate, admixture and water. Fly ash concrete increases the long term compressive strength of concrete when compared to plain cement concrete. It can be used in levels ranging at 15% to 25% by mass of cementitious material component.

The main aim of this experimental study is to design M 20 mix for pervious concrete by using fly ash .as per the test results, the specimens of pervious concrete of M20 mix for compressive strength, split tensile strength of pervious concrete with percentage of fine aggregate as 0%, 10% & 20% of concrete specimen tested for 7 days, 28 days & 90 days are presented in this paper and the cement has been replaced with fly ash accordingly in the range of 30% by weight of total cement.

Keywords— Pervious Concrete, Porous Concrete, Pervious Concrete With Flyash.

1. Introduction

Pervious concrete is also known as porous concrete or no fines concrete. It is an innovative approach to controlling, managing and treating storm water runoff. When used in pavement application, pervious concrete can effectively capture and store storm water runoff, thereby allowing the runoff to percolate into the ground, improve and recharge ground water supplies.

Pervious concrete contains little or no fine aggregate (sand) and carefully controlled amounts of water and cementious materials. The paste coats and binds the aggregate particles together to create a system of highly permeable, inter connected voids that promote the rapid drainage of water. Over the last few years, pervious concrete has become a very relevant topic in the construction industry. Some of these applications include parking lots, sidewalks, and even pavers where in the past these were solely the domain of conventional concrete or black top. The popularity of pervious concrete continues to rise with the increased awareness of environmental protection and preservation. Pervious Concrete is recognized by United States Green Building Council (USGBC), which sets the green building rating system known as the LEED program. It is a nationally accepted benchmark for the design, construction, and operation of high performance "green" building.

2. Materials

The strength of pervious concrete is dependent on the cement content, water to cement ratio, compaction level and aggregate gradations.

2.1 Coarse Aggregate

The size, shape and gradation of the aggregate play an important role in achieving a proper concrete, the flaky and elongated particles will lead to blocking problems in confined zones. The sizes of aggregates will depend on the angularity number. The coarse aggregate chosen for pervious concrete is typically rounded and angular in shape, is well graded and smaller in maximum size that suited for convectional concrete as well as special type of concrete like pervious concrete. Typical convectional concrete should have a maximum aggregate size of 20mm.Gradation is an important factor in choosing a coarse aggregate, especially in typical use of pervious concrete. Gap graded coarse aggregate promotes segregation to a greater degree than the well graded coarse aggregate. Machine crushed angular granite metal of 10mm and 20mm nominal size from the local source is used as coarse aggregate. It is free from impurities such as dust, clay particles and organic matter. The coarse aggregate s also tested for various properties. The specific gravity, bulk density, fineness modulus and water absorption of coarse aggregate are found to be 2.75, 1511 kg/cum, 7.16 and 0.1 respectively.

Table 1- Physical Properties of Coarse Aggregate

S.NO	PROPERTY	RESULTS
1.	Specific gravity	2.51
2.	Bulk density	
	a) Loose state	1414 kg/m^3
	b) Compacted state	1510.9 kg/m^3

3	Water absorption	0.1%
4.	Aggregate impact value	22.80%
5.	Los angles abrasion value	3.68%
6.	Flakiness index	2.41%
7.	Elongation index	12.80%

2.2 Fine Aggregates:

The locally available sand is used as fine aggregate in the present investigation. The sand is free from clayey matter, salt and organic impurities. The sand is tested for various properties like specific gravity, bulk density and water absorption.

Table 2- Physical Properties of Fine Aggregate

S.NO.	PROPERTY	RESULTS
1.	Specific gravity	2.64
2.	Bulk density *c)* Loose state *d)* Compacted state	 1494.6 kg/m^3 1595.13 kg/m^3
3	Water absorption	0.1%
4.	Zone	2

2.3 Cementitious material:

The content of cement is dependent on the amount and size of coarse aggregate and the water content. Locally available 53 grade of ordinary Portland cement was used in the investigation.

Table 3 – Physical Properties of cement

S.NO	PROPERTY	RESULTS
1.	Normal consistency	32%
2.	Initial setting time	90 min
3.	Final setting time	250 min
4.	Specific gravity	2.9

2.4 Water

Locally available water was used for mixing and curing which is potable, shall be clean and free from injurious amounts of oil, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete. The water to cement ratio is taken as 0.34 for the study.

2.5Supplementary Cement Materials

Fly ash

Fly ash can be used as an substitute for a portion of the cement. Two types of fly ash which are Class C and Class F fly ash can be used in pervious concrete. Currently, Fly ash can replace 30% of the Portland cement in convectional concrete. Fly ash is a by product of coal burning in power plants, its utilization saves the energy required to produce the cement. In addition, fly ash improves the flow ability and workability of concrete. Specific gravity of fly ash is 2.

3. Mix Proportion

A procedure f or producing initial trial batches for pervious concrete is given in ACI 522 – R 10. The w/c ratio taken was 0.34.

Table 4: Mix proportion for various mixes

MIX	PROPORTION (cement : fly ash: fine aggregate : coarse aggregate)
0% fine aggregate	1:0.43:0:7.5

10% fine aggregate	1 :0.43:0.5:4.9
20% fine aggregate	1 : 0.43:1.1:4.5

4. Preparation of Test Specimens

Mixing of ingredients is done in a rotating drum. Thorough mixing by hand, using trowel is adopted. The cementitious materials are thoroughly blended with hand and the aggregate is added and mixed followed by gradual addition of water and mixing. Wet mixing is done until a uniform color, and consistency are achieved which is then ready for casting. The moulds are cleaned of dust particles and applied with mineral oil on all sides before concrete is poured in the mould. The moulds of size 150mm *150mm *150mm for cubes and 150mm*300mm for the cylindrical specimens are used. The moulds are placed on a level platform and excess concrete is removed with trowel and top surface is finished. The specimens are left undisturbed in the mould for 24 hours at room temperature after casting. The specimens are then removed and immediately transferred to the curing pond containing clean and fresh water.

5.Results

Test Results on Properties of Pervious Concrete are given below:
3 types of mixes were used to find the properties of pervious concrete
F0 = mix with 0% fine aggregate
F10 = mix with 10% fine aggregate
F20 = mix with 20% fine aggregate

5.1Void Content

Total void content test was conducted in accordance with ASTM C138. The test results are given below:

Table 5: Test results of void content

S.no	Mix	W1 (gms)	W2(gms)	Void content (%)	Average void content (%)
1	F0	1115	1900	21.5	
2	F0	1158	1940	21.8	20.7
3	F0	1200	1980	20	
4	F10	1390	2185	19.8	
5	F10	1338	2140	19.5	18.5
6	F10	1275	2080	18.0	
7	F20	1483	2305	17.8	
8	F20	2285	2285	17.6	16.8
9	F20	2315	2315	16.5	

5.2Compressive Strength

Compressive is defined as the ability of the material to resist compressive stress without failure. The specimen was tested in accordance with IS 516:1969.

Table 6: Test results of Average compressive strength (WITH FLYASH)

S.No	Type of mix	7 days (Mpa)	28 days (Mpa)	90 days (Mpa)
1	F0	9.75	13.18	17.06
2	F10	10.96	16.06	21.75
3	F20	14.08	17.82	28.55

5.3Split Tensile Strength

Take the wet specimen from water after 7days of curing. Wipe out water from the surface of specimen.
Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
Note the weight and dimension of the specimen. Set the compression testing machine for the required range

Keep plywood strip on the lower plate and place the specimen. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate. Place the other plywood strip above the specimen. Bring down the upper plate to touch the plywood strip. Apply the load continuously without shock . Note down the breaking load (P).

Table 7: Test results on Average split tensile strength (WITH FLYASH)

S.No	Type of mix	7 days (Mpa)	28 days (Mpa)	90 days (Mpa)
1	F0	0.86	1.35	1.71
2	F10	1.25	1.75	1.80
3	F20	1.60	2.02	2.56

Table 8: Comparison of test results on Average compressive strength of pervious concrete with and without flyash

S.No	Type of mix	With flyash 7 days (Mpa)	w/o flyash 7 days (Mpa)	With flyash 28 days (Mpa)	w/o flyash 28 days (Mpa)	With flyash 90 days (Mpa)	w/o flyash 90 days (Mpa
1	F0	9.75	10.98	13.18	16.85	17.08	19.48
2	F10	10.96	17.18	16.06	28.72	21.25	30.70
3	F20	14.08	28.25	17.82	33.78	28.50	34.23

Table 9: Comparison of test results on Average split tensile strength of pervious concrete with and without flyash

S.No	Type of mix	With flyash 7 days (Mpa)	w/o flyash 7 days (Mpa)	With flyash 28 days (Mpa)	w/o flyash 28 days (Mpa)	With flyash 90 days (Mpa)	w/o flyash 90 days (Mpa
1	F0	0.86	0.61	1.35	1.02	1.71	1.64
2	F10	1.25	1.45	1.75	1.79	1.80	2.11
3	F20	1.60	1.80	2.02	2.90	2.56	3.10

6.Conclusions

The following conclusions are made from the study on properties of pervious concrete with the replacement of cement by 30% of fly ash and addition of 0%, 10% & 2% of fine aggregate:

1. The void content is observed to be in the range of 21% to 22% with average void content of 21.7% for 0% fine aggregate in the mix.
2. The void content was observed to be decreased by increasing in % of fine aggregate in the mix and it was observed to be decreased in the range of 9% to 18% for 10% and 20% fine aggregate.
3. The compressive strength of pervious concrete was found to be increased in the range of 10% to 34% for 10% and 20% of fine aggregate in the mix respectively.
4. The split tensile strength of pervious concrete was found to be increased in the range of 15% to 42% for 10% and 20% of fine aggregate in the mix respectively.
5. It is observed that the optimum mix is 20% fine aggregate mix, because the compressive strength of pervious concrete by using fly ash is 28.72 MPa at 28 days and void percentage is 19.6%.
6. The usage of fly ash in pervious concrete has shown to improve long term strength.

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