An Experimental Study on Strength and Properties of Thirsty Concrete

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***Abstract*- In this paper , a thirsty concrete used for roadway is introduced .It is an concrete with high porosity used for flatwork applications that allows to pass through which reduces the runoff from a site and help recharging ground water levels. Using the common material and method, the strength of the pervious concrete is low. Hence the materials with different type, shapes and sizes are used to get better results. The infiltration rate, abrasion resistance and durability of the materials used are also good. And an experimental study evaluating strength and permeability characteristics of a pervious concrete mix design is presented. The experimental work included compressive strength tests(at 7 and 28 days, and infiltration rate test(at 28 days) on clean specimens .Resulting that Its void content ranges from 18 to 35% with compressive strengths of 2.74 to 27.56 MPa .Pervious concrete is used in parking areas, roadways, pedestrian walkways, and greenhouses and contributes to sustainable construction. In this project scrap marble is used to make pervious concrete and also checking various parameters like permeability and compressive strength with respect to different shapes of aggregate like angular, rounded, and flaky type. Under the guidance of J. Kumar RMC plant PUNE, this project was successfully completed.**

I. INTRODUCTION

Improvement in construction industry and infrastructure in India, maximum metro cities tends to getting covered with impermeable concrete pavements which results into environmental problems such as fall of recharge of rainwater into the ground hence continuous reduction in water table which leads to water crisis during summer. environmental issues such as erosion, decrease in ground water table, pollution of rivers, lakes, and coastal waters are occurred due to the falling of maximum quantity of rainwater on impermeable surfaces hence the best solution to get rid of all these problems stated above is the installation of pavement surfaces made up of thirsty concrete which is an environmentally friendly material. Although emphasis has been placed on the conventional pervious concrete and it's porosity, not much research has been carried out to characterize the relationship between compressive behavior of pervious concrete with varied aggregate type and almost no research has been done using scrap marble as aggregate. In this research cubes using different types of aggregate where casted for M40 grade of concrete in which aggregate size vary from 4.75mm to 12.5 mm.

II. OBJECTIVES

Objectives of proposed work would be:

1. To enhance compressive strength of pervious concrete by using different shaped coarse aggregates and replacing aggregate with marble.
2. To study water penetration property of pervious concrete by varying shape of coarse aggregates and replacing aggregate with marble.
3. To study abrasion resistance property of pervious concrete pavement.
4. To check which type/shape of aggregate used for making pervious concrete gives maximum rate of infiltration.

III. EXPERIMENTAL WORK

i) Tests on material:

Following are the tests that have taken on materials used to get their physical properties:

	Angular	Rounded	Flaky	Scrap marble
Specifc gravity	2.84	2.62	2.7	2.78
Water absorption	0.78	0.62	0.81	0.5
Aggregate impact	13.68	16.86	20.9	22.68
Aggregate crushing	17.50	_	25.29	30.10
Flakiness index	11	6	40	_
Elongation index	31.58	_	8.6	_
LAabrasion value	17	11	22	10.46

TABLE 3.1 Physical properties of aggregates

ii) Design of Mix Proportion:

Concrete Mix Design

Step 1 — Determination of Target Strength

ftarget = fck + 1.65 x S

S = standard deviation in N/mm2 = 4 (as per table -1 of IS 10262- 2009)

Step 2 — Selection of water / cement ratio:-

From Table 5 of IS 456, (page no 20)

Maximum water-cement ratio for Mild exposure condition = 0.55

Step 3 — Selection of Water Content

From Table 2 of IS 10262- 2009,

Maximum water content = 186 Kg (for Nominal maximum size of aggregate — 20 mm)

If super plasticizer is used, the water content can be reduced up to 20% and above as per cl.4.2 of IS 10626-2007

Step 4 — Selection of Cement Content

As per clause 8.2.4.2 of IS: 456

Maximum cement content = 450 kg/m3.

Step 5: Estimation of Coarse Aggregate proportion:-

Table 3 Volume of Coarse Aggregate per Unit Volume of Total Aggregate for Different Zones of Fine Aggregate

(*Clauses* 4.4, A-7 *and* B-7)

Sl No.	Nominal Maximum Size of Aggregate	Volume of Coarse Aggregate[1] per Unit Volume of Total Aggregate for Different Zones of Fine Aggregate			
	mm	Zone IV	Zone III	Zone II	Zone I
(1)	(2)	(3)	(4)	(5)	(6)
i)	10	0.50	0.48	0.46	0.44
ii)	20	0.66	0.64	0.62	0.60
iii)	40	0.75	0.73	0.71	0.69

[1] Volumes are based on aggregates in saturated surface dry condition.

Step 6: Estimation of the mix ingredients

a. Volume of concrete
b. Volume of cement = (Mass of cement / Specific gravity of cement) x (1/100)
c. Volume of water = (Mass of water / Specific gravity of water) x (1/1000)
d. Volume of Chemical admixture (super plasticizer) = (Mass of chemical admixture / Weight density of admixture)
e. Volume of total aggregates =Volume of concrete - (Volume of cement + Volume of water + Volume of admixture)
f. Mass of coarse aggregates = (Volume of total aggregate) x Proportion volume of coarse aggregate x Mass density of coarse aggregate
g. Mass of fine aggregates = (Volume of total aggregate) x Proportion volume of fine aggregate x Mass density of fine aggregate

Step 7: Mix proportion per m³ concrete

C : FA : CA

iii) Trial Cube Schedule:

Sr No	W/C ratio	C:A ratio	Cement content(kg)	Aggregate (kg)	Infiltration rate (m/s)
1	0.25	1:1.83	2.808	5.03	0.009
2	0.45	1:4	1.846	7.45	-
3	0.29	1:4	1.846	7.45	0.009
4	0.45	1:6	1.2	7.2	0.022
5	0.45	1:8	1	8	0.06
6	0.35	1:1.533	1.5	8	0.01

TABLE 3.2

iv) Tests on specimen

Sr No	Type/ shape of aggregate	Tests	No of cubes	Size of cube (mm)	Days of testing
1	Angular	Infiltration	3	150x150x150	28
		Compression	9	150x150x150	7,14,28
2	Rounded	Infiltration	3	150x150x150	28
		Compression	9	150x150x150	7,14,28
3	Flaky	Infiltration	3	150x150x150	28
		Compression	9	150x150x150	7,14,28
4	Marble	Infiltration	3	150x150x150	28
		Compression	9	150x150x150	7,14,28

TABLE 3.3

Compressive Strength of Concrete -Cube Test

Compressive strength formula for any material is the load applied at the point of failure to the cross-section area of the face on which load was applied.

Compressive Strength = Load / Cross-sectional Area

Procedure for Concrete Cube Test

1. Remove the specimen from water after specified curing time and wipe out excess water from the surface.
2. Take the dimension of the specimen to the nearest 0.2m
3. Clean the bearing surface of the testing machine

4. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
5. Align the specimen centrally on the base plate of the machine.
6. Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
7. Apply the load gradually without shock and continuously at the rate of 140 kg/cm2/minute till the specimen fails

Record the maximum load and note any unusual features in the type of failure.

Infiltration Rate Test

The infiltration Rate of Pervious Concrete is measured on 28th day after casting of Pervious Concrete in following steps:

1. Pervious Concrete cube is placed in a polythene bag such that top surface of cube and that of polythene bag coincide.
2. After placing cube in a polythene bag such that its it is wrapped up in the bag covering all its vertical faces with the help of tape and leaving top face open outside, bottom face open inside the bag and care is also taken to make sure that covering around cube is watertight. Remaining length of the polythene bag which is not wrapped around Pervious Concrete cube is kept free to contain water which would be poured in from top face and percolate through Pervious Concrete cube and fall into free part of bag through bottom face.
3. Measured volume of water is poured in from top face into the polythene bag through Pervious Concrete cube.
4. After pouring is completed polythene bag with thirsty Concrete cube inside it is turned and all the water inside it is allowed to percolate through thirstyConcrete cube and time is measured required for draining out all the water.
5. With the help of measured volume of water, time required for all the water to pass through it and cross sectional area of cube, Infiltration rate of thirsty Concrete is found out.
6. Infiltration rate = Measured volume of water/C/S area of cube / time required for draining out entire vol. of water

IV. RESULTS AND DISCUSSION

	Angular Aggregate	Rounded Aggregate	Flaky Aggregate	Scrap marble
A) Mean Compressive Strength of Concrete - Cube Test	8.582 MPa	4.7MPa	6.89MPa	2.5MPa
C) Mean Infiltration Rate	0.035m/s	0.0274 m/s	0.051 m/s	0.0403 m/s

TABLE 4.1

V. CONCLUSION

- Among the all types of aggregate used , mean compressive strengths of cubes made up of angular and flakey aggregate are considerable.
- But mean infiltration rate of cubes made up of flakey aggregates is more than that of the angular aggregates, which satisfies the motto of thirsty concrete.
- Hence flakey aggregates can be used to make the thirsty concrete cubes.

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