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Pervious Concrete using Burnt Earth Aggregate

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***Abstract*— Pervious concrete is a special high porosity concrete used for flat work applications that allows water from precipitation and other sources to pass through here by reducing in the runoff from a site and recharging ground water level .In an effort to find an alternative material in concrete, much work has been focused to use brick aggregate in producing normal strength or even high strength concrete. However there is hardly any literature of producing pervious concrete using brick aggregate chip and tile aggregate chip as coarse aggregate. This paper describes an experimental investigation carried on pervious concrete made of brick and tile chip and also shed lights on the engineering properties of new product. Properties of pervious concrete such as compressive strength, splitting tensile strength and void ratio are investigated. Cube of size 150x150x150 are prepared to investigate compressive strength and 70mmx70mmx70mm are prepared to investigate void ratio. Cylinders of size 150mmΦ and 300mm high are prepared to investigate splitting tensile strength. These investigations should be carried out at the end of 7days and 28 days of curing. Different concrete mix proportion such as 1:6, 1:8&1:10 with different size of brick and tile such as 10mm and 20mm should be used to check these properties of pervious concrete. Stone aggregate are also to be used here for comparison purposes. Test result indicate that brick pervious can be used at place of high permeability requirement and tile pervious concrete is preferred at place were strength and permeability is having equal importance**.

I. INTRODUCTION

Pervious concrete is a special type of concrete obtained by omitting fine aggregates from the mix design. Thus the name no fine concretes is also applied, which is agglomeration of coarse aggregate particles surrounded by a coating of cement paste. Absences of fine particles introduce a high percentage of voids in concrete, which leads to its low compressive strength. However, these voids are large in size resulting in very low capillary movement of water, and high permeability. Comparing to conventional concrete which has a void ratio of about 3-5%, pervious concrete possesses void ratio as high as 15-40% depending on its application. This high percentage of void ratio results of its low unit weight of about 70% that of conventional concrete.

Low compressive strength of pervious concrete limits its application under low traffic loads and volumes. However, high flow rate of water together with light weight makes pervious concrete an ideal material to be used in pavements. High permeable pavement has a great advantage in reduction of storm water runoff as compared to other conventional non pervious pavements. This property has lead pervious concrete to be increasingly used in urban settings to improve the storm water quality and reducing rainfall runoff .This concrete has also been used as a load bearing walls in houses.

Permeability is the major requirement of pervious concrete, so the material are selected accordingly. Brick and tile are naturally porous materials. The main objective is to study the brick and tile aggregate for pervious concrete and to evaluate the strength behaviors in relation stone pervious concrete.

II. EXPERIMENTAL MATERIALS

Pervious concrete is mixture of cement, coarse aggregate and water. No fine aggregates are used for making pervious concrete, sometimes microfibers and admixtures are used to achieve adequate strength and durability of pervious concrete.

Table 1: The various properties of cement used(53 grade)

Property	Value
Standard consistency of cement	30%
Compressive strength at 7 days	23.3 N/mm^2
Compressive strength at 28 days	35.5 N/mm^2
Specific gravity	3.14

Table 2: the various properties of coarse aggregate

Test Conducted	Brick Aggregate Size		Tile Aggregate Size		Stone Aggregate Size	
	10mm	20mm	10mm	20mm	10mm	20mm
Water Absorption	6%	8%	4	5.5	0.74%	2.50%
Crushing Value	7	7	9	11	17	19

III. PEXPERIMENTAL METHODOLOGY

Three batches of test specimen were produced from each of the aggregate size representing aggregate cement ratios of 6:1, 8:1 and 10:1 with no fines in the mixes. Two different sizes of coarse aggregate (crushed stone aggregate, brick aggregate and burnt clay brick aggregate) were used in this study. The sizes are 10mm and 20mm. The batched materials are thoroughly hand-mixed with water so as to obtain uniform and homogenous pervious concrete. Water/cement ratio of 0.4 was added to form a cement paste. After 24 hours specimens were taken out and kept for water curing. After 7, 14,21and 28 days specimens were tested for compressive strength, splitting tensile strength, void ratio and permeability.

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A. *Compressive strength*

The test was carried out in accordance with BS1881-108: 1983 and ACI 522R-10. The test specimens, cubical in shape of size 150x150x150 mm are used. Compression tests are conducted at 7, 14, 21 and 28 days of the casting of specimens. The load applied without shock and continuously at a rate approximately 140 kg/cm/minute until failure of the specimen. The maximum load applied to the specimen until a failure recorded. Then based on the load value the compressive strength of the concrete specimen calculated as follows.

Compressive strength=ultimate load/contact area of the cube

B. *Splitting tensile strength*

The aim of the test is to determine the split tensile strength of pervious concrete. The test was carried out in accordance with BS1881-108: 1983 and ACI522R-10. A standard test cylinder of concrete specimen of size 300mm x 150mm is used to determine the split tensile strength. The test is done using compression testing machine. The specimens were tested for split tensile strength at specify ages of 7, 14, 21 and 28 days of curing. The splitting tensile strength of pervious concrete is calculated thus:

$$\text{Splitting tensile strength} = 2P/\pi DL$$

P: Compressive load on cylinder
L: Length of the cylinder
D: Diameter of the cylinder

C. *Void ratio*

The aim of the test is to determine the void ratio of pervious concrete. The void ratio was determined by calculating the difference in weight of the cube specimens of size70mmx70mmx70mm between the dry sample and the saturated under water sample. The void ratio of pervious concrete is calculated thus:

$$\text{Void ratio} = (1-(w_1-w_2)/v\rho_w)$$

W_1: weight under water, kg.
W_2: oven dry sample, kg.
ρ_w: density of water, kg/m^3
V: volume in m^3

IV. EXPERIMENT RESULT

A. *Compressive strength*

Table 3: compressive strength on pervious concrete

Cement to aggregate ratio	Curing period (Days)	Brick aggregate		Tile aggregate		Stone aggregate	
		10mm	20mm	10mm	20mm	10mm	20mm
1:6	7	4.998	2.980	5.193	3.125	5.778	3.333
	28	10.563	7.850	10.644	8.005	10.810	8.200
1:8	7	3.403	2.025	3.455	2.112	3.481	2.222
	28	7.536	4.700	7.775	4.900	8.074	5.111
1:10	7	3.112	1.721	3.285	1.921	3.407	2.000
	28	6.875	4.125	7.005	4.010	7.185	4.333

B. *Splitting tensile strength*

Table4: Splitting tensile strength on pervious concrete

Cement to aggregate ratio	Curing period (Days)	Brick aggregate		Tile aggregate		Stone aggregate	
		10mm	20mm	10mm	20mm	10mm	20mm
1:6	7	0.59	0.49	0.62	0.53	0.65	0.56
	28	1.45	1.25	1.51	1.31	1.55	1.35
1:8	7	0.55	0.47	0.59	0.51	0.61	0.53
	28	1.34	1.04	1.37	1.12	1.41	1.2
1:10	7	0.51	0.40	0.54	0.42	0.55	0.45
	28	1.054	0.78	1.09	0.821	1.11	0.81

C. *Void Ratio*

Table5: Void Ratio on pervious concrete

Cement to aggregate ratio	Curing period (Days)	Brick aggregate		Tile aggregate		Stone aggregate	
		10mm	20mm	10mm	20mm	10mm	20mm
1:6	28	41.27	48.67	34.83	39.88	23.8	28.34
1:8	28	43.65	49.23	35.18	41.18	25.23	30.56
1:10	28	45.76	50.12	37.65	42.12	27.12	34.12

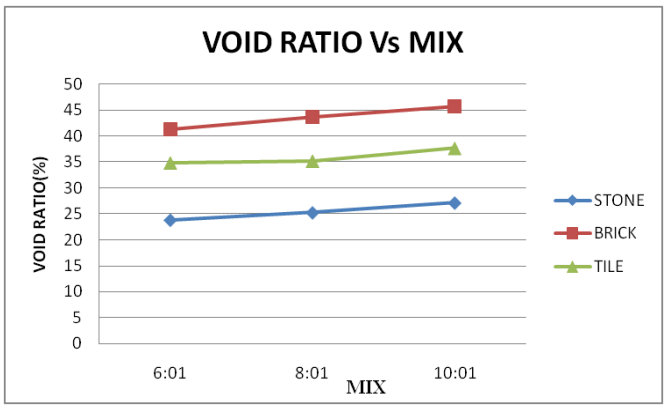

Fig .1 void ratio vs mix (10mm size aggregate)

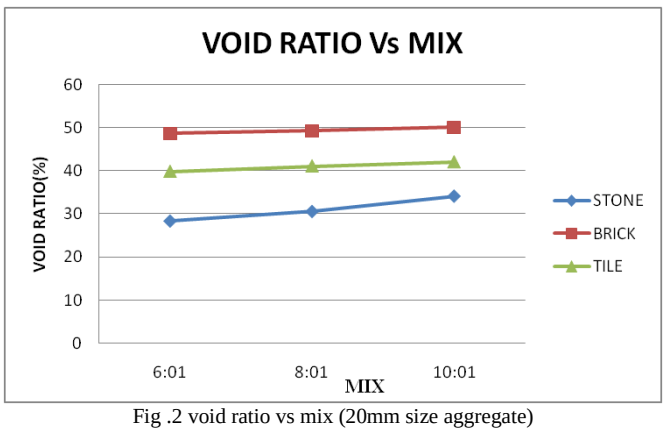

Fig .2 void ratio vs mix (20mm size aggregate)

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