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Utilization of Fly Ash Aggregates in Pervious Concrete

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Abstract*— As most of the places were covered with impermeable surfaces like cement concrete and bitumen. This has a major impact on the ground water table. Pervious Concrete pavement is an effective ways to minimize this issue. Pervious concrete is an open graded structure with interconnected voids through which rain and storm water is permitted to percolate into the aquifer. In reviewing technology advances through the centuries it is evident that material development plays a key role. Considerable efforts are still being made in every part of the world to develop the new construction materials. Porous concrete is an innovative material which is a mixture of coarse aggregate (25%Fly ash Aggregates and 75% of Coarse Aggregates), cement, water and little amount of sand to no sand along with or without chemical admixtures, A laboratory experiment was conducted to evaluate the properties of porous concrete. This study on permeability and strength properties of porous concrete. Trail Mix was done on the W/C Ratio of 0.45 and cement of 414 kg/m^3 for M20 grade by reducing the percentage of Fine aggregates and replaced by Coarse Aggregates(CA:FA- 30:70, 20:80, 10:90,0:100) and tested, As the cement slurry had settled down this caused obstruction to Permeability so the W/C Ratio of 0.375 and 0.35 are used with fixing cement of 400 kg/m3After the test we came to know that Permeability of 0.35 W/C ratio with 0:100 is having more permeability and W/C 0.375 with 20:80 ratio has more compressive strength. Porous concrete has wide range of applications so that it is applicable for – Sidewalks, pathways, parking lots, floors for green houses, noise barriers,and play grounds. Moreover it has several environmental benefits such as – allows groundwater to infiltrate into the ground to replenish groundwater aquifers, allows parking lots, Hence we can finally conclude that porous concrete is an environmental friendly .

Keywords—Fly ash aggregate ,Pervious concrete ,pellitization

I. INTRODUCTION (*Heading 1*)

Porous concrete is a performance-engineered structural material using the usual constituents of conventional Portland cement concrete, only with little or no sand in the mixture, allowing for a 15 to 30 percent air void factor. Taking advantage of the corresponding decreased density, the concrete is incredibly permeable while still able to provide a quality structural pavement. Instead of moisture (e.g. rain/snow melt) running off the surface horizontally, virtually all storm water falling onto porous concrete immediately drains directly down through the pavement to the sub grade, eliminating run of while providing filtration and ground water recharge. A porous concrete system can be designed with an appropriate porous aggregate base layer to function as a storm water storage basin that accommodates precipitation for a design storm event.

1.1 Scope and Objective

The purpose of the present dissertation work is summarized as the following objectives:

- Aggregate gradations and mix-design procedures for pervious concrete.
- To evaluate several laboratory pervious specimens.
- To evaluate the performance of porous specimens in terms of Permeability, compression, tensile, Flexure.
- Finally based on the experimental results, to establish relationships between various 'Pervious concrete Parameters'.

1.2 METHODOLOGY

PREPARATION OF FLY ASH AGGREGATE**:**

1. Fly ash and Ordinary Portland cement of ratio [fly ash: cement]
2. These proportion is thoroughly dry mixed in Concrete Mixer.
3. After dry mix water is sprinkled in a mixer until the formation of fly ash aggregates.
4. The contents were thoroughly mixed in concrete mixer until the formation of fly ash aggregate. These methods of formation of aggregates are called pelletization.
5. Once the aggregate is formed in mixer, it is collected in tray allowed to dry for a day.
6. Dried aggregate are cured for 7days and 28days for water curing.

Figure: 1 showing process of formation of fly ash aggregates by pelletization.

PERVIOUS CONCRETE SPECIMEN

The procedure of casting concrete specimen

1. The weighed materials of cement, fine and coarse aggregates, fly ash aggregates were then placed on a large mixing tray which is clean and free from impurities.
2. The ingredients were then mixed to obtain a uniform mix after which the required amount of water with admixture of 1.25 kg /m3 is poured and mixed.
3. The concrete mix was then placed into the concrete cube mould (150 mm x 150 mm x 150mm) in three successive layer with 25 blows each layer, with the help of a tamping rod , the top surface was then smoothened.
4. The concrete mould was then placed in a safe location for 24 hours, after which the mould was opened and the cube was placed in a curing tank for a specified period of time.

1.3Mix Proportions

The concrete mix is designed as per as IS 10262 -2009 and IS 456-2000, for different water to cement ratios

Pervious concrete mix designs (W/C=0.45)					
Pervious ratio (FA:CA)	Cement (kg/m3)	FA] (kg/m3)	CA (kg/m3)	FAA (kg/m3)	Ratio (C:FA:CA:FAA)
30:70	413	552	978	203	1:1.33:2.37:0.49
20:80	413.	368	1117	232	1:0.891:2.704:0.5
10:90	413.	184	1257	262	1:0.445:3.042:0.6
0:100	413.	0	1397	291	1:0:3.380:0.704

Table 1 showing Pervious concrete mix proportions for W/C=0.45

Pervious concrete mix designs(W/C=0.375)					
Pervious ratio(FA:CA)	Cement (kg/m3)	FA (kg/m3)	CA (kg/m3)	FAA (kg/m3)	Ratio (C:FA:CA:FAA)
20:80	400	390	1183	246	1:0.975:2.958:0.61
10:90	400	195	1331	277	1:0.487:3.327:0.69
0:100	400	0	1479	308	1:0:3.697:0.7

Table 2 showing Pervious concrete mix proportions for W/C=0.375

2.0 EXPERIMENTAL RESULTS ON FLY ASH AGGREGATE AND FOR CONCRETE SPECIMENS

2.1 Experimental results on Fly sh aggregate

Tests	Results	
Specific gravity	1.76	
Absorption	0.3%	
Bulk density	1027.6 kg/m3	

Table 3 showing fly ash aggregate properties

Observation: From the above values the fly ash aggregate is considered as light weight in nature. The water absorption is almost similar to natural aggregate

2.2 Experimental results of Compressive strength for M20 grade Pervious concrete

Ratio of FA : CA	Compressive strength (Mpa)(W/C=0.45)	
	7 days	28 days
0:100	10.16	16.18
10:90	12.45	21.45
20:80	13.80	26.40
30:70	16.30	28.33

Table 4 showing Compressive strength results for Compressive strength of M20 grade Pervious Concrete

Observation: Compressive strength for 10:90 and 20:80 shows better result over other type of proportions

2.3Experimental results of Split tensile strength for M20 grade pervious concrete

Ratio of FA : CA	Split Tensile (MPa) (W/C=0.45))	
	7 days	28 days
0:100	1.50	2.00
10:90	1.58	2.15
20:80	1.80	2.45
30:70	2.02	3.12

Table 5 showing split tensile strength values for varying Ratio of FA and CA.

Observation: Split tensile strength for 10:90 and 20:80 shows better result over other type of proportions.

2.4 Experimental results of Flexural strength for M20 grade pervious concrete

Ratio of FA : CA	Flexural strength (MPa) (W/C=0.45)	
	7 days	28 days
0:100	2.50	3.33
10:90	4.66	5.49
20:80	5.20	6.35
30:70	6.15	7.10

Table 6 showing Flexural strength values for varying Ratio of FA and CA.

Observation: Flexural strength for 10:90 and 20:80 shows better result over other type of proportions.

2.5 Experimental results of permeability test on M20 grade pervious concrete

The Permeability of the Pervious concrete is mainly dependent on the percentage air-voids of the compacted specimen which is in turn dependent on the gradation of the mix. But keeping the desired gradation fixed the percentage air-voids varies with the decrease of sand. Higher air-voids in pervious mix show higher permeability and vice-versa. The results of co-efficient of Permeability for different W/C ratio are tabulated

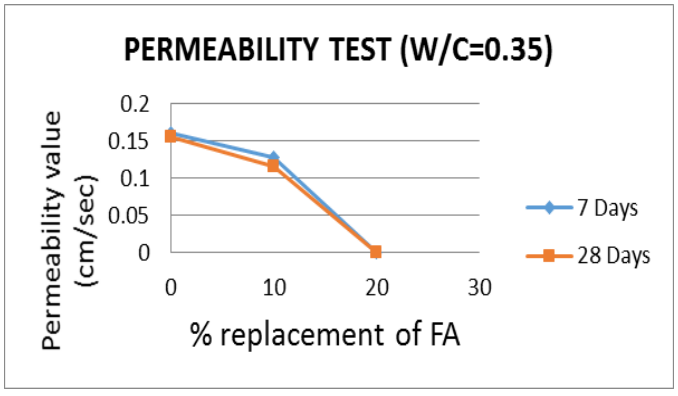

Figure 2 :Permeability test

SL No.	Water/cement	Ratio of Fine and Coarse Aggregate	Permeability value (cm/sec)	
			7 days	28 days
1	0.35	0:100	0.160	0.155
		10:90	0.127	0.116
		20:80	NR	NR
2	0.375	0:100	0.152	0.144
		10:90	0.111	0.090
		20:80	NR	NR

Table 7 showing Permeability value for different water cement ratio and different ratio of fine aggregate to coarse aggregate of M20 grade Pervious Concrete.

Observation: By decreasing the percentage of fine aggregate about 10 percent and 90 percent of coarse aggregate achieves maximum permeability and also achieve greater strength.

Graph 1 showing variation between permeability and percentage replacement of fine aggregate

Observation: As the percentage of fine aggregate decrease increases its permeability results in pervious ness of concrete increases.

3.0 CONCLUSIONS

- Varying amount of replacement of fine aggregate like 30, 20, 10 and 0 % has been considered for manufacturing the Porous Concrete.
- Compressive strength for 30 % replacement FA is having more of 28.33N/mm2 compared to 20, 10, 0 % having 26.40, 21.45 and 16.18 N/mm2 respectively.
- Split tensile strength is more for 30% replacement i.e. 3.12 N/mm2 and Flexural strength of 7.10 N/mm2.
- Compressive strength of W/C ratio 0.35 for 20% replacement FA is having more of 8.65.N/mm2 compared to 10, 0% having 7.24 and 4.50 N/mm2 respectively.
- Based on above experimental results compressive strength of concrete for W/C ratio 0.45 is high but it is not satisfying the porous concrete characteristics.
- Since accumulation of slurry at the bottom for W/C ratio 0.45.The water content is reduced to 140 and 150 liter per m3 with respect to W/C ratio 0.35 and 0.375.

- Compressive strength of pervious concrete for W/C ratio 0.375 is more then 0.35.
- Permeability of W/C ratio 0.35 for 28 days with FA replacement of 0% and 10% is 0.155 and 0.116 cm/sec respectively.
- Since we are using artificial light weight aggregates and reduction of fine aggregates, weight of concrete unit will get reduced. Since reduction of weight it can be widely used in precast units and various civil engineering works.

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