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Use of sand and fly ash in pervious concrete to determine strength and permeability properties

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Abstract — The main objective of this investigation is to increase the strength of pervious concrete by producing various mix design. In pervious concrete fine aggregate is not normally used but our aim is to use some percentage of sand and chemical composition to improve the strength of pervious concrete. To further improve the strength of pervious concrete addition of cementations material such as fly ash. The main properties studied are compressive strength, permeability and flexural strength. The falling head test method was used to find out permeability co-efficient. After various combinations fine aggregate size pervious concrete produced with mix size aggregate having more compressive strength than single size of aggregate.

Keywords- Concrete, Environmental, Strength of concrete, pervious concrete, Compressive strength, permeability.

I. INTRODUCTION

In Pervious concrete, carefully controlled amounts of water and cementations materials are used to create a paste that forms a thick coating around aggregate particles. A pervious concrete mixture contains little or no sand, creating a substantial void Content. Using sufficient paste to coat and bind the aggregate particles together creates a system of highly permeable with interconnected voids which drains quickly. In Pervious concrete 15% to 25% void can be achieved by not using fine aggregate

The first pervious placement in the Kansas City Metro Area was in Sugar Creek, MO in November 2005. Since that time about 30+ pavements have been placed and many lessons learned about what makes pervious concrete "good". Herein, are the current guidelines that have been learned and adjusted. There are some basics we know about placing a successful pervious pavement:

1. The design of the pervious pavement has a hand in its success.
2. The mix design delivered by the ready mix producer has a hand in its success.
3. The contractor placing the pervious concrete has a hand in its success.

II. EXPERIMENTAL PROCEDURE

1) Compressive strength test:

Compressive strength of the pervious concrete mix is at the ages of 7 and 28 days. Each result showed the mean of three identical cylinders tested at the same age of each concrete mixture. Noticeable strength variations were noted among the three specimens due to the variation in the degree of compaction. As expected, the compressive strength of the pervious

concrete increased with hydration. This is due the progress of cement hydration and pozzolanic reaction of the fly ash with lime liberated from cement hydration. The control pervious concrete mix with 100% cement (Mix 1) and that mix with 20% fly ash (Mix 2) showed 30% increase in the compressive strength from the age of 7 to 28 days.

The pervious concrete showed significantly lower strength than conventional concrete. It is to be found that as the density increases compressive strength also increases. It is to be found that pervious concrete shows the improvement in the strength with age.

From the table we are seen that normal pervious concrete for aggregate /cement ratio is compressive strength is 6.30 Mpa but replacement with 15 % sand and 20 % fly ash improving compressive strength up to 42 %. And using 20 % fly ash these results improve up to 25 % at 28 days.

2.) Permeability of pervious concrete:

ACI [4] recommended that the falling head method developed by Neithalath et al [4].could be used to determine the water permeability of pervious concrete. The schematic diagram of the falling head method for permeability testing is given in Figure 2.14.

The falling head method, illustrated by Neithalath et al.[4], measures the time taken by water level to fall from initial water head to the final water head, and water permeability is then calculated using Darcy's First Law. The equation is as follows:

$$k = \frac{A_1 l}{A_2 t} \times (log \frac{h_2}{h_1})$$

Where k = Coefficient of water permeability, A1= specimen cross-sectional area, A2= Tube cross-sectional areas (95mm), l = length of the specimen (150 mm), t = time, h1 = the initial water head (290mm)

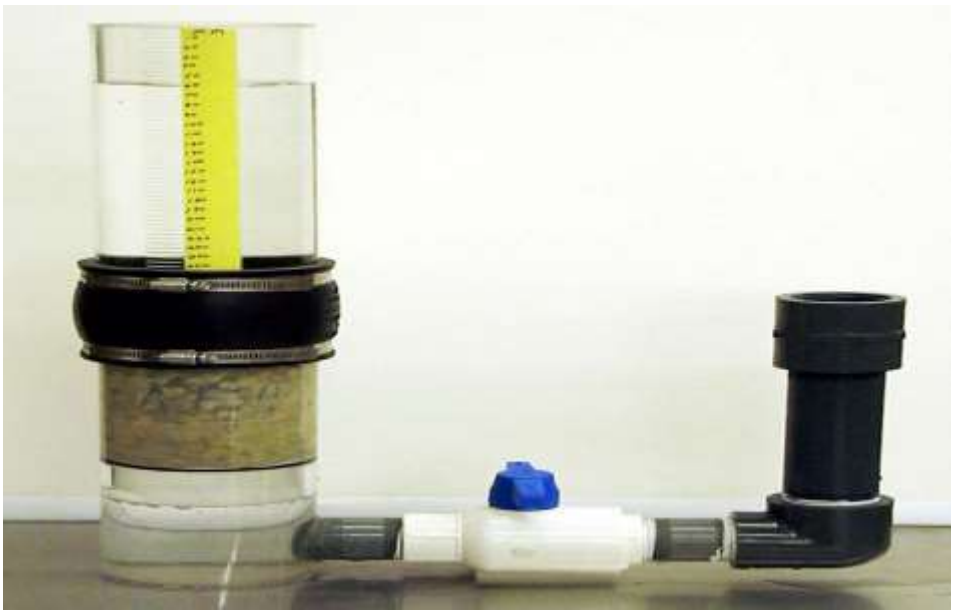

Fig 1: falling head apparatus

- **Mix Proportion of Concrete:**

Mix 1: Normal pervious concrete of aggregate/cement (A/C) 5:1 concrete mix.

Mix 2: Normal pervious concrete of of aggregate/cement (A/C) 4:1 concrete mix.

Mix 3: Pervious concrete with replacement of 15 % sand and 20% fly ash in pervious concrete of (A/C) 5:1 concrete mix.

Mix 4: Pervious concrete with replacement of 15 % sand and 20% fly ash in pervious concrete of(A/C) 4:1 concrete mix.

Mix 5: Pervious concrete with replacement of 20 % fly ash in pervious concrete of (A/C) 5:1 concrete mix.

Mix 6: Pervious concrete with replacement of 20 % fly ash in pervious concrete of (A/C) 4:1 concrete mix.

Table 1: Mix proportion of pervious concrete for aggregate/cement (A/C) 5:1

Materials	**Mix 1**	**Mix 3**	**Mix 5**
Cement	350 kg	308 kg	308 kg
w/c	0.35	0.35	0.35
Fine aggregate	-	262.5 kg	-
Coarse aggregate	577.5 kg	495.5 kg	577.5 kg
Coarse aggregate	1186.5 kg	1008.5 kg	1186.5 kg
Water	122.5 liter	122.5 liter	122.5 kg
Fly ash	-	77 kg	77 kg

Table 2: Mix proportion of pervious concrete for aggregate/cement (A/C) 4:1

Materials	**Mix 2**	**Mix 4**	**Mix 6**
Cement	380 kg	334.5 kg/m3	334.5 kg/m3
w/c	0.35	0.35	0.35
Fine aggregate	-	228 kg/m3	-
Coarse aggregate	506.5 kg	430.5 kg/m3	506.5 kg/m3
Coarse aggregate	1030.5 kg	875.5 kg/m3	1030.5 kg/m3
Water	133 liter	133 litre	133 litre
Fly ash	-	83.5 kg/m3	83.5 kg/m3

IV. TEST RESULTS

1. Compressive strength:

Table 3: Compressive strength result of various mix with pervious concrete for A/C ratio 5:1

Days	**Mix 1**	**Mix 2**	**Mix 3**
7 days	**5.40**	**7.23**	**6.95**
28 days	**6.30**	**8.90**	**7.85**

Table 4: Compressive strength result of various mix with pervious concrete for A/C ratio 4:1

Days	**Mix 1**	**Mix 2**	**Mix 3**
7 days	**5.40**	**7.23**	**6.95**
28 days	**6.30**	**8.90**	**7.85**

2. Permeability of Pervious Concrete:

Table 5: Permeability results of various mixes of pervious concrete A/C 5:1

MIX	Permeability	
	300 mm	**450 mm**
Mix 1	14.40 mm/sec	13.88 mm/sec
Mix 3	9.12 mm/sec	8.83 mm/sec
Mix 5	12.44 mm/sec	11.95 mm/ sec

Table 6: Permeability results of various mixes of pervious concrete A/C 4:1

Mix	Permeability	
	300 mm	**450 mm**
Mix 1	13.26mm/sec	12.86 mm/sec
Mix 2	8.05 mm/sec	7.50 mm/sec
Mix 3	11.37 mm/sec	11.02 mm/ sec

V. CONCLUSION

1. Compressive strength of pervious concrete contain sand and fly ash:

Compressive strength increase with adding sand and fly ash contain.

Normal Pervious concrete of aggregate/cement ratio 5:1 compressive strength is 6.30 Mpa but replacement of 15% sand and 20% fly gives more compressive strength 8.90 MPa and replacement of 20% fly ash gives compressive strength 7.85 Mpa.

Normal Pervious concrete of aggregate/cement ratio 4:1 compressive strength is 8.35 Mpa but replacement of 15% sand and 20% fly gives more compressive strength 10.05 MPa and replacement of 20% fly ash gives compressive strength 9.60 Mpa.

Adding 15 % sand and 20% fly ash gives better compressive strength than normal pervious concrete it is gives approximately 42 % more compressive strength

Adding 20% fly ash gives better compressive strength than normal pervious concrete it is gives approximately 25-40% more compressive strength

2. Permeability of pervious concrete contains sand and fly ash:

Addition of sand and fly reduced permeability properties of pervious concrete.

For replacement of 15% sand and 20% fly reduced permeability up to 25-30% of normal Pervious concrete.

For replacement of 20% fly reduced permeability up to 20-25% of normal pervious concrete.

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