Improvement of Ground Water Table By Using Pervious Concrete As A Rigid Pavement

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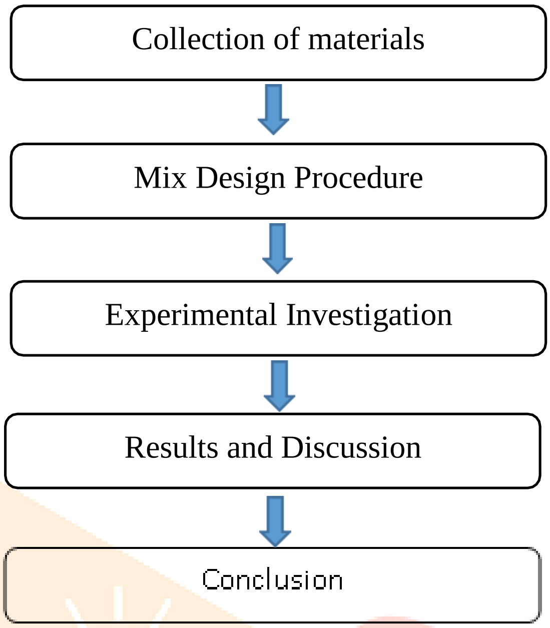
Abstract: Pervious concrete is a zero-slump, open graded material consisting of hydraulic cement, coarse aggregate, admixtures and water. Because pervious concrete contains little or no fine aggregates such as sand, it is sometimes referred to as "no-fines" concrete. It is a special type of concrete having a high void content of about 30%, is becoming popular nowadays due to its potential to reduce the runoff to the drainage systems which can provide a water flow rate around 0.34 cm/second. Pervious concrete has a large open pore structure hence less heat storage and faster. Pervious concrete also finds its effective application in low loading intensity parking pavements, footpaths, walkways and highways. The pervious concrete is considered as an Environmental Protection Agency (EPA) for providing pollution control, storm management and suitable development. Here, pervious concrete mix is designed without sand and adding silica fume as an admixture using ACI 522R-06 code, the mechanical strength of the concrete is increased to an extent. The aim of this project is to lay the pervious concrete in platform and car parking thus transmitting the water to the underground surface very easily for maintaining the ground water table even in all the places.

INTRODUCTION:

Water is one of the most essential elements in the world which is used in day to day lives. Generally, water reaches earth in the form of rainfall or snowfall. The use of materials like tar, bitumen, asphalt, and concrete for laying the roads, act as a damp proof coating over the soil which seals the infiltration of rain water thus restricting the groundwater recharge, and increasing the run off .Pervious concrete which is different from conventional concrete which contains cement, coarse aggregate, and water as main constituents. Pervious concrete is also referred as no-fine concrete, zero slump concrete, porous or permeable concrete. The coarse aggregates are bonded with paste formed from cement and water leaving void spaces which allows water to infiltrate. Unlike conventional concrete pervious concrete has high permeability, lower compressive strength and lower unit weight. The percentage of voids in pervious concrete can vary from 15% - 40% whereas the void percentage in conventional concrete varies from 3to4%. Pervious concrete hasal so proved to be effective means to address the important environmental issues and sustainable growth. Pervious concrete acts as a soak pit there by storing rain water and allowing the water to infiltrate and recharging ground water table. Controlled amount of water and cementious material is used to form the paste. The paste forms bond between the aggregates, this results in aggregate to aggregate contact thus forming interconnected voids which makes it possible for water to flow through it. The lack of sand inpervious concrete results in very harsh mix that negatively affects mixing and placement. Due to high void content the unit weight of pervious concrete is less (16-19KN/m^3) Pervious concrete can be used in a wide range of applications, although its primary use is in pavements which are in: residential roads, alleys and driveways, low volume pavements, low water crossings, sidewalks and pathways, parking areas, tennis courts, slope stabilization, sub-base for conventional concrete pavements etc. Practical for many applications, pervious concrete is limited by its lack of durability under heavy loads. This lack of resiliency restricts the use of pervious concrete to specific functions.Perviousconcreteislimitedtouseinareassubjectedtolowtraffic volumes and loads. Although once used as load bearing walls in homes pervious concrete is now utilized primarily in parking lots but does have limited applications in areas such as greenhouses, driveways, sidewalks, residential streets Pervious concrete system has advantages over impervious concrete in that it is effective in managing run-off from paved surfaces, prevent contamination in run-off water, and recharge aquifer, repelling salt water intrusion, control pollution in water seepage to ground water recharge thus, preventing subterranean storm water sewer drains, absorbs less heat than regular concrete and asphalt, reduces the need for air conditioning.

METHODOLOGY

The following flow chart depicts the main stages of project



MIX DESIGN

In this section we mainly focus on procedures utilized for making pervious concrete mix and the various tests performed. To draw reasonable conclusions regarding the best and appropriate mix proportions to achieve maximum strength. Compression and flexure tests are carried on pervious concrete moulds subjecting it loads until failure occurs.

In order to arrive at proper mix proportion initial trial mix were carried out taking cement content as 280 kg/m^3 & varying water/cement ratio (w/c) from .035 to 0.45 for various C:A ratios (1:6 & 1:8). Cubes were casted and tested for 7 days strength.

Since the target strength couldn't be achieved the cement content was increased to 320 kg/m^3, and w/c ratio was taken as 0.40 from initial trails for 1:4 and 1:6 C:A ratios. Cubes were casted and were tested for 7days.

As the target strength was achieved for both C:A ratios, the following parameters were used throughout the project,

Stipulations for Proportioning

1.	Type of cement	: PPC confirming IS: 1489part1
2.	Maximum nominal size of aggregate	: 20mm
3.	Minimum cement content	: 320kg/m^3
4.	Maximum water cement ratio	:0.4
5.	Exposure condition	: Moderate
6.	Degree of supervision	:Good
7.	Maximum cement content	: 450kg/m^3
8.	Chemical admixture	: POLYVINYLALCOHOL

Mix Calculations

Quantity of material for 1m^3 1:4 (C: A) ratio

1. Quantity of cement for 1m^3 =320 kg/m^3
2. Quantity of aggregates for 1m^3 =1280kg/m^3
3. Quantity of waterfor1m^3 =128kg/m^3
4. Water /cement ratio =0.4

For one cube

1. Quantity of cement =1.08 kg
2. Quantity of aggregates =4.32kg
3. Quantity of water =0.432 liters Quantity of

material for 1m^3 1:6 (C: A)ratio

1) Quantity of cementfor 1m^3 =320 kg/m^3
2) Quantity of aggregates for 1m^3 =1920kg/m^3
3) Quantity of waterfor1m^3 =128liters
4) Water /cementratio =0.4

For one cube

1) Quantityofcement =1.08 kg
2) Quantity of aggregates =6.48kg
3) Quantityofwater =0.432liters

Table 1 Mix proportions for various C:A ratio with admixtures

S. No	Type of C:A ratio	Cement content kg/m^3	Coarse aggregates kg/m^3	W/C ratio	Water Kg/m^3	Silica fume kg/m^3	PVA kg/m^3	Zeolite kg/m^3
1	1:4	320	1280	0.4	128	0	0	0
2	1:4	288	1280	0.4	128	32	0	0
3	1:4	288	1280	0.4	122.88	32	5.12	0
4	1:4	288	1280	0.4	121.60	32	6.4	0
5	1:4	288	1280	0.4	128	0	0	32
6	1:6	320	1920	0.4	128	0	0	0
7	1:6	288	1920	0.4	128	32	0	0
8	1:6	288	1920	0.4	122.88	32	5.12	0
9	1:6	288	1920	0.4	121.60	32	6.4	0
10	1:6	288	1920	0.4	128	0	0	32

RESULTS AND DISCUSSION:

1. Specific gravity of cement

Specific gravity	Trail 1	Trial 2	Trial 3
Weight of cement (W) gm	64 gm	64 gm	64 gm
Initial reading of flask(V_1) ml	0.5 ml	0.5 ml	0.5 ml
Final reading of flask(V_2)ml	24	23.7	23.8
weight of equal of water((V_2-V_1) x sp.wt of water)	23.5	23.2	23.3
Specific gravity of cement.(W/(V_2-V_2))	2.72	2.76	2.74

Result: Specific gravity of cement is 2.74

2. Normal consistency of cement

Percentage of water	Depth of penetration from top(mm)
28% water by weight of dry cement	26
30% water by weight of dry cement	28
32% water by weight of dry cement	30
34% water by weight of dry cement	31
35% water by weight of dry cement	34

Result: Normal consistency of cement is 35%

3. Initial Setting Time

Setting time(min)	Penetration(mm)
0	0
5	0
10	25
15	27
20	28
25	29
30	30
35	32
40	35

Result: The initial setting time of cement is 40minutes

4. Specific gravity of C.A

Specific gravity:	**Trail 1**	**Trail 2**
Weight of vessel + water + coarse aggregate (W1)	3110	3108
Weight of water + vessel (W2)	2460	2460
Weight of saturated surface dry sample (W3)	998	998
Weight of oven dry sample (W4)	996	994
Specific gravity	2.86	2.84

Result: Specific gravity of coarse aggregate is 2.86

5. Aggregate Crushing value

	Trail 1	**Trail 2**	**Trail 3**
Weight of surface dry aggregate (W1) gm	2280	2220	2190
Weight of aggregate passing 2.36mm (W2) gm	80	90	88
Aggregate Crushing value %	3.51	4.05	4.01

Result: Aggregate crushing value is 3.86%

6. Aggregate Impact value

	Trail 1	**Trail 2**	**Trail 3**
Weight of surface dry aggregate (W1)gm	314	310	310
Weight of aggregate passing 2.36mm (W2)gm	90	94	90
Aggregate Impact value %	28.66	30.3	29.03

Result: The aggregate impact value is 29.33%

7. Aggregate Abrasion value

	Trail 1	Trail 2	Trail 3
Weight of surface dry aggregate (W1)gm	5000	5000	5000
Weight of washed & oven dried aggregate passing 1.7 mm (W2)gm	3480	3460	3560
Aggregate Abrasion value %	30.4`	30.8	28.8

Result: The aggregate abrasion value is 30%

8. Flakiness index and Elongation index of aggregate

Passing sieve	Retained sieve	Weight of aggregates		Weight of aggregates passing on thicknessgauge (gm)		Flakiness index	
		Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
20mm	16mm	1266	1115	114	106	23.2%	15.06%
16mm	12.5mm			180	54.02		
12.5mm	10mm			0	8		
Passing sieve	**Retained sieve**	**Weight of aggregates**		**Weight of aggregates retained on length gauge (gm)**		**Elongation index**	
		Trial 1	**Trial 2**	**Trial 1**	**Trial 2**	**Trial 1**	**Trial 2**
20mm	16mm	1266	1115	170	62	18.8%	20.1%
16mm	12.5mm			60	124		
12.5mm	10mm			8	38		

9. Compressive strength for various mix proportions 7 and 28 days

S.No	Proportion (Cement: Aggregates)	w/c ratio	Percentage of cementreplaced with	Density KN/m^3	Compressive strength at 7 days(MPa)	Compressive strength at 28 days(MPa)
1	1:4	0.4	0%	18.51	5.79	8.5
2	1:4	0.4	10% SF	18.49	4.67	7.6
3	1:4	0.4	10% SF+1.6%PVA Sol.	17.96	4.1	6.4
4	1:4	0.4	10% SF+2%PVA Sol.	18.19	4.01	6.2
5	1:4	0.4	10% Zeolite	18.49	6.89	12
6	1:6	0.4	0%	18.21	4	6.2
7	1:6	0.4	10% SF	18.00	3.43	5.5
8	1:6	0.4	10% SF+1.6%PVA Sol.	18.02	3.44	5.3
9	1:6	0.4	10% SF+2%PVA Sol.	18.02	3.26	5
10	1:6	0.4	10% Zeolite	18.63	4.6	6.22

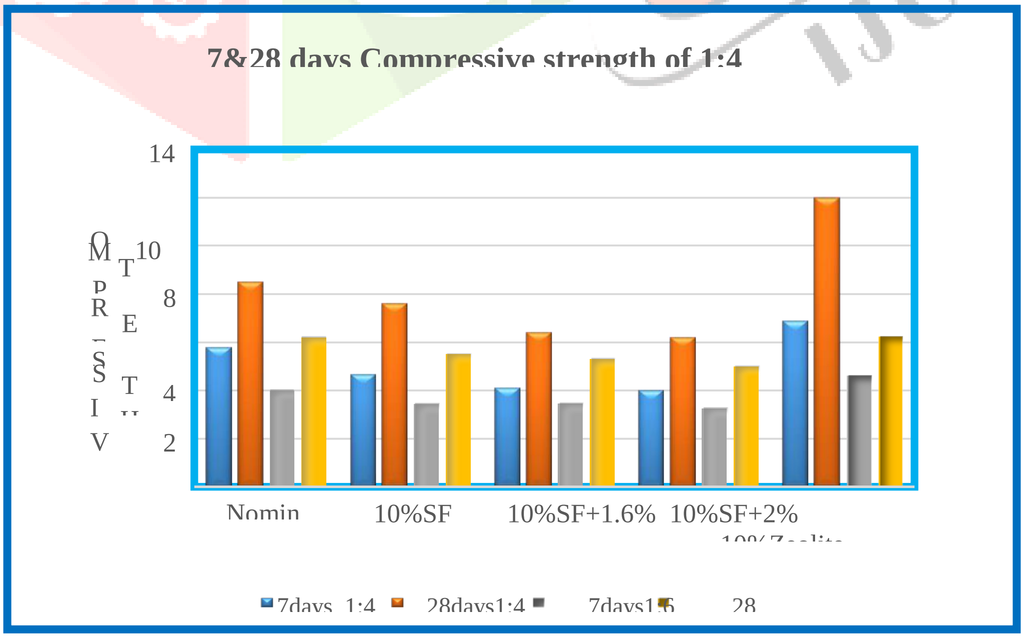


Figure 2: Graphical representation of compressive strength

10. Flexural strength for various ix proportions 7 and 28 days

S,No	Proportion (Cement: Aggregates)	w/c ratio	Percentage of cementreplaced with	Flexure strengthat 7 days(MPa)	Flexure strengthat 28 days(MPa)
1	1:4	0.4	0%	1.69	2.66
2	1:4	0.4	10% SF	1.19	1.87
3	1:4	0.4	10% SF+1.6%PVA Sol.	1.16	1.78
4	1:4	0.4	10% SF+2%PVA Sol.	1.11	1.71
5	1:4	0.4	10% Zeolite	1.81	2.68
6	1:6	0.4	0%	1.10	1.70
7	1:6	0.4	10% SF	1.06	1.64
8	1:6	0.4	10% SF+1.6%PVA Sol.	1.03	1.59
9	1:6	0.4	10% SF+2%PVA Sol.	1.01	1.56
10	1:6	0.4	10% Zeolite	1.48	1.8

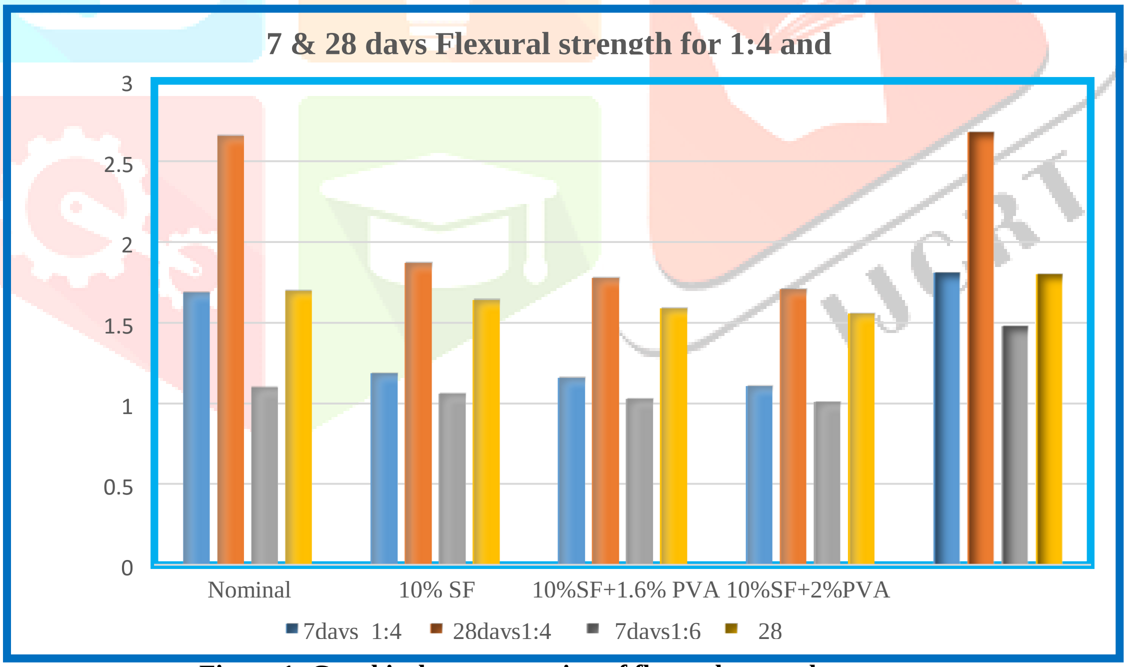


Figure 1: Graphical representation of flexural strength

CONCLUSION:

Base don't the experimental results and their plots and subsequent discussion on the results the following conclusions are drawn:

- Pervious concrete pavements are a very cost-effective and environmentally friendly solution to support sustainable construction
- Ability to capture storm water and recharge ground water while reducing storm water runoff enables pervious concrete to play a significant role.
- Pervious concrete is an ideal solution to control storm water, re-charging of ground water, flood control at downstream and sustainable land management
- The compressive and flexure strength of previous concrete decreased withthe addition of 10% silica fume, silica fume and PVA solution of different proportions
- From the above experimental results it is observed that replacement of cement with 10% zeolite has a drastic increase in compressive strength for 1:4 C: A ratio whereas the increase in flexural strength is very small. Hence these can be used at places where the strength parameter considerations are of less important. E.g. pathways.
- These can also be used as sound absorbing walls in classrooms, auditorium etc. This can also be use detail way platforms. This will help in reducing water accumulation on railway track sand also absorbs co_2 in air a sit contains zeolite.

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