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An Experimental Study on Pervious Concrete (Mix-Ratio, Strength and Porous Properties)

Dev Pratap Mani Tripathi [1]
[1] Student of Final year Civil Engineering,
Allenhouse institute of Technology, Rooma,
Kanpur

S. M. Ashraf Hussain[2]
[2]Assistant Professor,
Civil Engineering Department,
Allenhouse institute of Technology,
Rooma, Kanpur

Praneet Madhav [3]
3Assistant Professor,
Civil Engineering Department,
Allenhouse institute of Technology,
Rooma, Kanpur

***Abstract*— Pervious concrete is a composite material consisting of coarse aggregate, Portland cement, and water, which allows rainwater to percolate through the surface and into the ground before it runs off. This approach reduces storm water runoff volumes and minimizes the pollutants introduced into storm water runoff from surface areas, and recharging Ground Water Levels. Strength and Water Absorption are important properties of Pervious Concrete. This paper represents the experimental methodology and experimental results related to strength, Mix ratio and water absorption. Cubes of size 150 mm*150mm*150 mm height are prepared to investigate both these properties. This investigation is carried out at the end of 1day,3day.7day and 28 days for Strength of pervious concrete and for water absorption. Different concrete mix proportion such as 1:4, 1:5, 1:6, and 1:7 with different size of gravel such as 20 mm,12.5mm and 9.6 mm should be used to check both these properties of pervious concrete. Test results indicates that pervious concrete made by 1:4 concrete mix proportion has more strength full and less water absorption and pervious concrete made by 1:7 mix proportion has more water absorption and less strength, that's why strength and water absorption are inversely proportional to each other.**

The pervious concrete can mainly have applied to Parking areas, Sidewalks & pathways, Residential roads, alleys and driveways, Shoulders & Medians, Under Overpasses & Bridges, Swimming pool decks, Slope stabilization, footpaths. Using selected aggregates, fine mineral, admixtures, organic intensifiers and by adjusting the concrete mix proportion, strength and abrasion resistance can improve the pervious concrete greatly.

Keywords*— *Pervious concrete, porosity, strength, mix-ratio, water absorption.

1. INTRODUCTION: -

Pervious Concrete is a special type of concrete in which no fine aggregates are used and gravel has been used in place of the coarse aggregate. Pervious Concrete is a homogeneous mixture of cement, aggregate or gravel, water and little or no sand which creates an open cell structure that allows water and air to pass through it. Pervious Concrete is also called as "porous concrete", "permeable concrete", "no fines concrete" and "porous pavement" concrete. The voids can range from 18 to 35% so the infiltration rate of pervious concrete will fall into the range 80 to 720 liters /minute/square meter. The correct quantity of water in the concrete is critical. Too much water will cause segregation, and too little water will lead to balling in the mixer and very slow mixer unloading. The Water/Cement ratios are normally ranges from 0.25 to 0.45 and Cement/Aggregate ratio is 1:3.5 to 1:7. The main ingredients are cementitious material, water, aggregate. and admixtures is used when it required.

The pervious concrete pavement possesses many Advantages that improve city environment as follows:

I. The rainwater can quickly filter into ground, so the groundwater resources can renew in time. As the pavement is air permeable and water permeable, the soil underneath can be kept wet.
II. The pervious concrete pavement can absorb the noise of vehicles, which creates quiet and comfortable environment.
III. In rainy days, the pervious concrete pavement has no plash on the surface and does not glisten at night, this improves the comfort and safety of drivers.

OBJECT: -

The Primary object of this investigation that get a maximum compressive Strength without any change in permeability characteristic of the pervious concrete. This will be completed through experiments on test cube of Size (150x150x150mm) developed for this purpose. These experiments are including various Aggregate Test, Sieve Analysis, Permeability test and compression test. Loading condition on pervious concrete consist a key role in the design. In this design we study about pervious concrete.

3. EXPERIMENTAL MATERIALS: -

Pervious Concrete is a mixture of Cement, Coarse Aggregate little or no sand and Water. Fine Aggregates are not used for making pervious properties in concrete. Sometimes admixtures are used for achieving extra strength and special properties of pervious concrete. Pervious Concrete has been casted with different concrete mix proportion such as 1:3.5,1:4,1:5,1:6,1:6.5,1:7,1:8 and 1:10 with 20 mm 12.5mm and 9.5 mm gravel size with PPC Cement. And we also casted

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concrete mix proportion 1:6 with 20 mm 12.5mm and 9.5 mm gravel size with PPC Cement, stone dust and admixtures.

TABLE 1: - PROPERTIES OF CEMENT: -

Property	Value of Cement (PPC)	IS Recommendation IS: 12269-1987
Sp. Gravity	2.93	3.10-3.15
Consistency (%)	31.5%	30 -35(%)
Initial setting time (Min)	35minutes	30 minutes (min)
Final setting time (Min)	230 minutes	600 minutes (max)
Compressive strength at 7 days (N/mm^2)	38.49N/mm^2	43N/mm^2
Compressive strength at 28 days (N/mm^2)	51N/mm^2	53N/mm^2

4.EXPERIMENTALMETHODOLOGY:

4.1 Strength of Pervious Concrete: [IS:2386– (PART – III)1963]

We caste pervious concrete in different mix proportion. Cube specimen size is 150mm* 150mm*150mm taken, we mix concrete properly with a specific W/C ratio, then we fill into the mould in three layers. At every layer we done 25 times tempering through tempering rod (16 mm dia and 0.6m long). Sample is placed before 30 minutes; the test specimens are stored in place free from vibration for 24 hours ± ½ hours from the time of adding of water. And After this period remove from mould and submerged into the clean fresh water unless for required for test and at the time of test remove the specimen from water and wipe out excess water take the dimension nearest 0.2cm.

Curing of concrete play, a significant role in strength of concrete. For strength of pervious concrete, we test cubes on Compressive testing machine under various consideration such as one day of curing,7 day and 28 days of curing. for compressive testing we place specimen into the Compressive testing machine and apply the load gradually and continuously 14N/mm^2 per minute pressure rate until the cracking and record maximum load and note the reading and calculate the strength of pervious concrete cubes.

$$Strength\ of\ Specimen = \frac{Maximum\ load\ applied\ till\ failure\ (N)}{Area\ of\ Specimen(mmXmm)}$$

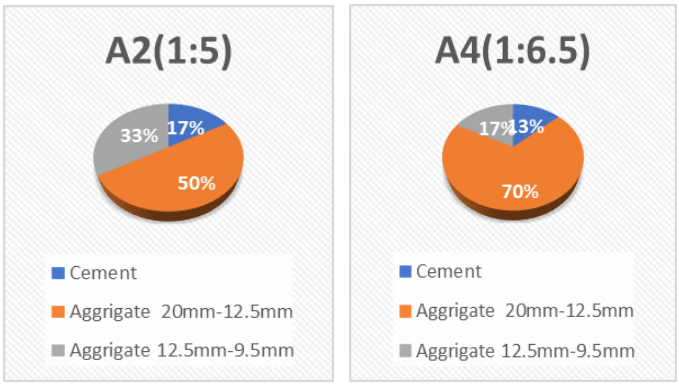
We test Specimen for Compressive Strength after 1,3,7 and 28 days of Curing.

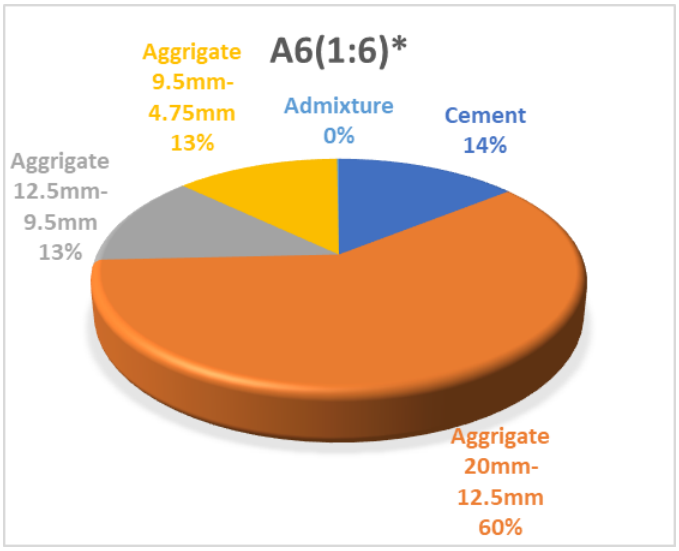
TABLE 3:-IS Recommendation for Compressive strength of Cube after various days of curing.

S. No.	Day of Curing	Compressive Strength of Specimen (%)
1	1	16
2	3	40
3	7	65
4	14	90
5	28	99

TABLE 3: - % Material Used in different grade Pervious Concrete

Ratio	% Material Used				
PERVIOUS CONCRETE MIX (CEMENT & AGGREGATE)	Cement	Aggregate 20mm-12.5mm	Aggregate 12.5mm-9.5mm	Aggregate 9.5mm-4.75mm	Admixture
A1(1:4)	20	56	24	0	0
A2(1:5)	16.67	50	33.33	0	0
A3(1:6)	14.28	51.42	34.3	0	0
A4(1:6.5)	13.33	69.34	17.33	0	0
A5(1:7)	12.5	52.5	35	0	0
A6(1:6)	14.26	60	12.8	12.8	0.14





4.2 Infiltration test of Pervious Concrete: [ASTM C 1701]

With help of this test we determine water infiltration rate of pervious concrete. Perform this test at multiple time and take average for calculation. Before the test started cleaning the surface of pervious concrete and dry it. in this test infiltration ring placed on the cleaned concrete surface and secured in place with plumber's putty and fix apparatus properly at the upper surface and set stop-watch zero, after that we started allow the water to pass through the specimen (water flow and stop watch started together) from top surface continuously for 1 minutes and then stop water flow, when water is no longer present on the surface record the time and note the amount of water pass through the specimen stored in the box/ storage tank.

We done this activity min 2 times for a specimen and calculate the average. 1:4 ratio specimen is pass lowest quantity water and 1:7 is pass maximum quantity.

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$$I = \frac{K * M}{D * D * T}$$

Where
I= Infiltration Rate (mm/h)
M= Mass of infiltrate water (KG)
T= time required for measured amount of water to infiltrate the concrete (Sec)
K= 4583666000 in SI units, or 126870 in FKS

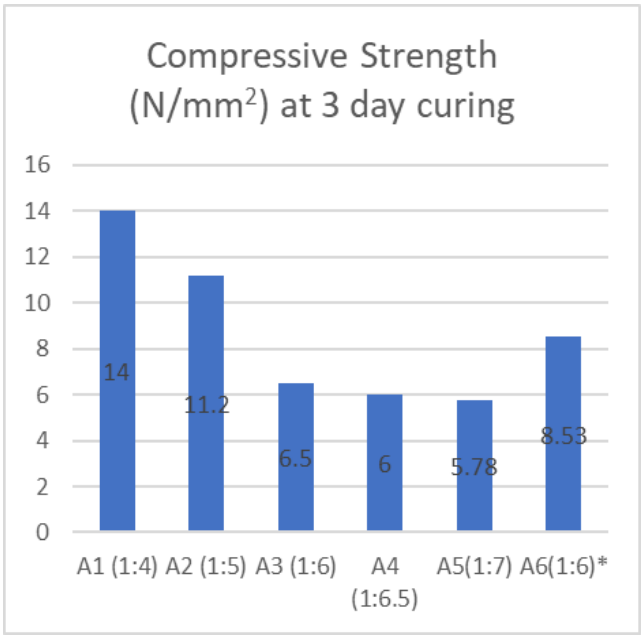
Note: in the hot environment where surface temperature is over 38ºC (100ºF) where plumber putty may not adhere to the concrete surface easily. Therefore, it is advisable to perform this test in low temperature.

5. EXPERIMENTAL RESULTS:

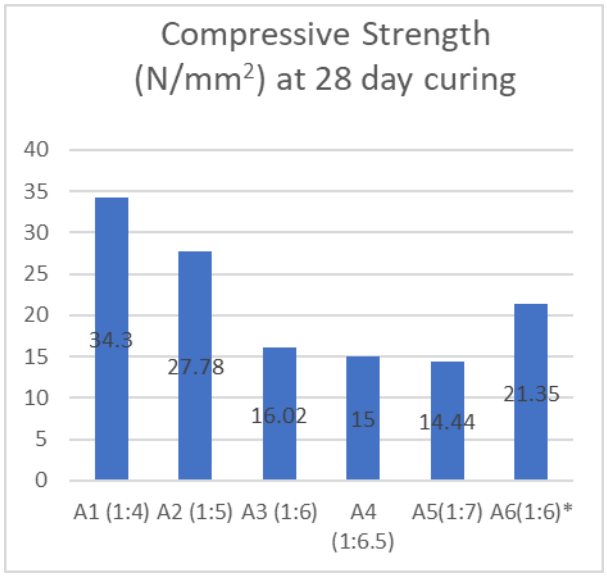
5.1 Strength of Pervious Concrete: [IS:2386– (PART – III)1963]

Compression test results for cube (150 mm * 150mm * 150 mm) with Portland cement

S. No.	Concrete Mix	Water/ Cement Ratio	Compressive Strength (N/mm2)			
			Day of Curing			
			1	3	7	28
1	A1(1:4)	0.3	6.26	14	22.75	34.3
2	A2(1:5)	0.3	5.87	11.2	18.2	27.78
3	A3(1:6)	0.35	2.56	6.5	10.4	16.02
4	A4(1:6.5)	0.35	2.4	6	9.8	15
5	A5(1:7)	0.4	2.31	5.78	8.7	14.44

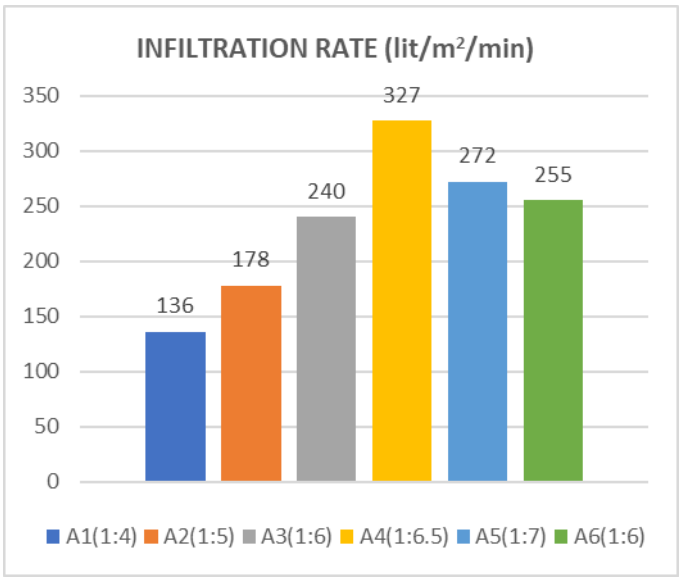


Graph: -1



Graph: - 2

5.2 Infiltration test of Pervious Concrete: [ASTM C 1701]



INFILTRATION RATE (lit/m²/min)

6. CONCLUSIONS:

- We could develop strong and durable pervious concrete mixes for low-volume roads and side sloping of Dams.
- From the experimental results following conclusion we find out:
- When we mix pervious concrete in aggregate ratio 60-40 then strength increases and when we mix in 80-20 ratio then strength decreases.
- When we mix pervious concrete in aggregate ratio 80-20 then perviousness increases and when we mix in 60-40 ratio than perviousness decreases.
- So, Gravel ratio is affected the strength and perviousness of pervious concrete.

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- Mix ratio 1:4 is strongest in compressive test but less pervious and 1:7 mix proportion is less strong but more pervious, but when we mix Admixtures in the concrete mix then strength is increase. So, with the help of admixtures we make more strongest and more pervious concrete.
- In addition of steel fibres was used to increase the strength parameter.

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BIOGRAPHIS:

Dev Pratap Mani Tripathi was born in 1995 in Thuthibari, Maharajganj, Uttar Pradesh India. He received his Diploma in Civil Engineering from the Govt. Polytechnic Orai. Jalaun in 2012, After He worked more than 3 years in the construction industry; mainly in Quality Control in MNC. at present he is Final year student of Bachelor of Technology in Civil Engineering from Allenhouse Institute of Technology, Kanpur. He is interested in research work on the Mix -Ratio, Strength and Pores Properties of Pervious Concrete.

S.M. Ashraf Husain was born in 1970 in Kanpur city, Uttar Pradesh. He completed his Diploma Engineering (Civil) in 1990. He worked over a decade in the construction industry; mainly in Quality Control at International Level. He received his Bachelor of Technology degree in Civil Engineering from Integral University, Lucknow, in 2011. In 2014 he received his Master's Degree in Structural Engineering from Integral University, Lucknow. Presently he is Assistant Professor, in Department of Civil Engineering at Allenhouse institute of technology, Kanpur. He has n numbers of Papers Published in International Journals/Conferences. He is also an Associate Member of Institution of Engineer's.

Praneet Madhav was born in 1989 in Kanpur city, Uttar Pradesh. He received his Bachelor of Technology degree in Civil Engineering from RGP University, Bhopal, in 2012. Presently he is Assistant Professor, in Department of Civil Engineering at Allenhouse institute of technology, Kanpur.