Mechanical Properties of No Fines - Pervious Concrete

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Abstract - *Owing to the increasing demand of water in day to day life, efficient storm water management through innovative construction practices has become mandatory. Pervious concrete, a type of special concrete comes to the help of a civil engineer by replacing the storm sewers and in addition recharging the ground water table. In this project work, an experimental investigation on Pervious Concrete (PC) has been carried out for different mix proportion ratios such as 1:3,1:4,1:5 and 1:6. (cement: coarse aggregate). Their mechanical properties such as compressive strength and splitting tensile strength of Pervious concrete for various mix ratios were carried out on cubes. A comparison of test results was performed after 7 days and 28 days of curing.*

Key Words: *Compressive strength, Mechanical properties, mix ratio, Pervious concrete, Splitting tensile strength*

1. INTRODUCTION

It's tough to balance the demand for development with the need to preserve our natural resources. However, this balance becomes easy to achieve when we construct our parking lots, pavements, garden roads, street ways, temple grounds, etc., using pervious concrete. A Mix of coarse aggregate, cement and water results in pervious concrete. As there is no use of fine aggregates it is also known as "no- fines" or porous concrete. This mixture after curing, creates an open-cell structure revealing a permeable layer that is capable of allowing rainwater to pass through them and reach the underlying sub soil. Storm water runoff occurs when there is rain fall. Increased pollution in rivers and streams, flash floods, and loss of rainwater is witnessed due to the effect of runoff. Pervious concrete has a 15-25% void structure and allows water to pass through the ground. By designing it as a natural ground cover, pervious concrete is the best choice for storm water management. It puts rainwater back in the ground where it belongs.

2. METHODOLOGY

- Collection of materials
- Study on Material properties
- Mix design
- Casting and curing of specimens
- Testing for Mechanical properties
- Results and discussion

3. MATERIALS USED

3.1 CEMENT

Ordinary Portland cement of grade 53 is used for casting owing to its rich quality and appreciable durability

3.2 AGGREGATES

Coarse aggregates of size 12mm and 18mm are used for the mix. As very large sized aggregates result in open texture with reduced workability and very fine aggregates end up with reduced voids, narrow gradation is done. The importance of pervious concrete is that little or no fine aggregates are used in the mix. Here no fines are used.

3.3 WATER

Potable water from the water supply system that is free from organic materials is used in the mix for concreting

4. PRELIMINARY TESTS FOR MATERIALS

4.1 CONSISTENCY TEST FOR CEMENT:

The consistency test on cement is done to find the quantity of water required. The mortar (cement: water) is prepared on trial and error basis and appropriate amount is determined.

Table- 1: Consistency test on cement

SL.NO	PERCENTAGE OF WATER	WATER ml	READING OF POINTER FROM TOP
1	24	96	36
2	26	104	34
3	28	112	30
4	30	120	26
5	32	128	13
6	34	136	6

Amount of water = 0.85P = 0.85*34*400/100
= 115.6 ml.

4.2 SETTING TIME TEST FOR CEMENT

The initial and final setting time tests where done on the cement mortar (cement: water) to ensure its plasticity.

Table- 2: Setting time test for cement

SL.NO	TIME IN MINUTES	READING OF POINTER
1	0	0
2	5	0
3	10	2
4	15	2
5	20	3
6	25	4
7	30	5

4.3 FINENESS OF CEMENT

The fineness test on cement is performed to determine the proportion of the cement whose grain size is larger than specified mesh size sieving as per IS:4031(part I)1996 ie.,

90µ IS sieve ant the following was observed.

Weight of the sample taken =100gm

Weight of the material retained after sieving=2gm

% of the residue left on the sieve = (Wt. Retained /Wt. Taken) × 100

= (2/100)*100

4.4 FINENESS MODULUS OF COARSE AGGREGATE

A 5 kg sample was taken and sieve analysis was performed to ensure proper gradation of aggregates and the observations are tabulated below:

Table- 3: Fineness modulus of coarse aggregate

I.S SIEVE SIZE mm	WEIGHT RETAINED	%WEIGHT RETAINED	%WEIGHT PASSING	CUMMULATIVE %WEIGHT RETAINED
12.5	1650	33	67	33
10	2350	47	53	80
4.75	1000	20	80	100

Fineness modulus of coarse aggregate = C/100 =713/100
C =7.13

4.5 SPECIFIC GRAVITY TEST FOR COARSE AGGREGATE

The Specific gravity test on coarse aggregate is done and the following observations where made:

Weight of basket =4100 gm
Weight of basket + aggregate = 7000 gm
Weight of basket + aggregate + water = 8200 gm
Weight of basket + water = 6400 gm
Specific Gravity = (W2-W1) / ((W2-W1) – (W3-W4))
= (7000 – 4100) / ((7000 – 4100) – (8200 – 6400)) = 2.63

4.6 SPECIFIC GRAVITY OF CEMENT

Specific gravity of the cement is determined from the following observations

Weight of bottle = 135 gm
Weight of bottle + water = 365 gm
Weight of bottle + kerosene = 320 gm
Weight of bottle + cement + kerosene = 365 gm
Weight of cement = 60 gm
Specific gravity of kerosene, g = (W3 – W1) / (W2 – W1)
g = (320-135) / (365-135)
= 0.804

Specific gravity of cement = (W5/ (W5+W3-W4)) *g
= (60/ (60+320-365) *(0.804)
= 3.21

5. MECHANICAL PROPERTIES

5.1. COMPRESSIVE STRENGTH

The cube specimens of size 150*150*150 mm where cast for different mix proportions 1:3, 1:4, 1:5 and 1:6 of cement and coarse aggregate by manual mixing. The cubes are then allowed to cure for 28 days. The cured specimens are allowed to dry and the compressive tests are carried out after 7 and 28 days in a compression testing machine. The test setup involves, the specimens are placed in such a manner that the load is applied to the opposite sides of the cubes. The axis of the specimen is carefully aligned with the centre of the thrust of the spherically seated plate. The maximum load applied until the failure is recorded. The results obtained are tabulated.

5.2 SPLITTING TENSILE STRENGTH:

The cylindrical specimens of size 150mm diameter and 300mm length are cast for the1:3, 1:4, 1:5 and 1:6 of cement and coarse aggregate by manual mixing and they are properly cured for 28 days and allowed to dry. The specimens are tested on a CTM of 500kN capacity and the failure load is noted down to calculate the split tensile strength of concrete specimens.

6. RESULTS AND DISCUSSIONS

6.1 COMPRESSIVE STRENGTH

The 7 and 28-day compressive strengths are tabulated below. The compressive strength values for various mix ratios after the curing of 7 days shows decrease in the values such as 8.8, 7.82, 7.0, 6.5 (N/mm^2) with the increase in coarse aggregate. Likewise, the values for 28 days strength also shows decrement as 18, 16, 13.5, 10.5(N/mm^2). This shows that, the strength of the PC depends on its bonding strength. Therefore, when the cement: coarse aggregate ratio is minimum, there exists greater bonding strength. Hence here the minimum ratio 1:3 has greater bonding strength and compressive strength.

Table- 4: Compressive strength of concrete

SPECIMEN (MIX RATIO)	7 DAYS	28 DAYS
1:3	8.8	18
1:4	7.82	16
1:5	7.0	13.5
1:6	6.5	10.5

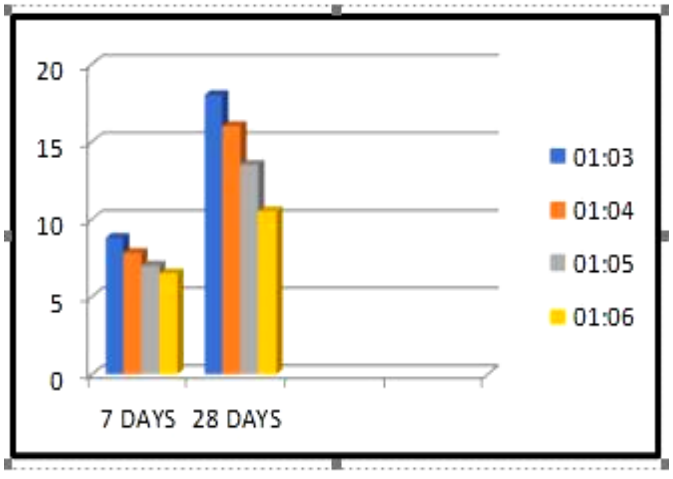

Chart- 1: Compressive strength of concrete

6.2 SPLITTING TENSILE STRENGTH

Similar to the compressive strength, the splitting tensile strength also shows gradual decrement in the values for successive mix proportions. Since it is well known that concrete has less tensile strength, the values obtained are low when compared to compression strength. The values for 7 days strength ranges as 1.6, 1.3, 1.0, 0.8(N/mm^2) and for 28 days it varies as 4.75, 3.8, 3.4, 3.2(N/mm^2). The maximum value is obtained for minimum mix ratio 1:3 as it offers a greater bonding strength.

Table- 5: Splitting tensile strength of concrete

SPECIMEN (MIX RATIO)	7 DAYS	28 DAYS
1:3	1.6	4.75
1:4	1.3	3.8
1:5	1.0	3.4
1:6	0.8	3.2

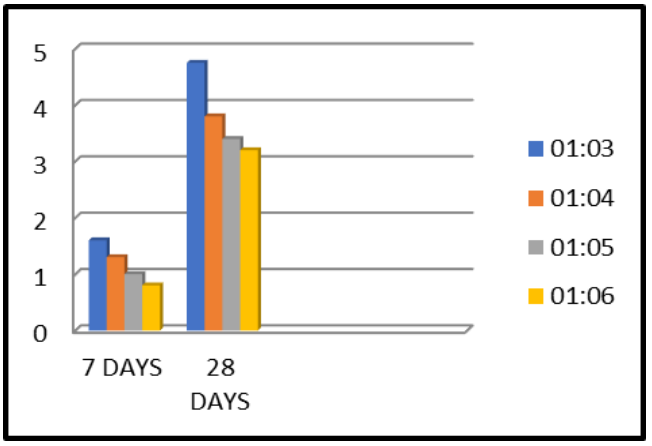

Chart- 2: Splitting tensile strength of concrete

7. CONCLUSIONS

The maximum compressive strength obtained from the experimental investigation is 18 N/mm^2 from 1:3 mix ratio after 28 days of curing in pure water. The maximum splitting tensile strength obtained is 4.75 N/mm^2 from 1:3 mix ratio after 28 days of curing in pure water. The strength obtained from 1:3 mix proportion is greater than all other ratios due to its higher bonding strength. There is a reduction of 26% in value from 1:3 to 1:4. As compared from different types of mix ratios, we could conclude that the strength obtained from 1:4 mix ratio also shows considerable strength. Hence the values of various proportions were compared and thereby we had concluded that minimum cement: coarse aggregate ratio is the best since it gives good strength. Air entraining admixtures can also be used when there is a need for extra voids

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