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PERMEABLE CONCRETE - VIABLE SOLUTION TO WATERLOGGING PROBLEMS

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ABSTRACT
Permeable concrete is sometimes referred to as no-fines gap graded, pervious or enhanced porosity concrete. Permeable pavement is sustainable solution for the modern infrastructure.
It allows water to pass through it, reducing the runoff and quality of the water. This project will explore you about for benefits and the importance of the permeable concrete pavement. In the India there is problem of the flooding in the most of the area due to the irregularities in the management of the drainage system. Improper management system of the rain water harvesting which cause insufficient supply of water and the flooding hazard, by helps of the permeable concrete the surface runoff of the water gets collected and use as the daily based necessaries. Also, due to heavy rain the blockage of the drainage system can prevent by helps of the permeable concrete pavements. permeable pavement reduces the stormwater runoff and pollution, prevent from the flooding. It also helps to increase the quality of the water and the recharge the ground water table.

INTRODUCTION

Permeable concrete is the special type of the concrete which use for concrete flatwork application the allows water to penetration from it and other sources to pass directly from it, and therefore reducing runoff and recharging the water table.
Permeable concrete is made of the large aggregate and little no fine aggregates. permeable concrete is traditionally use in the parking areas and light traffic roads, footpaths, residential streets and greenhouse.
Permeable concrete where first use in the Europe in 1800s as the pavement surfacing and load bearing walls.it again become popular in 1920s in Scotland and England for two story homes. The mixture has water-to-cement ratio 0.3 to 0.5 and with the porosity 15 to 25 percent
Using the permeable concrete for pavement making safer for pedestrian in the winter because the water won't settle on the surface and there will no freeze which lead to dangerously icy condition

Fig 1. Permeable Concrete Road

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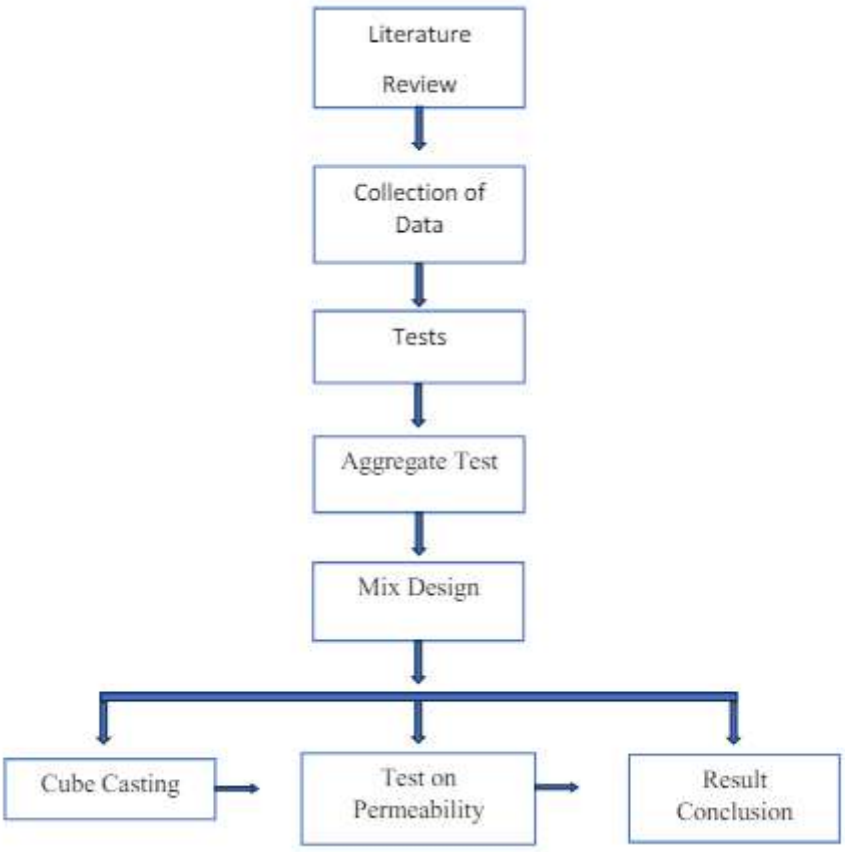
WHAT IS PERMEABLE CONCRETE?

Pervious concrete (also called porous concrete, permeable concrete) is a special type of concrete with a high porosity used for concrete flatwork applications that, allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge.
It is also known as the gap graded concrete which has large amount of the voids which helps water to penetrate through it.
Due the large amount of the void it reduces the strength of the concrete. Pervious concrete is one of the most useful type of the concrete which helps to recharge ground water table.

Fig. 2 Permeable Concrete

METHODOLOGY



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TEST ON AGGREGATE

a) IMPACT TEST:

1) Sample is passing through 12.5 mm and retained on 10 mm IS sieve.

2) Sample is oven dried at 100-110°C for 3 hours.

3) Sample is then filled in cylinder and weight of aggregate measured (A)

4) Then the cylinder is placed in impact testing machine where 15 blows of hammer of 13.5 to 14 kg weight are applied.

5) Then the sample is taken out and sieved through 2.36 mm IS sieve. Fraction passing through the sieve is weighted (B)

Aggregate impact value

$$= \left(\frac{B}{A}\right) \times 100\%$$

(1)

(2)

Fig. 3 Impact test Equipment

b) SPECIFIC GRAVITY TEST:

It is the ratio of dry weight of aggregate to the weight of equal volume of water. It is very important property required in concrete mix design.

To calculate specific gravity of Sand, pychnometer bottle is used. Mass of empty pychnometer (M_1) calculated in gm. Then 400 gm dry aggregate put inside the pychnometer and combine weight (M2) noted. Then fill the pychnometer sand with water and weight taken (M3). Then fill the pychnometer with water only and weight (M4) noted. Sp. gravity of aggregate

Specific gravity of coarse aggregate determined with the help of wire basket. The procedure given in IS 2386 part III.

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Sp. gravity of

$$CA = \frac{C}{B-A}$$

Apparent sp. gravity

$$= \frac{C}{C-A}$$

Water absorption

$$= \frac{100(B-C)}{C}$$

A = Weight of saturated aggregate in water (A1 - A2) gm

A_1 = Weight of aggregate and basket in water

A2= Weight of empty basket in water

B = Weight of saturated surface dry aggregate in air

C= Weight of oven dried aggregate in air.

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OBSERVATION TABLE:

Detail of Sample	Observation
• Wt of Aggregate suspended in water with Bucket (A1)	2063 gm
• Wt of Bucket suspended in water (A2)	803 gm
• Wt of Saturated Aggregate (A)	1260 gm
• Saturated surface Dry Aggregate wt (B)	1999 gm
• Oven Dry Aggregate wt	1955 gm

Table 1. Specific Gravity Observation Table

Fig. 4.1 Specific Gravity Apparatus

Fig. 4.2 Wet Aggregate

Specific gravity of aggregate : 2.64

MIX DESIGN OF PERMEABLE CONCRETE

Step 1 – Target mean Strength.

$$f\acute{c}k = fck + 1.65 \times 5$$

Assume M35 Grade of Concrete

$$f\acute{c}k = 35 + 1.65 \times 5$$
$$= 35 + 1.65 \times 5$$
$$= 43.25\ N/mm^2$$

Step 2 – Selection of w/c ratio

Exposure: –severe

w/c ratio for 28 Days compressive strength of concrete 43.25 N/mm^2 for opc grade cement is 0.45

Step 3 – Water Content

. water content for 100mm slump $= 186 + (6\%) \times 186 = 197.16L$

Step 4 – Calculation of cement content

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$\therefore$ cement content $= \frac{\text{water used}}{\text{w/c ratio}} = \frac{157.72}{0.45} = 350.48\text{kg/m}^2 < 250\text{kg/m}^2$ $-$Hence ok

Step 5 $-$ Calculation of volume of coarse aggregate

But, w/c ratio is $= 0.45$, $\therefore 0.5 - 0.45 = 0.05$, $= 0.64 + 0.01 = 0.65$

Reducing10% $= 0.65 - (10\% \times 0.65)$

Volume of coarse aggregate $= 0.585$

Step 6 $-$ Calculation per unit volume

1) Volume of concrete $= 1\text{m}^3$

2) Volume of Entrapped Air $= 1\%$ for 20mm coarse aggregate $= 0.01\text{m}^3$

3)Volume of cement $= \frac{\text{mass of concrete}}{\text{Sp. Gravity}} \times \frac{1}{1000} = \frac{350.48}{3.15} \times \frac{1}{1000} = 0.111\text{m}^3$

4)Volume of water $= \frac{\text{mass of water}}{\text{Sp. Gravity}} \times \frac{1}{1000} = \frac{157.72}{1} \times \frac{1}{1000} = 0.157\text{m}^3$

5)Volume of Aggregate

$= 1 - [\text{Volume of cement} + \text{Volume of water} + \text{Volume of Entrapped Air}]$

$= 1 - [0.111 + 0.157 + 0.01] = 0.723\text{m}^3$

. mass of coarse aggregate $= 0.723 \times 0.585 \times 2.64 \times 1000 = 1116.25\text{kg}$

Step 7 $-$ Mix proportion[1: 0: 3.18]

Batch	Mix Ratio
4	1:0:3.18
5	1:0:3.18
6	1:0:3.18
7	10:3.18
Fly Ash	1:0:3.18
Plasticizer	1:0:3.18

Table 2. Mix Ratio of Permeable Concrete Cubes

(1) (2)

Fig. 5 Permeable Concrete

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INFILTRATION TAST

Infiltration tests are performed on permeable concrete to assess its ability to allow water to pass through and infiltrate the underlying soil. This helps determine the effectiveness of the permeable concrete in managing stormwater runoff and preventing flooding. It also helps in evaluating the design and performance of permeable pavement systems for sustainable urban drainage.

$$I = \frac{KM}{D^2 \times t}$$

Where, I = Infiltration Ratio (mm/h)
M = Mass Of Infiltrated Water (kg)
D = Inside Diameter Of Infiltration Ring (mm)
t=Time Required For Measured Amount Of Water to infiltrate the concrete (s)
K =126,870 in (constant)

(1)

(2)

Fig. 6 Block Specimens

INFILTRATION TEST CHART:

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INFILTRATION TEST CHART

Batch	Quantity of Water Collected	Time Required (t)	Permeability Coefficient (f) mm/sec
4	960 ml	10.3	9.66
5	990 ml	12.9	7.71
6	920 ml	15.2	6.54
7	925 ml	15.6	6.38
Fly Ash	965 ml	13.6	7.31
Plasticizer	970 ml	13.4	7.42

Table 3. Infiltration Test Chart

Fig 7. Specimen Preparation

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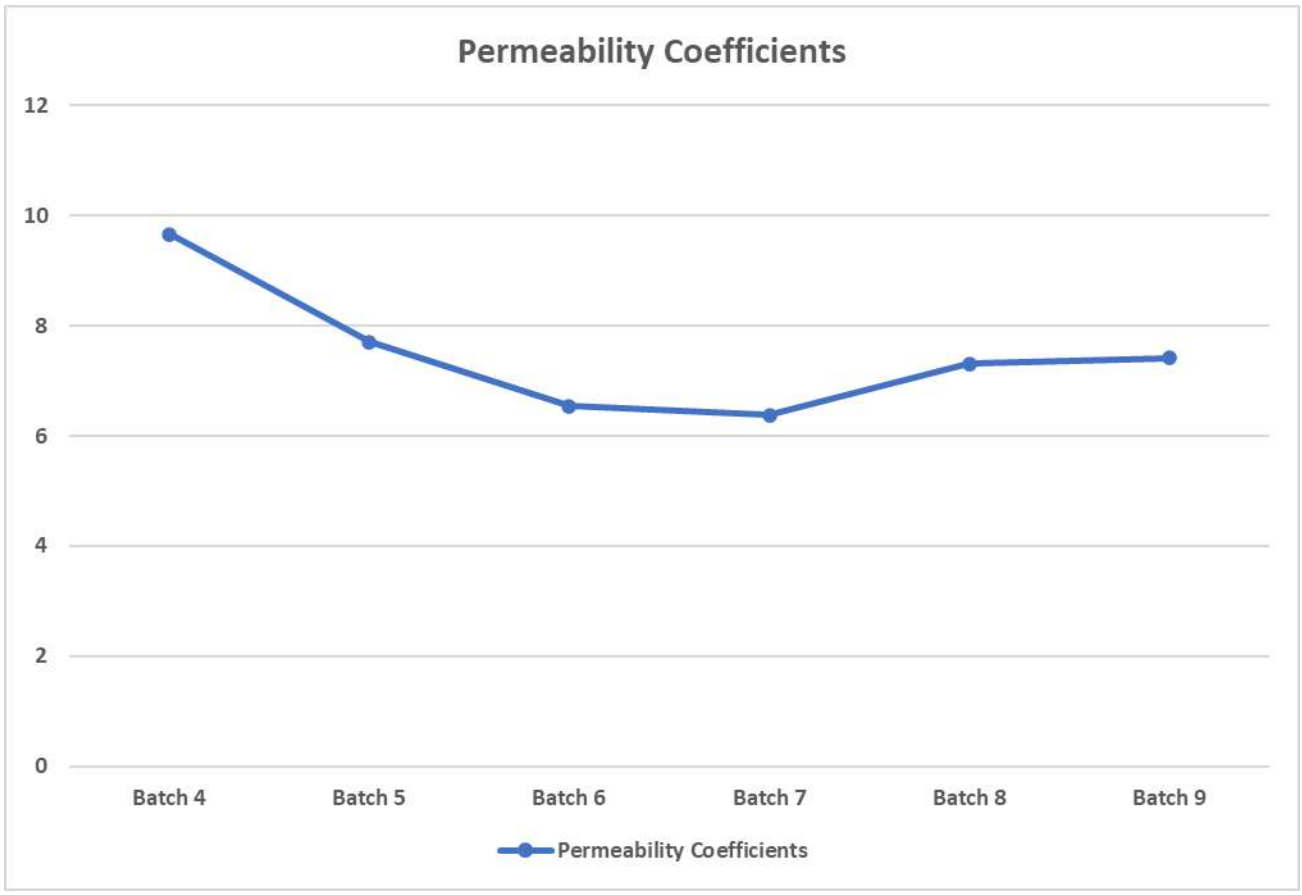

Fig 8. Infiltration Test Graph

(1) **(2)**

Fig 9. Test Process- (1) & (2)

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ESTIMATION FOR PARKING AREA

- Approximate Parking dimenssion for
  1 car = 8ft wide & 16ft long.

. Area required for 1 car = 128 sq. ft

Therefore,
. Area Required for 10 cars = 1280 sq. ft

$$\begin{aligned} \text{Volume} &= \text{Area} \times \text{Height} \\ &= 1280 \times 0.180 \\ &= 230.4 \text{ cu. ft} \end{aligned}$$

- Calculation for one Pervious Concrete

$$\text{Volume} = 0.1191 \text{ ft. cube}$$

$$\begin{aligned} \text{No of Pervious Block} &= \frac{230.4}{0.1191} \\ &= 1934.50 \\ &\cong 1935 \text{ Nos.} \end{aligned}$$

- $Wastage\ Add\ 5\% = 1935 \times \frac{5}{100}$
  $= 96.75$
  $= 97\ Nos.$

- Total No of Pervious Block.
  $= 1935 + 97$
  $= 2032.$

CONCLUSION

- Hence, we have observed that permeable concrete is sustainable pavement for environment.
- By help of permeable concrete minimization of surface runoff can be observed.
- It recharges ground water level.
- It also helps to prevents the flooding hazards.
- Following terms plays a crucial role in the strength of pervious concrete:
  a) Size of coarse aggregate
  b) Water-cement ratio
  c) Aggregate to cement ratio
- We also, concluded that the maximum size of the aggregate helps in the permeability of the concrete
- The size of the aggregate is directly proportional to the permeability of the concrete.
- Permeable concrete has one weakness that it can't bear heavy loads.
- The void ratio and unit weight are two important parameters of pervious concrete in the context of mix design.
- We concluded that aggregate of size 20 mm gives the optimum porosity in pervious concrete.

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