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Pervious Tiles by using Epoxy coated Aggregate

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ABSTRACT: Concrete is the Most Basic Material Used in Construction Areas. However the Concrete is Pervious in Nature but It is Not that much as it Required For Pavement construction Pervious concrete is a special and different type of unlike other ordinary Concrete they are having less porosity as compare to Pervious it is having a high porosity (15%-30%) mainly used for flatwork applications that allows water to Penetrate from Ground other sources to pass through, thereby reducing the runoff from a site and recharging ground water levels. Its void content ranges from 15 to 30% with compressive strengths of 2.5 N/Sq-mm to 28 N/ Sq-mm. The infiltration rate of pervious concrete will fall into the range of 8 litters to 70 lit per minute per square foot (85 to 750 litres per minute per square meter). Typically, pervious concrete has no fine aggregate it just a mixer of cement course Aggregate and water but I use epoxy for Coating the reason of using Epoxy is it resist water from Absorption and has just enough cementitious paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids. Pervious concrete is traditionally used in parking areas, walking areas and pedestrian walkways, and Housing and contributes to sustainable construction.

KEYWORDS: Pervious Concrete, Pervious Tiles, Interlocking Tiles.

I. INTRODUCTION

Pervious pavement and Tiles is a new and effective means to manage important environmental related issues and support greenery, sustainable growth. By collecting Rain water and discharge it into the ground, with a high porosity used for concrete base allows water to Penetrate underground which will be very helpful to maintain the ground water level, drainage system etc. It also help to filter the storm water naturally with a high void content to allow water or air to permeate. In general, pervious concrete has pores with sizes in the range of 2–8 mm, the void content is 15%–30% and the compressive strength is 2.8–28.0 MPa

This introduction of pervious tiles pavements reviews its applications and engineering properties, including many environmental benefits, structural properties, and durability. Both hydraulic and structural design of pervious concrete pavements are discussed, as well as construction techniques and very cheap compare to other Concrete Pavement

In pervious concrete, carefully controlled amounts of water and Cement materials are used to create a mortar of just cement that forms a thick coating around aggregate particles. A pervious concrete mixture contains no sand, creating a substantial void content. Using sufficient paste to coat and bind the aggregate particles together creates a system of highly permeable that Discharge complete water, interconnected voids that drains water quickly. Typically, between 15% and 25% voids are achieved, previous pavement has many economical and environment factors like it is very low cost material and doesn't required a particular drainage system for water flow it will be very helpful for safety and accident because it has rough surface and due to voided in nature the frictional value of surface increases and due to water Discharging property it helps to resist surface from slipping

II. MATERIAL PROPERTIES

AGGREGATE:- Pervious concrete we generally use Singular Size of coarse aggregates. For design of pervious Concrete we used 10-12.5 mm of coarse aggregates as per IS Code 10262:2009 for mix design and also if coarse aggregate Size decreases compressive strength increases.

CEMENTITIOUS MATERIAL:- we used Portland Pozzolana cement of OPC Grade-43(Birla cement) as per the Is code IS code 1489:1991

EPOXY:-An epoxy coating is a coating compound or Liquid consisting of two distinct Products: an epoxy resin and a polyamine hardener (also known as a catalyst). When mixed together the resin and hardener comes in a chemical reaction that creates cross-linking of the elements as it cures. When the epoxy coating is fully cured, the resulting product is a durable, rigid plastic coating with numerous desirable mechanical property's.

Reasons and Aim of Achievement

As My Project is based on Previous Pavement my aim for Achievement is to make a Pervious Tiles that Doesn't absorb water and help to penetrate Approximately 90% of its Amount and to achieve that 90% Penetration i am using Epoxy Resins Paint for coating. The reason of using epoxy paint is

1st It is already used in construction area like Coating of reinforcement bars, filling cracks through Epoxy injection, floor coating and To stick two Surfaces.

2nd Aggregates is also Some short of Pours in nature study tells it absorbs approximately 5% of water from it surface. Aggregates are of 2 type High pours and low pours the Aggregates which we use in home construction is high pours but the Aggregates use in Heavy construction site is low in Porosity and low pours Aggregate are Higher in strength.

3rd The compressive strength of 170-180 N/mm² which is even more then a Different Grades of Concrete

4th Due to Higher compressive strength and use in many area it will not remove Easily when use in Coating and it will also help to Bear a Load and to resist the Absorption of Water.

Why Coated Pervious Tiles and Pavement

1st The Reason of Choosing Coated Pervious tiles and Pavement is to Help in Areas and Sections where drainage is a challenging problem and Rainfall in heavy.

2nd Epoxy Coated Pervious Tiles and Pavement will help to penetrate the ground water easily without any absorption it doesn't Required any kind of curvature or special treatment in pavement for Drainage.

3rd It helps to Directly recharge from Ground and helps to Prevent warm and polluted water from getting into streams.

4th It eliminate detention ponds that are use for storm water management practices and it is very costly.

5th Due to porosity in nature the frictional value of pavement is also increased which help to prevent from slipping and helps to reduce safe distance between vehicle.

Why ½ inches of Aggregate in Pervious Tiles

1st Various study Tells that by increasing the size of Aggregate will also increase the permeability and if the porosity will increase it will automatically decrease the Compressive strength of Pervious pavement helps to maintain the Compressive strength of Pervious pavement and Tiles we had Chosen ½ inches of Aggregate. It will help to maintain the compressive strength as well as porosity for water Discharging.

2nd increasing the size of Aggregate will automatically increase the frictional value of Ground which will cause damage in Tyres and the running surface So, we have to Provide a Required frictional value for better run off for vehicles.

Why not less the ½ inches of Aggregate

1st Decreasing the size of Aggregate below ½ inches will cause problems in Penetration as the size of porosity decreases Discharging of water or Detention time will Decrease which cause water flow over the surfaces.

2nd Decreasing the size of Aggregate will cause blockage in porosity and if not, it will cause blockage in future from mud sand or other substances which cannot be remove Easily so it may cause loss of Required Porosity which will cause problems in water penetration.

3rd ½ inches Aggregates will also help to Bound the surface properly as it is having a Required porosity and High compressive strength the bond between the paste and Aggregate is Good which will help to prevent from Cracks from compression.

Why Grade of Ratio of cement and Aggregate is 1:4

1st Grade of Pervious Concrete will affect the Strength of Concrete By increasing the Grade of Concrete will increase the Strength of Pavement by increasing the grade will also Decrease the porosity of pavement So, the Ratio of 1:4 will be suitable for strength as well as porosity.

2nd Due to the absence of fine Aggregate the Grade of Concrete provide more strength due to the absence of sand Ratio as the Ratio of Sand particles is empty and having a porosity of 15% the empty space will take 20% of cement and 80% of Aggregates.

3rd Cement is also Pours in nature so by increase the amount of as per requirement will increase the absorption of water and our Main aim is to Prevent Pavement from Absorption and complete Discharge from Ground but Decreasing the amount of cement will also Decrease the strength of pavement. Grade4 for pavement is much suitable compare to any other Grade of Pavement.

Why Epoxy coating

1st Epoxy Resins is having a compressive strength of 170-180 N/mm² so it will Not remove or Break Easily after coating and it will also help to Bear a load while compression.

2nd Epoxy coating help to resist complete water from Ground because Epoxy is Having 0% Porosity.

3rd As it is use to fill the crackers in Beam, column and slabs it will help to Prevent Aggregate from cracking.

4th while Doing a Practical work it is observed that 80ml of Epoxy Required to paint 1kg of Coarse Aggregate (10mm-12.5mm)

5th It is cheaper in use as the amount required for quoting is not more as compare to other coating products.

Why interlocking Tiles

1st One of the main advantages of interlocking floor tiles is the ease and speed of which they can be installed.

2nd Doesn't Required special Manual labour for installation

3rd It can removed without any damage on flowering and it can be reuse in some other areas of Pavement.

4th As by Name interlocking it helps to interlock with each other

For Mix Design

For Designing a pervious Tiles we used IS code from Table 5 of IS456-2000

Maximum W/C Ratio = 0.30 – 0.45 lit

Water: cement: course Aggregate : fine Aggregate: epoxy paint
0.45: 1 : 4: 0: 0.08 (as per IS code 10262: 2000)

Material Used for Previous Tiles and Block

1st Epoxy paint (Asian paints)

2nd Coarse Aggregate (10mm -12.5mm)

3rd PCC cement (of OPC 43 Grade)

Epoxy Coating on an Aggregate

*80ml of epoxy paint Required for 1kg Aggregate coating (7mm-12.5mm)

*Dry it for 24 hr (as per the direction mentioned behind)

*Used a brush for coating (3 inch, Nylon)

As we Have to test At least 3 Block for Compressive strength we need to calculate the Amount of material required as well as Procedure for preparing Epoxy coated Pervious block and the same procedure will carry for pervious Tiles

Process of Making Pervious block of Epoxy Coated Aggregate for Testing

Step 1 (Calculation of material required for block preparation)

The Ratio we are taken For Preparing a Pervious block is M15 Grade

M15 Grade of Concrete 1:2:4

As we are working on Pervious Concrete and in Pervious Concrete fine Aggregate is not present so the ratio of fine Aggregate is divided equally in the ratio of cement and Aggregate 1:4 (20% cement and 80% Aggregate)

So, we are Going to Prepare 3 specimen cube for compressive strength test of (7 Days, 14Days, 28Days)

Size of 1 cube is 150mm×150mm×150mm

Volume of Cube is = 3.37×10^{-3} cu-m

Volume of 3 Cube is $3 \times (3.37 \times 10^{-3} \text{ cu-m}) = 0.01$ cu-m

Total Ratio of Volume = (1+4) = 5

Volume of Dry concrete = $1.57 \times$ Volume of wet Concrete

Calculation for 0.01 cu-m volume

Volume of cement Required

Volume of cement = $(\text{cement Ratio} \times 1.57 \times 0.01) / \text{Total ratio} = (1.57 \times 0.01) / 5$

Volume of cement Required for Block = 3.14×10^{-3} cu-m

Volume of Aggregate Required

Volume of Aggregate = $(\text{Aggregate Ratio} \times 1.57 \times 0.01) / \text{Total Ratio} = (4 \times 1.57 \times 0.01) / 5$

Volume of Aggregate Required for 3 Blocks = $0.012 = 1.25 \times 10^{-2}$ Cu-m

Density of cement is 1440 kg/cu-m

Mass of cement Required = $1440 \times 3.14 \times 10^{-3} = 4.52$ kg

So, weight of cement Required for block Preparation is = 4.52 kg

And the Ratio of Pervious Block and Tiles is 1:4

So, weight of Aggregate Required for block Preparation is = $4.52 \times 4 = 18$ kg

As per the calculation 0.4 lit of water Required for W/C Ratio

But to achieve perfect consistency we had Taken 0.45 lit (IS:456-2000)

So, for 4.52kg of cement we required = $4.52 \times 0.45 = 2.03$ Lit of water

Volume of Epoxy Required for Coating

For every 1 kg of Aggregate we required 80 ml of Epoxy

So, for the preparation of blocks we Required $18 \times 80 \text{ ml} = 1440 \text{ ml} \approx 1.5$ Lit So, the volume of Epoxy Required for block Preparation is = 1.5 Lit

Cement = $4.52 \approx 4.6$ kg

Aggregates = $18 \approx 18.5$ kg

Epoxy = $1.5 \text{ lit} \approx 1.6$

Water = $2.03 \approx 2.2$ lit



Epoxy



Aggregate



Cement

Step 2 (Coating of Epoxy on an Aggregate)

1st It Required 1.6 lit of Epoxy to paint 18.5kg Aggregate but due to some wastage while paint it Takes Approximately 2 Buckets of 1 Lit

2nd method which is use for Painting is i use to pour Required Volume of Paint on an Aggregate inside the box and mixed it with the Help of Paint Brush

3rd After Painting I left this for Drying it Approximately take 24hr for completely Drying

4th The paint is very Sticky in nature so I use Plastic Sheet to avoid sticking



Step 3 (Process Of making Cubes)

1st Taken 4.6 kg PCC (of OPC 43 Grade) Cement

2nd The Required Quantity of coated Aggregate is Dumped (19 Kg)

3rd The coated Aggregate and cement is then mixed intimately with spade, turning the mixture over and over Layer by layer again and again until the cement Ratio mix evenly

4th Make a well type structure by using spade

5th Pour Required water in between the Material (2.2 lit)

6th Mix it properly by collapsing the wall Material into the Centre

7th Mix it properly and watch the consistency of Material if it feels less liquidity mix a bit of water extra to find the Perfect consistency.



Step 4 (Final, moulding and Curing)

- 1st Pour Concrete in 3 Layers and compact each Layer with 35 Nos. Of Stroke by using Tamping Rod (16mm Diameter)
- 2nd Finish the Top surface by Trowel after the compaction of Last Layer
- 3rd After 24 hrs remove the Specimen from mould
- 4th while removing take care of the Edges
- 5th Mark the Cube and submerge the block in clean fresh water
- 6th Test each block in (7 days, 14 Days and 28 Days)



Moulding & Curing

EPOXY COATED TILES PREPARATION

“Geometrical Design of Interlocking Tiles”

The Two Tiles design that are taken

1) A- SHAPED

and

2) Hexagonal shaped

Surface Dimension

AB= 12 inch, BC=4-inch, CD= 4 inch
DE= 4 inch, EF= 4 inch, FA= 12 inch
AG= 1.5 inches (Thickness)

Angular Dimensions: -

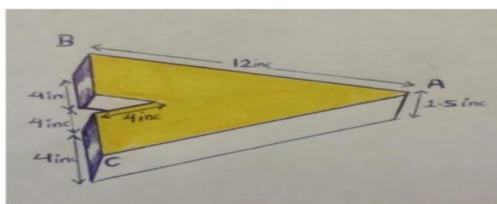
<ABC=60°, <BAF=60°, <AFE=60°
<BCD=120°, <CDE=60°, <DEF=120°

Surface Area Dimensions: -

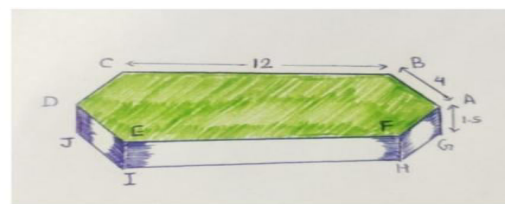
AB= 4 inch, BC= 12 inch, CD= 4 inch
DE= 4 inch, EF= 12 inch, FA= 4 inch
AG= 1.5 inches(Thickness)

Angular Dimension

<ABC=120°, <BCD= 120°, <CDE= 120°
<DEF= 120°, <EFA=120°, <FAB= 120°

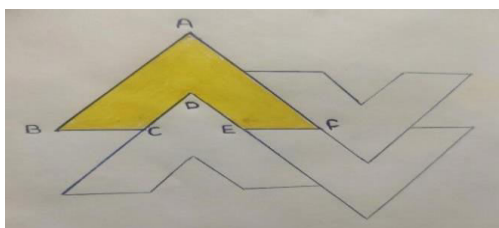


A-Shaped

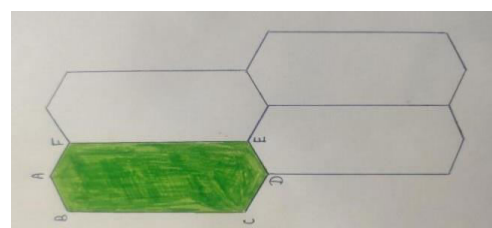


Hexagonal Shaped

“Geometrical Design of A and Hexagonal Shaped Tiles”



A-Shaped Interlocking Design



Hexagonal Interlocking Design

Quantity of Material Requires For A-Shaped Tiles

Volume of Tiles= Volume of Prism (ABC) – volume of Prism (CDE)

Volume of Prism (ABC)= $\frac{1}{2} \times 12 \times 10.4 \times 1.5 = 93.5 \text{ inch}^3$

Volume of Prism (CDE)= $\frac{1}{2} \times 4 \times 3.46 \times 1.5 = 10.38 \text{ inch}^3$

Volume of Tiles= $93.5 - 10.38 \text{ inch}^3 = 83.12 \text{ inch}^3 = 0.0013 \text{ cu-m}$

So, volume for 2 interlocking Tiles = $0.0013 \times 2 = 0.0027 \text{ cu-m}$

Ratio Taken:- 1:4(C&A)

Volume of Dry concrete= $1.57 \times$ volume of wet concrete

So, material Required for 0.002 cu-m

Volume of cement= (Cement ratio $\times 1.57 \times 0.002$)/Total Ratios of Mixture

= $\frac{1}{5} \times (1.57 \times 0.002)$

= 0.0006 cu-m

Density of cement= 1440 kg/m^3

Mass= Density \times volume

Mass of cement= $1440 \text{ kg/m}^3 \times 0.0006 \text{ m}^3 = 0.86 \approx 0.9 \text{ kg}$

Weight of cement required for Tiles = $0.9 \text{ kg} \approx 1 \text{ kg}$

Volume of Course Aggregate= $(4 \times 1.57 \times 0.002)/5$

= $0.0125/5 = 0.0025 \text{ m}^3$

Density of Course Aggregate= 1600 kg/m^3 (1500-1800)

Weight of Aggregate Required = $0.0025 \times 1600 = 4 \text{ kg}$

Weight of Aggregate = 4kg

W/C Ratio (as per the given direction of IS456-2000)

0.45(W/C Ratio as per consistency and IS456-2000)

0.45×0.9

0.40 Lit. Of Water Required



1kg Cement (PPC)



4kg Epoxy Coated Aggregate

Quantity of Material Required for Hexagonal Tiles

Volume obtained as per calculation = 0.002 cu-m

Volume of 2 interlock hexagonal Tiles= 0.004 cu-m

Total Ratio of a material using (1:4) = 5

Volume of Dry concrete= $1.57 \times$ volume of wet concrete

Calculation of material for 0.004 cu-m

Volume of cement= $(1 \times 1.57 \times 0.004)/5$

Volume of cement = 0.00125 cu-m

Density of cement = 1440 kg/m^3

Weight of cement = $1440 \times 0.00125 = 1.8 \text{ kg} \approx 2 \text{ kg}$

Volume of course Aggregate= $(4 \times 1.57 \times 0.004)/5 = 0.005$

Density of Course Aggregate= 1600 kg/m^3 (1500-1800)

Weight of Course Aggregate Required= $1600 \times 0.005 = 8 \text{ kg}$

0.45(W/C Ratio as per consistency)

$0.45 \times 2 = 0.9 \text{ lit of Water Required}$



2kg Cement



8kg Epoxy coated Aggregate

Procedure of Epoxy coated Pervious Tiles

Step 1(Mixing And Moulding)

- 1st Take A Required and calculated amount of Cement and Epoxy coated Aggregate.
- 2nd As the Amount of cement(3kg) and Aggregate(12kg) is already calculated
Mix both the Material by using Spade
- 3rd After Mixing both the Material make a well type structure and Pour the Amount of water that is calculated $0.45 \times 3 = 1.35 \text{ Lit} \approx 1.4 \text{ Lit}$
- 4th Mix all the Ratios Properly At least 3 times and if the consistency will not achieve mix some extra amount of water to Achieve Perfect consistency
- 5th Put all the materials in the Frame of Interlocking and remove extra Materials and plan it by using spade.



A-Shaped Tiles



Hexagonal Tiles

Step 2 (Final setting and Curing)

- 1st Remove the Frame after 24hr
- 2nd While removing the frame Take care of the Edges and corner
- 3rd After Removing the Frame Submerge both the Tiles in Fresh water



Step 3 (Result after 28 Days of Curing)



A-Shaped Interlocking Tiles curing



Hexagonal Interlocking Tiles curing

Final Result of Pervious Tiles(Interlocking)



A-Shaped Tiles



Hexagonal shaped

III. TESTING AND RESULTS

WATER ABSORPTION TEST OF EPOXY COATED AND NORMAL AGGREGATE

Water(lit)	0.5 lit(500ml)	0.5 lit(500ml)
Weight(kg)	0.5kg	0.5kg
Size(mm)	10mm-12.5mm	10mm-12.5mm
Aggregate Type	Epoxy Coated	Normal Aggregate
Time Period (hr)	24hr	24hr
Error	30ml	30ml
Heated (100°C)	4hr	4hr

Result carried out:-

Absorption	5-7ml	20-21ml
Retained volume	0.46lit (465ml)	0.44lit (450ml)
Absorption period	24hr	24hr

Result- ½ Kg of Aggregate Absorb 4.5% of water whereas Epoxy coated
Almost resist the Water Absorption

Compressive Strength Test

Compressive strength of a pervious tiles depends on the size of coarse Aggregate, void Ratio, bond between the Aggregates, mortar and material quality

In 7 days cube of Pervious Concrete will achieve the Min Strength of 30%

In 21 days cube of Pervious Concrete will achieve the Min Strength of 70%

In 28 days cube of Pervious Concrete will achieve the Min Strength of 95%

After testing a cube of void ratio (15%-30%)

Compressive strength achieved in 7 Days = 10.69 N/mm²

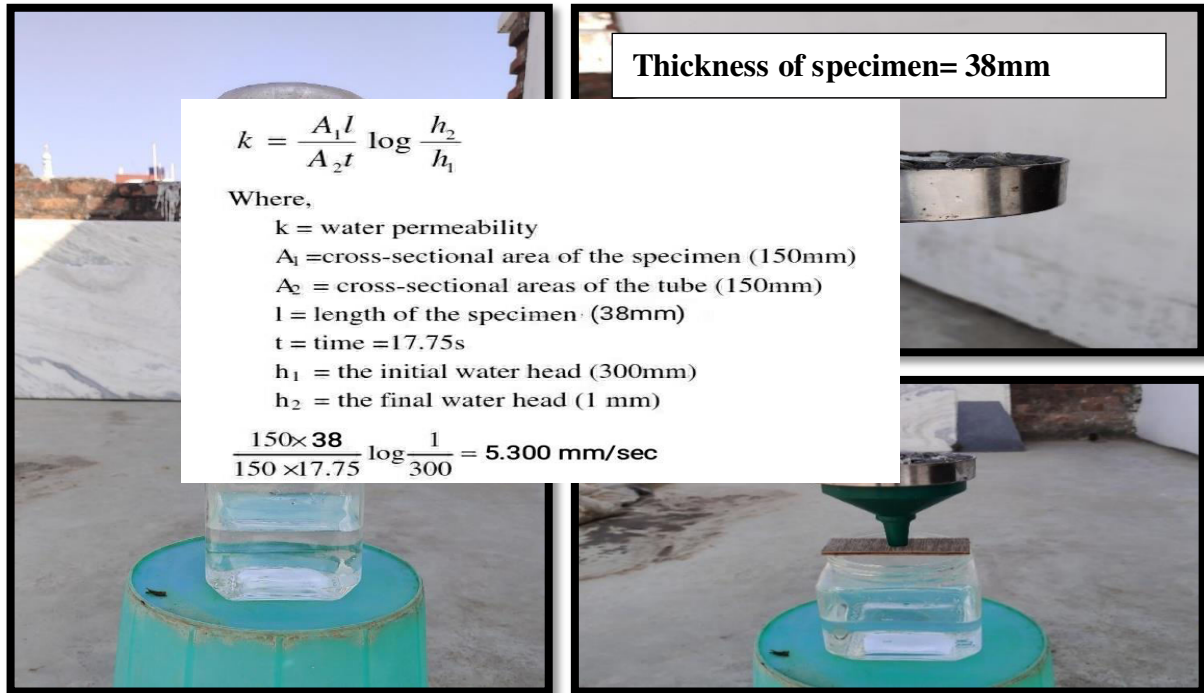
Compressive Strength achieved in 21 Days = 14.89N/mm²

Compressive Strength Achieved in 28 Days = 16.85N/mm²



Compressive strength Test

Permeability Test of pervious Tiles



Concrete is determined by special arrangement of cylindrical shape bucket or specific container which should be open from both the side and has to arranged in such a way so that one side could be used for pouring of water and other resting on pervious concrete as shown in figure below.

Procedure

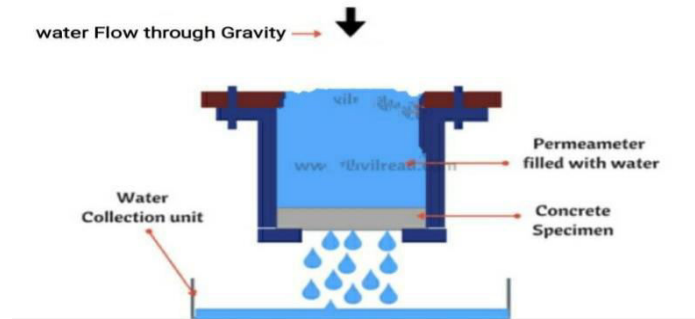
1. The concrete having a thickness more than 20mm(As we taken 76mm) is placed on Measuring Beaker.
2. And then fill the Beaker with Calculated amount of water.
3. To find the permeability of concrete the water is through the disc is collected at the water collection unit.
4. To accelerate the process, you can apply pressure from the top.
5. Calculate the Time while water is Discharging

Result- 5.300 mm/sec is the Coefficient of Permeability that takes 17.75 sec to pass the 38mm thick specimen

Factor Affecting the Permeability of Pervious Tiles

1st Water-Cement Ratio-Excessive water is added to the concrete mix to increase the workability of concrete. This additional mixing of water, more than required increases the porosity in concrete will decrease strength of concrete. To resist the entry of water into the concrete 0.4 water-cement ratio is adopted. Experiments proved that taking a water-cement ratio of 0.4 makes concrete impermeable.

2nd Improper compaction- In concrete is the major problem for porosity in concrete. Concrete should be adequately compacted using hand compaction method or machine compaction methods. Poorly compacted concrete leads to the formation of honeycomb which ultimately makes steel to corrode and forms surface cracks.



Water Permeability Test

IV. CONCLUSION

From the experimental result, the pervious concrete of Epoxy coated Aggregate Absorb less water as compare to other Pervious Pavement. While we know that strength and porosity is inversely Proportional to each other. The pervious concrete of 1:4 Ratio is perfect for Tiles and Pavement. Strength as well as penetration Due to the absence of Sand Ratio the empty section of sand takes the place by cement and aggregate as their Ratio is divided it helps to Achieve even more strength as compare to Normal Concrete. As it has the Required Porosity and strength to Absorb Compression it can be use widely in Home, footpath and cycling path.

0% of sand comprises of strength more then M15 Grade of Concrete. Mostly M15 grade of concrete use in Pavement construction Thus, Epoxy coated Pervious Concrete of 1:4 Ratio is recommended for Pavement construction and Epoxy coated Interlocking Tiles is Recommended for Home purpose.



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