

# Pervious Interlocking Tiles by using Epoxy Coated Aggregate for Pavement

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**Abstract** - Concrete is the Most Basic Material Used in Construction Areas. However the Concrete is also 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/mm<sup>2</sup> to 28 N/mm<sup>2</sup>. The infiltration rate of pervious concrete will fall into the range of 8 liters to 70 lit per minute per square foot (85 to 750 liters per minute per square meter). Typically, Pervious Tiles & pavement is a special Type of Pavement compare to other Concrete structure it Absorbs more water and Due to Highly porous in Nature it helps to Penetrate water Easily which causes Increase in Ground water Discharge, Detention time and Absorption Rate But we also know the Materials which we are using in Pavement construction they are also porous in Nature Like Aggregate so Our Aim is to Promote Complete water Discharge without Any Absorption that's why we are using Epoxy paint for coating which Helps To Resist water Absorption on an Aggregate and Promote Complete Water Penetration

**Keywords:** Pervious Tiles, Pervious Pavement

## 1.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 2.5-28.0 MPa

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.

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 another Concrete Pavement.

## 1.1 Materials

**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 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

## 1.2 Reasons and Aim

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.

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.

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

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.

### 1.2.1 Reason of ½ inches of Aggregate

Various study Tells that by increasing the size of Aggregate will also increase the permeability and porosity and if 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. increasing the size of Aggregate will automatically increase the frictional value of Ground which may cause damage in Tyres and Running surface So, we have to Provide a Required frictional value for better run off for vehicles.

### 1.2.1 Problem in Less than ½ inches of Aggregate

Decreasing the size of Aggregate below ½ inches will cause problems in Penetration as the size of Aggregate Decrease the amount of porosity will also Decreases which Increase Detention time and Decrease Discharging Rate. It will also cause Easily Blockage in Pores

### 1.2.2 Problem in More than ½ inches of Aggregate

Increasing the size of Aggregate will increase the size of porosity but porosity is inversely proportional to its Strength. By Increasing size of an Aggregate will cause Increase in Roughness which Increases the Frictional value of a surface.

### 1.2.3 Epoxy coating

Epoxy Resins is having a compressive strength of 170-180 N/mm<sup>2</sup> so it will Not remove or Break Easily after coating and it will also help to Bear a load while compression. Epoxy coating help to resist

water Absorption from Ground because Epoxy is completely Non-Pores in Nature As, it is use to fill the crackers in Beam, column and slabs it will help to Prevent Aggregate from cracking. while Doing a Practical work it is observed that 80ml of Epoxy Required to paint 1kg of Coarse Aggregate (10mm-12.5mm) .

### 1.2.4 Why interlocking Tiles

One of the main advantages of interlocking Tiles is the ease and speed of which they can be installed Doesn't Required special Manual labors for installation It can remove and use without any damage it can be reuse in some other areas of Pavement As by Name interlocking it helps to interlock with each other

## 2. Mix Design

For Designing a pervious Tiles

Maximum W/C Ratio = 0.30 - 0.45 lit( Table 5, IS456:2000)

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

### 2.1 Material Used

- Epoxy paint (80ml Paint Required for 1kg Aggregate Coating and Dry it for At least 24 Hours)
- Coarse Aggregate (10mm -12.5mm)
- PCC cement (of OPC 43 Grade)

### 2.2 Material Calculation for Block Preparation

Dimensions of Cube for Testing = (0.15×0.15×0.15)m

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

Total Volume of 3 Cubes =  $3 \times (3.37 \times 10^{-3} \text{ m}^3) = 0.01 \text{ m}^3$

Total Ratio of Material = 5 (Cement & Aggregate)

Volume of Dry concrete = 1.57× Volume of wet Concrete

Calculation for 0.01 m<sup>3</sup> volume

#### Weight of cement Required: -

Volume of cement = (cement Ratio × 1.57 × 0.01)/Total Ratio =  $(1.57 \times 0.01)/5 = 3.14 \times 10^{-3} \text{ m}^3$

Density of Cement = 1440 kg/m<sup>3</sup>

Weight of Cement = 1440 kg/m<sup>3</sup> ×  $3.14 \times 10^{-3} \text{ m}^3 = 4.52 \text{ kg}$

#### Weight of Aggregate Required:-

Volume of Aggregate = (Aggregate Ratio × 1.57 × 0.01)/Total Ratio =  $(4 \times 1.57 \times 0.01)/5 = 1.2 \times 10^{-2} \text{ m}^3$

Density of Aggregate = 1500 kg/m<sup>3</sup> (1500kg/m<sup>3</sup>-1600kg/m<sup>3</sup>)

Weight of Aggregate =  $1500 \text{ kg/m}^3 \times (1.2 \times 10^{-2} \text{ m}^3) = 18 \text{ kg}$

We can Also Use this Method, As the Calculated cement weight is 4.5kg and Ratio of Material (1:4) So, The weight of Cement is  $4 \times 4.5 = 18 \text{ kg}$

As per IS:456-2000 (W/C Ratio is 0.4) But to achieve perfect consistency we had Taken 0.45 lit (IS:456-2000 Recommends 0.3-0.45) Water Requires for 4.52kg of Cement = 2.03 Lit

### Volume of Epoxy Required:-

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

So, For Block Preparation we Required  $18 \times 80 \text{ ml} = 1440 \text{ ml} \approx 1.5 \text{ Lit}$  So, the volume of Epoxy Required for Coating = 1.5 Lit

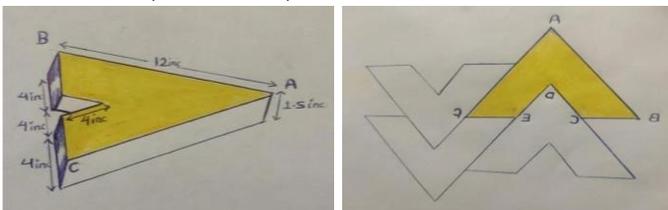
### 3. Geometrical Design of Interlocking Tiles

Two Design of Interlocking Tiles is Prepared A-Shaped and Hexagonal Shaped

#### 3.1 A-Shaped (Design and Dimensions)

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

Angular Dimension:-  $\angle ABC=60^\circ, \angle BAF=60^\circ, \angle AFE=60^\circ, \angle BCD=120^\circ, \angle CDE=60^\circ, \angle DEF=120^\circ$



Geometrical Design of A-Shaped

#### 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=  $83.12 \text{ inch}^3 (93.5 - 10.38 \text{ inch}^3) = 0.0013 \text{ m}^3$

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

Volume of cement=  $(\text{Cement Ratio} \times 1.57 \times 0.001) / \text{Total Ratios} = (1 \times 1.57 \times 0.0013) / 5 = 0.0004 \text{ m}^3$

Weight of cement=  $0.0004 \text{ m}^3 \times 1440 \text{ kg/m}^3$  (Density of cement  $1440 \text{ kg/m}^3$ ) = 0.5 kg

Volume of Aggregate=  $(\text{Aggregate Ratio} \times 1.57 \times 0.001) / \text{Total Ratio} = (4 \times 1.57 \times 0.0013) / 5 = 0.0016 \text{ m}^3$

Weight of Aggregate=  $0.0016 \text{ m}^3 \times 1500 \text{ kg/m}^3 = 2.4 \text{ kg}$

#### 3.2 Hexagonal Shaped (Design and Dimensions)

Surface Dimensions:-

AB=4inch,BC=12inch,CD=4inch,

DE=4inch,EF=12inch,

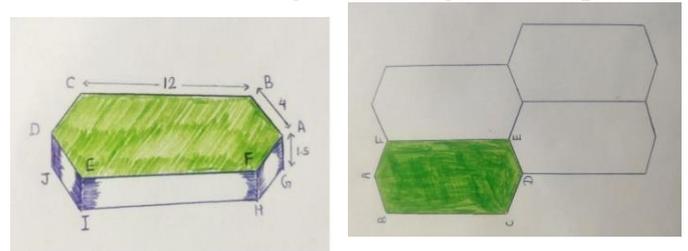
FA=4inch,

AG=1.5inch(Thickness)

Angular Dimension:-  $\angle ABC=120^\circ, \angle BCD=120^\circ, \angle CDE=120^\circ$

,  $\angle DEF=120^\circ, \angle EFA=120^\circ, \angle FAB=120^\circ$

#### Geometrical Design of Hexagonal Shaped



#### Quantity of Material Required for Hexagonal Tiles

Volume obtained as per calculation =  $0.002 \text{ m}^3$

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

Volume of cement=  $(1.57 \times 0.002) / 5 = 0.000628 \text{ m}^3$

Density of cement =  $1440 \text{ kg/m}^3$

Weight of cement =  $1440 \text{ kg/m}^3 \times 0.000628 \text{ m}^3 = 0.9 \text{ kg}$

Volume of Aggregate=  $(4 \times 1.57 \times 0.002) / 5 = 0.00251 \text{ m}^3$

Density of Course Aggregate=  $1600 \text{ kg/m}^3$  (1500-1800)

Weight of Aggregate=  $1600 \times 0.00251 = 4.01 \text{ kg}$

W/C Ratio= 0.45 (IS:456-2000) {As Per Consistency}

Amount of Water Required=  $0.9 \text{ kg} \times 4.5 = 0.40 \text{ Lit}$

### 4. Procedure of Block and Tiles Preparation

- Take the calculated Amount of PCC (of OPC 43 Grade) and coated Aggregate then mixed intimately with spade, turning the mixture over and over Layer by Layer again &
- Again until the cement Ratio mix evenly Then Make a well type structure by using spade
- Pour Required water in between the Material
- Mix it properly by collapsing the wall Material in between the center
- While mixing the Material watch the consistency of Material if it feels less liquidity mix a bit of water extra to find Perfect consistency



### BLOCK PREPARATION

- Pour the mixture in 3 Layers of block and 1 Layer of molding Interlock Frame Then compact each layer of block and Frame by (35-38) Strokes, Remove Extra Materials Above the Frame And block by using Spade to make it even
- Rest the Molding specimen for 24-36hr and Remove the Molds, Then put the Specimen for Curing.

Compressive Strength Achieved in 28 Days= 16.85N/mm



### Compressive Strength Test

#### 5.2 Water Absorption Test

Water absorption test should be conduct, To calculate the Rate of water absorption in per unit weight of Aggregate.

Water	0.5 lit(500ml)	0.5 lit (500ml)
Weight (kg)	0.5 kg(500g)	0.5 kg(500g)
Size (mm)	7mm-12.5mm	7mm-12.5mm
Aggregate type	Epoxy coated	Normal Aggregate
Time period	24 hrs	24 hrs
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 where  
As Epoxy coated Aggregate Almost resist the Absorption

#### 5.3 Water Permeability Test

Concrete is determined by special arrangement of cylindrical shape bucket or specific container which



### Interlocking Tiles Preparation

## 5. Testing and Results

#### 5.1 Compressive strength Test

In 7 Days Specimen will achieve Min Strength of 30%  
In 21 Days Specimen will achieve min strength of 70%

In 28 Days Specimen will achieve Min Strength of 95%

After testing a cube of void ratio (25%)

Compressive strength achieved in 7 Days = 10.69 N/mm<sup>2</sup>

Compressive Strength achieved in 21 Days= 14.89N/mm<sup>2</sup>

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.

### 5.3.1. Procedure

- The concrete having a thickness more than 20mm(As we taken 76mm) is placed on Measuring Beaker.
- And then fill the Beaker with Calculated amount of water.
- To find the permeability of concrete the water Is through the disc is collected at the water Collection unit.
- To accelerate the process, you can apply Pressure from the top



**Water Permeability Test**

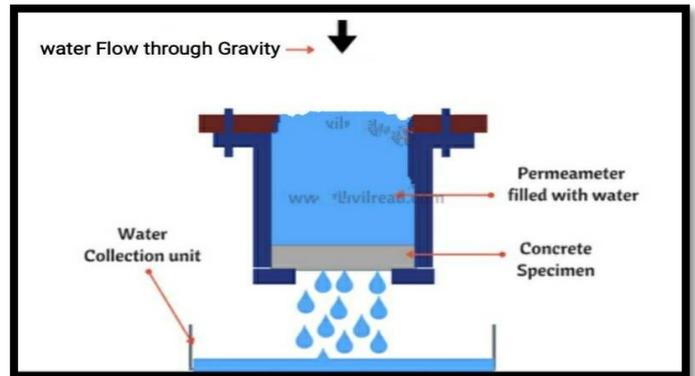
### 5.3.2 Factor Affecting the Permeability of Tiles

W/C Ratio:- 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 W/C Ratio of 0.4 makes concrete impermeable.

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.



**Permeability Test of Pervious Tiles**

$$k = \frac{A_1 l}{A_2 t} \log \frac{h_2}{h_1}$$

Where,

k = water permeability

A<sub>1</sub> = cross-sectional area of the specimen (150mm)

A<sub>2</sub> = cross-sectional areas of the tube (150mm)

l = length of the specimen (38mm)

t = time =17.75s

h<sub>1</sub> = the initial water head (300mm)

h<sub>2</sub> = the final water head (1 mm)

$$\frac{150 \times 38}{150 \times 17.75} \log \frac{1}{300} = 5.300 \text{ mm/sec}$$

## 6. Conclusion

From the experimental result, The Pervious Pavement 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 So, The Ratio of 1:4 is perfect for Tiles and Pavement Construction for its Strength as well as penetration Due to the absence of Sand Ratio the empty Space of sand taken the place by cement and aggregate

as the same Divided Ratio which 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. Mostly M15 grade of concrete use in Pavement construction Thus, Epoxy coated Pervious Pavement and Tiles of 1:4 Ratio is recommended for Pavement construction.



Final Result of Interlocking Tiles

## BIOGRAPHIES



Mr. Hamza Khan is a Final Year student of B.Tech (CE) from Amity University Lucknow Campus



Dr. Arif Siddiquie is an Associate Profesor of Department of Civil Engineering from Amity University Lucknow campus

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