Experimental study on water absorbing pavement through model

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Abstract - *Water absorbing pavement is a type of innovative pavement technology designed to mitigate the negative impacts of urbanization on water resources. This technology allows pavements to absorb rainwater, reducing runoff and facilitating water infiltration into the ground. The water absorbing pavement has been gaining popularity in recent years due to its potential to reduce flooding and erosion, enhance water quality, and support sustainable urban development. This abstract provides a brief overview of the water absorbing pavement, highlighting its benefits, limitations, and applications. The abstract concludes by identifying future research directions and the need for collaboration among researchers, practitioners, and policymakers to fully exploit the potential of this technology in promoting sustainable urbanization.*

Key Words: Water absorbing pavement, concrete pavement, compressive strength, permeable concrete, porous concrete.

1.INTRODUCTION

Rainwater and runoff can pass through porous pavement to the storage layer below and eventually soak into the underlying soil thanks to this storm water drainage system. Because it may lower air temperatures on hot days, treat storm water quality, restore ground water supplies, and reduce storm water volume, permeable pavement is good for the environment.

In order to create a mass of aggregate particles covered in a thin layer of paste, porous concrete is a performance-engineered concrete made with controlled proportions of cement, coarse aggregates, water, and admixtures. There is a significant amount of vacuum space in a pervious concrete mixture since it includes little or no sand. When enough paste is used to coat and bind the aggregate particles, a network of swiftly draining, highly porous gaps is formed. Low water/cementitious material (w/c) ratios are necessary for strength and to prevent the paste from flowing and filling the gaps. The production's performance depends on the w/c ratio.

1.1 Relevance

In the case of a water absorbing pavement project, some reasons why it might be chosen could include:

- Addressing a pressing environmental issue: Urbanization and increased rainfall intensity have led to an increase in flooding, erosion, and water pollution. Water absorbing pavement offers a solution to these issues by reducing runoff and improving water quality, which can make a significant impact on the environment.
- Advancing sustainability goals: Sustainability is becoming increasingly important in urban development, and water absorbing pavement aligns with sustainability goals by reducing environmental impact and promoting the efficient use of resources.
- Enhancing public safety: Flooding and erosion can pose risks to public safety and property. Water absorbing pavement can help mitigate these risks by reducing the likelihood of flooding and erosion, which can improve the safety of roads and sidewalks.
- Demonstrating innovation and leadership: Undertaking a water absorbing pavement project can showcase a commitment to innovation and leadership in urban development, which can enhance the reputation of the individuals or organizations involved.

Overall, the decision to choose a water absorbing pavement project may be driven by a desire to address environmental issues, promote sustainability, enhance public safety, or demonstrate leadership and innovation.

1.2 OBJECTIVE

To study water absorbing roads. To create workable model of water absorbing roads. To conduct appropriate tests on model of water absorbing roads. Interpret results with traditional roads. To prepare and submit proposal of the same.

2. STUDY WORK

What is the pervious concrete?

Pervious concrete, commonly referred to as water absorbing concrete, is a unique kind of concrete made with the intention of allowing water to travel through it. Water-absorbing concrete is porous and may absorb water into its structure, in contrast to conventional concrete, which is impermeable and allows water to run off its surface. As a result, there is less stormwater runoff and more groundwater recharge since the water can be filtered and held in the ground.

2.1 Pattern and texture

Pervious concrete has a rough, open texture like a rice cake. Because the rough texture lowers the glare associated with typical concrete pavement, the color may be more noticeable. The coarse aggregate size and shape (round or angular) in a mixture are important visual design factors.

2.2 Materials used in water absorbing pavement

Coarse aggregates: -

Coarse aggregates such as crushed stone, gravel or recycled concrete are used in the mixture of permeable concrete. These aggregates are typically between 3/8 and 3/4 inches in size and provide the necessary strength and durability to the pavement.

Properties of coarse aggregate:

Gradation: The gradation, or size distribution, of coarse aggregate is critical in determining the permeability of pervious concrete.

Strength: The strength of the coarse aggregate affects the overall strength and durability of the pervious concrete.

Shape: The shape of the coarse aggregate can affect the permeability of the pervious concrete.

Cement: -

The most typical type of cement utilized in the creation of permeable concrete is Portland cement. It serves as a binding agent, keeping the aggregates together and giving the pavement strength.

Water:

In order to hydrate the cement and start the chemical processes that result in concrete, water is required.

Properties of water for making block: -

It should be potable.

The pH of water should not be less than 7.

It should be free from impurities.

3. STEPS FOR PREPARATION OF BLOCK

3.1 Sieving

Only coarse-grained materials can be used to make blocks; fine-grained materials cannot be used. The 20mm sieve should be used as a particular procedure to reduce large materials. Hand sieves can be used for dirt with minimal content. As a result, the particles will have a smooth texture.

Figure 1. Sieves

3.2 Materials selection

Water, cement, coarse and fine aggregates, and other components should all be chosen according to the application.

Figure 2. Sample of block before test

Figure 3. Sample of block after test

3.2 Mixing

It is important to thoroughly mix the ingredients. Hand mixing should be used to combine all materials. The expense of hand mixing should be reasonable for small volumes. All the materials we utilized for the experiment are balanced. So, the calculation for our raw material should be made. 1900 ml of water are required to make a concrete block. An essential component of mixing is the binding of the materials together; the removal of air gaps must be accomplished through compaction. So that it can reach its optimum strength, the concrete block. When inspecting it, the finishing should be taken into consideration.

We are using different type of proportion for permeable concrete: - cement: coarse aggregate (1: 3)

4. PREPARATION OF PERMEABLE SLAB

4.1 Actual Procedure of Slab Casting:

The materials that will be used to create the slab should be kept in one location. then subtract the cement's weight. It is important to confirm the aggregate size, which was previously determined by experimentation. By reading numerous papers in different ratios, the water's composition should be chosen.

Figure 4. Weighing of cement

We will construct a box measuring 16 inches by 17 inches by 5 inches for our experiment. which uses the same proportions of the ingredients as our block. When constructing a slab, mix 11 kg of cement with 33 kg of coarse aggregate and 3.5 liters of water.

Ingredients were added to the pan proportionately. The water is added using the sprinkling method after it has been thoroughly mixed. To eliminate voids, prepared materials are put into a mould and compacted. It needs to be pounded with the blows.

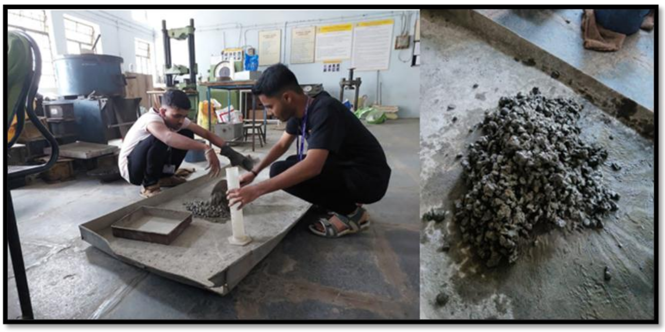

Figure 5. Mixing of material

Once the slab is made, it should be kept for curing up to 28 days. After the curing of block, we are conducting compressive strength test.

After testing of first set of blocks we changed proportion of water as below. And carry out same procedure as mentioned above.

1) 1: 3 (35% w/c ratio)
2) 1: 3 (32% w/c ratio)

Figure 6. Casted Slab

4.2 Comparison of Finishing

Comparison between convention pavement and our pavement are below. The finishing of our pavement is not equal to the conventional concrete pavement.

Figure 7. Casted pavement

Figure 8. Conventional pavement

5. TESTING

5.1 Test performed on block

1) Name of test: Compressive strength:

Observation Table: -

For proportion: - 1: 3

Table 1. Compressive strength test

Sr. No.	Sample no	Dimensions of the brick (mm)			C/s area of the brick (A) in mm^2	Compressive strength $\sigma = P_1/A$ in N/mm^2	Curing time
		L	W	H			
1	1	150	150	150	22500	14.93	7
2	2	150	150	150	22500	25	14
3	3	150	150	150	22500	29	28

Figure 9. Set up of block

Figure 10. Reading on the dial of CTM

Figure 11. Brocken block

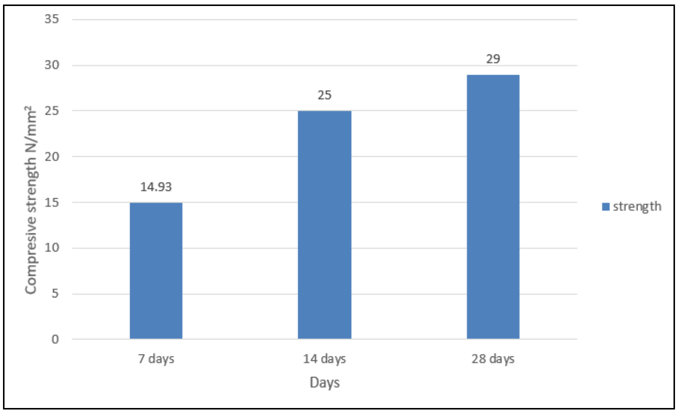

Chart 1 Compressive strength v/s Days

6. COMPARISON

6.1 Comparison between water absorbing pavement and traditional pavements

Water absorbing pavements and traditional pavements have several differences in terms of their design, effectiveness, and cost. Here are some of the key differences between the two:

Design: Rainwater can infiltrate through porous water-absorbing pavements and into the earth below thanks to their design. They are often constructed from porous materials like asphalt, sand, and gravel. Traditional pavements, on the other hand, are constructed of impermeable substances like concrete or asphalt, which stop water from penetrating through.

Effectiveness: When it comes to minimizing runoff during intense rainfall, water-absorbing pavements are significantly more effective than conventional pavements. Unlike conventional pavements, which can only absorb about 20% of the rainwater, they can absorb up to 80% of it. As a result, metropolitan areas can greatly benefit from the use of water-absorbing pavements to reduce flooding and water damage.

Cost: Installing water-absorbing pavements typically costs more than installing standard pavements. In the long run, nevertheless, they are more cost-effective since they eliminate the need for pricey flood prevention systems like storm drains and retention ponds. They are thus a practical option for municipalities and cities seeking to lower the overall cost of flood prevention.

Maintenance: When compared to standard pavements, water-absorbing pavements require additional upkeep. Over time, the pavement's pores may clog and lose some of their capacity to absorb water. Water-absorbing pavements can still be helpful at preventing flooding, though, with routine upkeep and cleaning.

6.2 Cost Comparison

Here is a cost comparison between water absorbing pavements and traditional pavements:

1. **Costs of Installation:**

Because water absorbing pavements require more materials and labour during installation than regular pavements do, these costs are often greater. The cost of putting water-absorbing pavements can be up to 50% greater than the cost of installing conventional pavements, according to a report by the National Research Council of Canada. The type of permeable pavement utilized and the amount of the area to be paved, however, may affect this cost.

Depending on the pavement type, size, and location, the price to construct water-absorbing pavements can range from Rs.500 to 1600 per square foot. The average cost per square foot for conventional pavements made of asphalt or concrete is between Rs. 250 and 850. As a result, building water-absorbing pavements might cost up to 50% more than doing so with standard pavements.

2. **Maintenance costs:**

To keep their ability to absorb water, water-absorbing pavements need to be maintained on a regular basis. This entails routine surface cleaning to prevent pore clogging, the elimination of dirt and vegetation, and sporadic repairs. Although this cost might vary depending on the level of maintenance required, maintenance costs for water-absorbing pavements are typically greater than maintenance costs for standard pavements.

Pavements that collect water need routine care, which may include cleaning, fixing, and even replacing the surface. Depending on the level of maintenance necessary, the cost of maintaining water-absorbing pavements can range from Rs. 41 to 160 per square foot per year. Contrarily, the annual maintenance expenditures for traditional pavements typically range from Rs. 17 to 40 per square foot.

3. Flood Damage Costs:

Reducing the risk of flood damage in urban settings is one of the main advantages of water-absorbing pavements. Flood damage may be expensive, with expenditures for emergency services, property damage, and repairs all adding up. Water-absorbing pavements have the potential to save cities and municipalities a lot of money over time by lowering the danger of flood damage.

4. Savings from Reduced Flood mitigation systems:

Cities and municipalities may also be able to save money by using water-absorbing pavements instead of pricey flood mitigation systems like storm drains and retention ponds. The use of water-absorbing pavements can minimize the demand for stormwater management infrastructure by up to 80%, according to a study done by the National Research Council of Canada.

Note: The costs I gave are based on analysis from a variety of sources, including industry data, scholarly research, and official publications. The real cost of water-absorbing pavements and conventional pavements, however, might vary based on several factors, including the location, the type of pavement utilized, and the size of the area to be paved. The prices I gave should be regarded as rough estimates since they might not be relevant in all circumstances.

7. CONCLUSIONS

Water-absorbing pavements are a viable method of minimizing the harmful effects of urbanization on the hydrological cycle. These pavements provide various advantages, including reduced runoff, improved water quality, reduced flooding danger, and increased groundwater recharge. Water-absorbing pavements have been found to be more successful than regular pavements in decreasing runoff and flood damage while also encouraging sustainable urban development.

Water-absorbing pavements have been shown in experiments to effectively reduce runoff in metropolitan areas, resulting in enhanced water quality and reduced flood danger. Furthermore, the cost-benefit analysis shows that, while water-absorbing pavements are more expensive to install and maintain than standard pavements, they may be more cost-effective in the long term due to lower flood damage and flood mitigation measures.

It is crucial to note, however, that the performance of water-absorbing pavements can be influenced by a variety of factors, including the type of pavement used, the size of the area to be paved, and the amount of upkeep. To ensure the success of these pavements in metropolitan areas, meticulous planning and design are required.

Overall, the use of water-absorbing pavements is a viable strategy for fostering sustainable urban growth, mitigating flood risk, and enhancing water quality. More study and experimentation are required to improve their performance and applicability in various urban situations.

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