Performance Of Pervious Concrete Pavement

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***Abstract*—Pervious concrete pavement is an environmentally friendly alternative to conventional concrete pavements, designed to enhance stormwater management by allowing water to infiltrate through its porous structure. This sustainable pavement system reduces surface runoff, mitigates urban flooding, and aids in groundwater recharge. Additionally, it improves skid resistance, reduces hydroplaning, and contributes to heat island effect reduction. However, challenges such as durability, clogging, and maintenance need to be addressed for widespread application. This paper explores the design, materials, benefits, limitations, and advancements in pervious concrete pavement technology. To develop a strong and durable pervious cement concrete mix using different types of aggregates with varying the quality of fine aggregates. Pervious concrete is a unique cement-based product whose porous structure permits free passage of water to the concrete and into the soil without compromising the concretes durability or integrity. Pervious concrete is a composite material consisting of coarse aggregate, Portland cement and water. It is different from conventional concrete in that it contains no fines in the initial mixture, recognizing however, that fines are introduced during the compaction process. The aggregate usually consists of single size and is bounded together at a point of contact by a paste formed by the cement and water.**

***Index Terms*—Pervious concrete, porous pavement, stormwater management, sustainable pavement, permeability, urban drainage, environmental impact, heat island effect, groundwater recharge, durability, maintenance.**

I. INTRODUCTION

1.1 General: Pervious concrete pavement is an innovative and sustainable solution designed to address modern urban infrastructure challenges, particularly stormwater management. Unlike conventional concrete, pervious concrete has a high porosity that allows water to pass through its structure, reducing surface runoff and promoting groundwater recharge. This characteristic makes it an essential material for environmentally friendly construction, aligning with green building standards and sustainable development goals**.** The concrete paste then coats the aggregates and allows water to pass through the concrete slab, pervious concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways and green houses. It is an important application for sustainable construction and is of many low impact development techniques used by builders to protect the water quality. Pervious concrete has been increasingly used to several sustainability- relative benefits offered by this material. Pervious concrete includes other environmental benefits such as reduced noise generated by tire-pavement interaction, reduced urban heat, minimized road splash, improve skid resistance, recharge of ground water table, reduced storm water runoff, limited pollutant penetration into the ground water and preservation of native eco system. Despite these benefits, the potential for lower compressive strength, clogging, raveling and sustainability to freezing and thawing damage, have limited use of pervious pavements in cold climatic conditions when compared to conventional concrete pervious concrete exhibits sustainability, because of its properties.

Pervious concrete is a unique cement-based product whose porous structure permits free passage of water to the concrete and into the soil without compromising the concretes durability or integrity. Pervious concrete is a composite material consisting of coarse aggregate, Portland cement and water. It is different from conventional concrete in that it contains no fines in the initial mixture, recognizing however, that fines are introduced during the compaction process. The aggregate usually consists of single size and is bounded together at a point of contact by a paste formed by the cement and water. pervious concrete has limitations, including lower strength compared to traditional concrete, potential clogging due to debris accumulation, and maintenance challenges. However, ongoing research and technological advancements are continuously improving its performance, making it a viable alternative for sustainable urban development.

Fig 1. Permeability Test

Fig 2: Pervious concrete

II. OBJECTIVES

- To enhance the overall strength, durability, and load-bearing capacity of concrete structures by carefully selecting high-quality materials and optimizing the mix design to meet the specific requirements of construction projects. In the present investigation M sand is used.
- To improve the workability, consistency, and setting time of concrete by using appropriate admixtures and water-cement ratios, ensuring ease of placement, finishing, and long-term performance in various environmental conditions.
- To minimize the risks of shrinkage, cracking, and structural deformities by implementing proper curing techniques, maintaining adequate moisture levels, and controlling temperature variations during the hardening process.
- This will be accomplished through extensive experiments on the test cubes created for this purpose. Experiments include specific gravity test, permeability, compressive test and infiltration test.
- To promote sustainability and environmental responsibility in concrete production by incorporating eco-friendly materials such as recycled aggregates, fly ash, and supplementary cementitious materials, reducing carbon emissions and waste generation.

III. ADVANTAGES

- Pervious concrete offers high strength and durability for long-lasting structures.
- It has excellent resistance to weathering, chemicals, and abrasion.
- The material provides superior workability and ease of placement.
- It reduces shrinkage and cracking, ensuring structural stability.
- Reduces risk of flooding and top soil wash away.
- Improves the quality of landscaping and reduces the need for watering Safety.
- Pervious concrete enhances thermal insulation, improving energy efficiency
- It has a lower environmental impact by incorporating sustainable materials.
- the concrete requires minimal maintenance, reducing long-term costs.
- Prevents glare.
- It offers better bonding with reinforcement, improving structural integrity.
- Reduces hydroplaning and flooding.
- When pervious concrete is designed correctly all the precipitation should be absorbed by sub-grade or diverted away from pavement by a drainage system (in case of low absorption sub-grade). This results in reduced flooding and a puddle- free surface, eliminating hydroplaning.
- Its fast-setting time accelerates construction and project completion.
- Increases facilities for parking by reducing water

retention areas.

- The material can be customized for specific strength and performance needs.
- Pervious concrete improves fire resistance, enhancing building safety.
- Requires less costly repairs than black top.
- It ensures cost-effectiveness by reducing material wastage and labor costs.

IV. METHODOLOGY

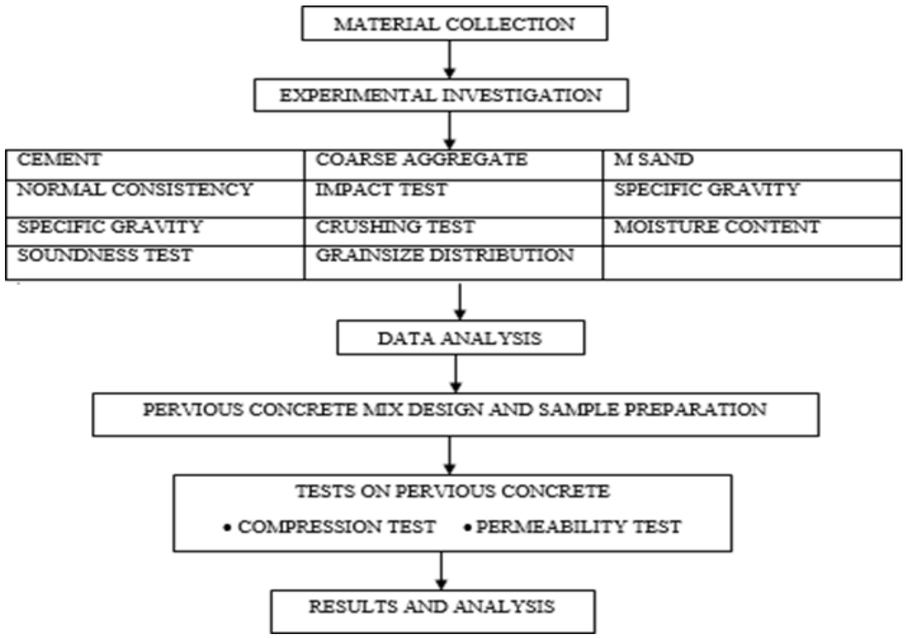

Fig 3 Methodology

V. MATERIALS, ITS PROPERTIES AND MIX DESIGN

Materials: Ordinary Portland Cement (OPC), Coarse Aggregate, Fine Aggregate, water.
Mix Proportioning: Mix design is done as per IS 10262:2009 and mix portions are tabulated.

Table 1

Cement	Water	Fine Aggregate	Coarse Aggregate
1	0.27	0.2	4

VI. EXPERIMENTAL INVESTIGATION AND RESULT

6.1. Slump TEST
Table 2**:** Slump test results

Water/Cement ratio	Slump in mm
0.27	80

6.2. Compressive Strength: Compressive test we carried to specimen of 150x150x150 after 3,7,14,21,28 days of curing with both water and gunny bag curing method. The compressive strength of the cube is calculated as:
Compressive strength=[P/(150x150)] N/mm^2
Table 3: Compressive strength results

No of Days	pressive Strength C= L/A in N/mm²
7	10.5
14	15.2
28	20.3

6.3. Split Tensile Test**:** The split tensile strength of the cylinders is calculated as follows
Split Tensile Strength = [2P/(π*r*h)] N/mm^2
Table 4: Split Tensile strength results

No of Days	Split Tensile Strength T=L/A in N/mm²

7	1.2
14	1.5
28	1.8

6.4. Permeability test: Quantity of water that flows under a given hydraulic gradient through a concrete block of a known dimensions and cross section area in a given time. water is allowed to flow through cylindrical sample of a concrete block under a constant head.

Procedure

1. For the constant head arrangement, the specimen shall be connected through the top inlet to the constant head reservoir.
2. Open the bottom outlet.
3. Establish steady flow of water.
4. The quantity of flow for a convenient time interval may be collected.
5. Repeat three times for same interval.

Table 5: Permeability Test Results

Sr.no	No of Days	Infiltration rate (mm/sec)
1	7 days	2.5
2	14 days	2.8
3	28 days	3.0

VII. COMPARISONS AND RESULTS

- The percentage decreases in compressive strength in pervious concrete is 50 - 75% compared with conventional concrete.
- The percentage decreases in split tensile test in pervious concrete is 45-50% compared with conventional concrete.
- The percentage of void ratio is increased to 3% in pervious concrete as compared with conventional concrete. So that the permeability is also high.

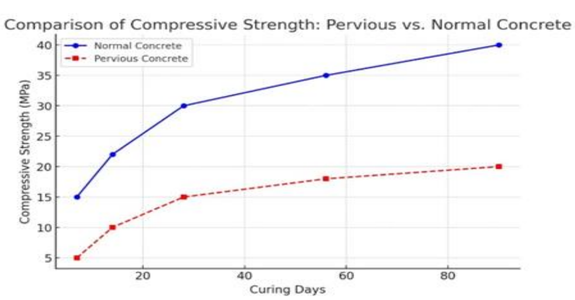

Fig 4: Comparison between compressive strength of pervious and normal Concrete.

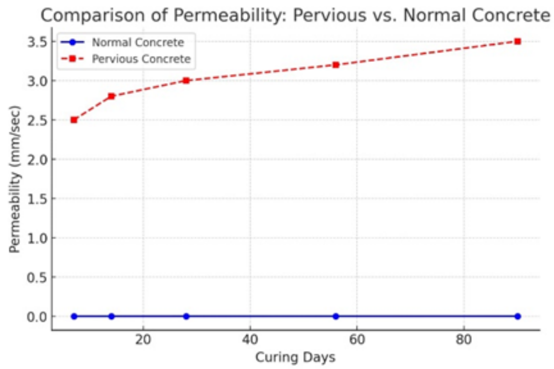

Fig 5: Comparison between permeability of pervious and normal concrete.

VIII. CONCLUSION AND SUMMARY

8.1. Specific Conclusion**:** The following conclusions are drawn based on the experimental investigation on compressive strength and permeability of pervious and normal concrete:

- Pervious concrete has lower compressive strength than conventional concrete, with a reduction of 30–50%, depending on the mix design and curing period.
- The permeability of pervious concrete is significantly higher compared to normal concrete, allowing better water infiltration and reducing surface runoff.
- Using smaller aggregate sizes in pervious concrete can improve compressive strength while slightly reducing permeability.
- A higher aggregate-to-cement ratio in pervious concrete increases permeability but reduces strength, making it more suitable for pavement applications.

8.2. General conclusions

- Pervious concrete is an eco-friendly material that enhances stormwater management by allowing water infiltration, reducing surface runoff, and helping groundwater recharge.
- Normal concrete exhibits higher compressive and tensile strength compared to pervious concrete, making it more suitable for structural applications.
- The porous structure of pervious concrete results in lower strength but significantly higher permeability, making it ideal for applications such as pavements, parking lots, and walkways where

water drainage is essential.

- The use of pervious concrete contributes to sustainable construction by minimizing urban flooding, reducing heat island effects, and promoting environmentally friendly infrastructure.

IX. SUMMARY

This project focuses on the use of pervious concrete for road pavement applications, aiming to enhance water permeability, reduce surface runoff, and contribute to sustainable urban infrastructure. Pervious concrete, characterized by its high porosity, allows water to pass through its structure, promoting groundwater recharge and reducing stormwater runoff, thereby minimizing urban flooding.

The study involves the design, testing, and evaluation of pervious concrete in road pavement applications. Key parameters such as compressive strength, permeability, porosity, and durability were analyzed and compared with conventional concrete. The research explores the effects of varying aggregate sizes, water-to-cement ratios, and curing conditions to optimize the mix design.

Results indicate that while pervious concrete has lower compressive strength (30–50% lower than normal concrete), it offers significantly higher permeability, making it ideal for non-load-bearing applications such as low-traffic roads, parking lots, pedestrian pathways, and driveways.

Overall, this study highlights the benefits of pervious concrete pavement as a sustainable solution to urban drainage challenges, reducing waterlogging, mitigating heat island effects, and promoting eco-friendly road construction.

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