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# Pervious Concrete: Sustainable Solutions for Construction and Ground Water Recharge

**Prof. Supriya Shinde[1], Vishal Kushwaha[2], Pratham Raut[3], Aryan Ingale[4], Amar Khetri[5], Vidyesh Patil[6]**
Lecturer, Department of Civil Engineering[1]
Students, Department of Civil Engineering[2-6]
Bharati Vidyapeeth Institute of Technology, Navi Mumbai, India

**Abstract:** *Pervious concrete is an innovative and sustainable material designed to address urban drainage and pavement durability challenges. Unlike conventional concrete, pervious concrete has a highly porous structure, allowing water to pass through, thereby reducing surface runoff, enhancing groundwater recharge, and mitigating urban flooding. This study focuses on evaluating the characteristics of pervious concrete through laboratory experiments, including compressive strength and permeability tests.*

**Keywords:** pervious concrete, highly porous structure, groundwater recharge, mitigating urban flooding

## I. INTRODUCTION

Pervious concrete, also known as permeable or porous concrete, is an innovative construction material designed to enhance stormwater management by allowing water to pass through its porous structure. Unlike traditional concrete, which creates impervious surfaces leading to increased runoff and drainage challenges, pervious concrete facilitates natural water infiltration, reducing urban flooding and enhancing groundwater recharge.

The composition of pervious concrete differs from conventional concrete as it contains little or no fine aggregate (sand), leading to a high void content (typically **15% to 25%**). This characteristic makes it highly permeable, enabling water to flow through at rates between **0.2 to 2.5 cm/s**. The material is commonly used in low-traffic pavements, driveways, sidewalks, and parking areas, promoting sustainable infrastructure development.

- **Environmental sustainability:** enhancing groundwater recharge and conserves natural resources.
- **Cost-effectiveness:** lowers material costs, especially in regions with limited natural aggregate availability.
- **Energy efficiency:** reduces the energy required for mining and transportation of natural materials.

Desperatesome challenges, like lower strength or durability if not properly processed, ongoing research and improved recycling techniques continue to enhance the performance and reliability of recycled aggregate concrete, making it an essential component of modern, eco-friendly construction practices.

**Present scenario of flooding in india:**

Any developing countries like India, where population density is high and migration to urban areas has surged, unregulated development poses serious concerns. The **increase in extreme weather events, including floods, is linked to the climate crisis,** with over 64% of Indian sub-districts experiencing more heavy rainfall days in the past decade than in the previous 30 years

## II. LITERATURE REVIEW

**1. Tennis, P. D., Leming, M. L., & Akers, D. J. (2004) - *Pervious Concrete Pavements***

**Description:** This paper provides a comprehensive introduction to pervious concrete, including its composition, benefits, applications, and construction methods. It also discusses permeability, durability concerns, and potential applications in sustainable urban drainage systems (SUDS).

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**2. Yang, J., & Jiang, G. (2003) - *Experimental study on properties of pervious concrete pavement materials***
**Description:** This study investigates the mechanical properties of pervious concrete, such as compressive strength and permeability, based on different aggregate sizes and mix proportions. It highlights the inverse relationship between strength and porosity.

**3. Lian, C., & Zhuge, Y. (2010) - *Optimum mix design of enhanced permeable concrete – An experimental investigation***
**Description:** The authors examine the influence of water-to-cement ratio, aggregate gradation, and admixtures on the strength and permeability of pervious concrete. They propose an optimized mix design for balancing mechanical performance with permeability.

**4. Kevern, J. T., Schaefer, V. R., & Wang, K. (2008) - *Pervious concrete mixture proportions for improved freeze-thaw durability***
**Description:** This research explores how pervious concrete can be designed to withstand freeze-thaw cycles by modifying the mix proportions and using air-entraining agents. The study suggests methods to enhance durability in cold climates.

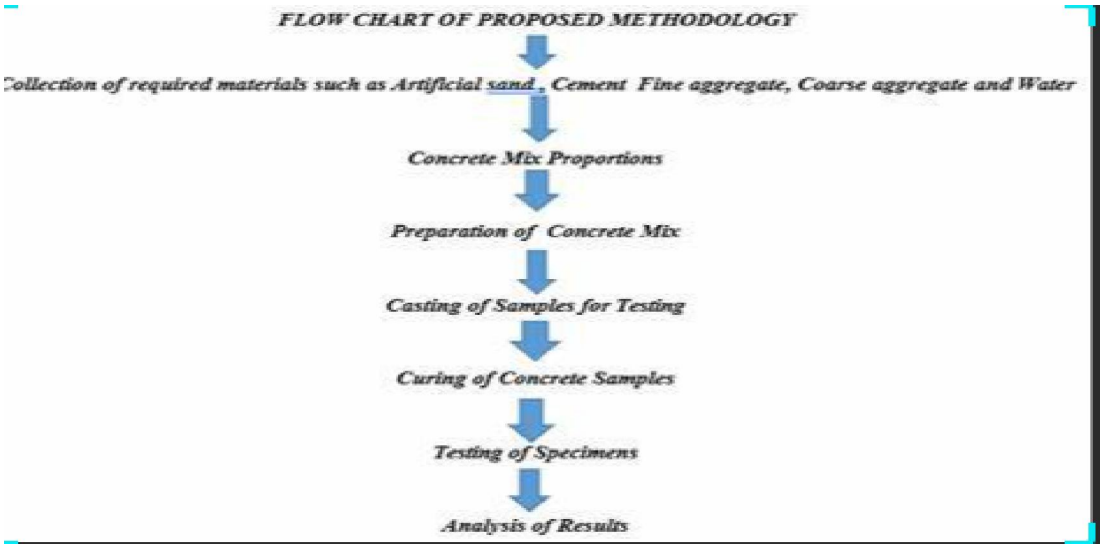
**5. Haselbach, L. (2008) - *Potential for carbon footprint reduction through permeable pavement systems***
**Description:** This paper discusses the environmental benefits of pervious concrete, particularly its role in reducing the urban heat island effect and lowering the carbon footprint of pavements.

**6. Schaefer, V. R., Wang, K., Suleiman, M. T., & Kevern, J. T. (2006) - *Mix design development for pervious concrete in cold weather climates***
**Description:** The authors focus on developing a pervious concrete mix suitable for cold weather applications, addressing freeze-thaw durability and deicing salt resistance.

**7. Chandrappa, A. K., & Biligiri, K. P. (2016) - *Pervious concrete as a sustainable pavement material – Research findings and future prospects***
**Description:** This review paper summarizes various research findings on pervious concrete's mechanical properties, permeability, durability, and sustainability aspects, along with suggestions for future research directions.

**8. Montes, F., Valavala, S., & Haselbach, L. M. (2005) - *A new test method for porosity measurements of Portland cement pervious concrete***
**Description:** The authors introduce a novel method for accurately measuring the porosity of pervious concrete, a key factor in determining its permeability and overall performance.

## III. METHODOLOGY



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## IV. RESULTS AND DISCUSSIONS

**Test report of pervious concrete**

| Number of days | Compressive strength in (N/MM2) |
|---|---|
| 7 days | 16 .25 |
| 14 days | 22.5 |
| 21 days | 26 |

## V. GRAPHICAL REPRESENTATION

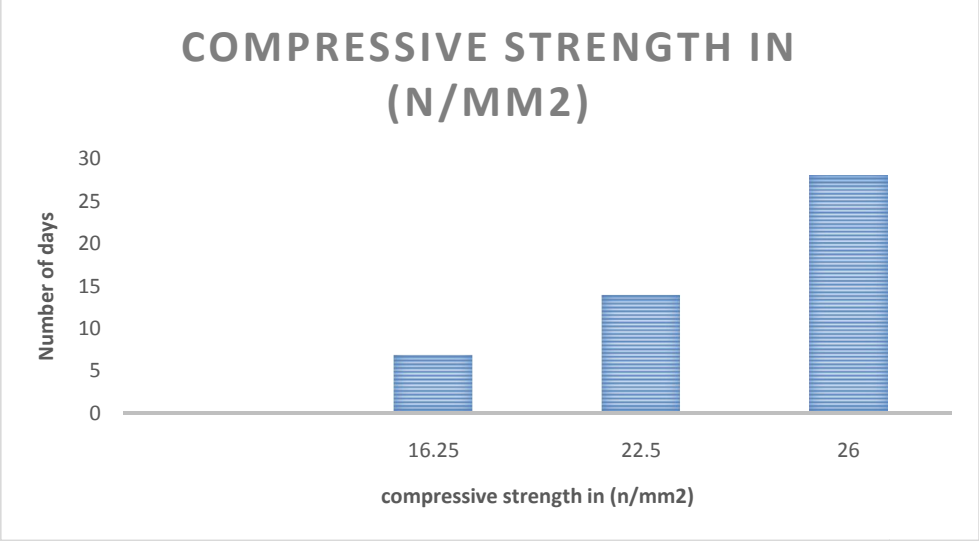


**Fig 5.1. Number of days vs compressive strength comparison**

**Objectives of the study:**

- To analyze the composition and mix design
- To evaluate the mechanical properties
- To assess the hydraulic performance by measuring permeability, porosity, and infiltration rates.
- To investigate the environmental benefits,
- To compare the cost-effectiveness of pervious concrete with conventional concrete in terms of lifecycle costs, maintenance, and environmental impact..

**Significance of research**

- Environmental Impact and Sustainability.
- Advancement in Construction Materials.
- Practical Applications in Urban Development.
- Economic and Policy Implications
- Future Research Directions

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**Materials:**

**Portland cement**

Ordinary portland cement (opc) is used specifically 53 grades. (ultratech cement). The grey colour of cement is due to iron oxide and in the absence of impurities. It remains grey. The following tests will be conducted on the cement.

Following tests will be conducted, on cement:

- Initial setting time and final setting time.
- Consistency limit test: - three sample were tested.

**Coarse aggregate**

**Fresh crushed coarse aggregate**

The coarse aggregate used in this study will be 10mm and 20mm crushed granite stone sourced from quarries. The physical properties will be assessed in accordance with is:

**Water**

The water used in the mix design was potable water from the supply. Free from suspended solids and organic materials that could affect the properties of fresh and hardened concrete.

The presence of tannic acid or iron compounds is undesirable. The requirements for water usmixing and concrete shall comply with is: 456-2000

Although visual evidence indicates the presence of adhered mortar on the parent material, it was virtually impossible to estimate its percentage. However, the adhered mortar does not appear to be present in significant quantities its impact on the characteristics of recycled course aggregate concrete cannot be overlooked.

**Experimental program**

Use Ordinary Portland Cement (OPC 43/53 grade**)** or alternative Supplementary Cementitious Materials(SCMs**)** such as fly ash, silica fume, or ground granulated blast-furnace slag (GGBS).

coarse Aggregates**:** Typically, crushed stone or gravel with sizes between 4.75

Fine Aggregates: Usually eliminated or used in small amounts to maintain permeability.Use potable water for mixing to ensure consistent hydration.

## VI. SUMMARY AND CONCLUSIONS

Pervious concrete is an eco-friendly, sustainable, and efficient pavement material that helps in reducing surface runoff, preventing urban flooding, and improving groundwater recharge. While it has limitations in strength, it serves as an excellent alternative for stormwater management in urban planning. With optimized mix design and maintenance, pervious concrete can be a key solution for sustainable infrastructure development.

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