Permeable Concrete Road in Pune Road Infrastructure

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***Abstract*—Permeable concrete, also known as Permeable or porous concrete, is an innovative paving material designed to allow water to pass directly through its surface, thereby reducing surface runoff and promoting natural groundwater recharge. The use of permeable concrete in road construction offers an effective solution to urban drainage problems, flooding, and water pollution caused by impermeable pavements. This study focuses on the design, materials, mix proportion, and performance evaluation of permeable concrete roads. Key parameters such as compressive strength, permeability rate, porosity, and durability are analyzed to achieve an optimal balance between structural strength and hydraulic performance. The results indicate that with appropriate aggregate gradation and binder content, permeable concrete can achieve sufficient strength for low to medium traffic roads while significantly improving stormwater management. The application of permeable concrete roads contributes to sustainable urban infrastructure, environmental protection, and resilience against climate-induced water challenges.**

***Index Terms*—Permeable Concrete, Compressive Strength, Permeability, Fly Ash, Rice Husk Ash**

I. INTRODUCTION

Road pavements are an essential part of transportation infrastructure. Conventional concrete roads are impermeable and do not allow rainwater to seep into the ground, resulting in surface runoff, waterlogging, and reduced groundwater recharge. To overcome these problems, permeable concrete has emerged as an effective and sustainable solution. Permeable concrete, also known as pervious concrete, is a special type of concrete with interconnected voids that allow water to pass through it. It helps in reducing stormwater runoff, controlling urban flooding, and replenishing groundwater levels. Due to its environmental benefits, permeable concrete is increasingly used in roads, parking areas, footpaths, and other pavement applications.

This project focuses on the study of permeable concrete for road construction. The performance of permeable concrete is evaluated through compressive strength and permeability tests. Materials such as cement, coarse aggregates, fly ash, and rice husk ash are used to improve the properties of concrete while maintaining adequate permeability.

The main aim of this project is to develop an eco-friendly pavement material that provides sufficient strength and effective water drainage. The study contributes to sustainable construction practices and promotes the conservation of natural water resources.

II. LITERATURE REVIEW

1. Malhotra (1976) – Introduced no-fines concrete and highlighted its good drainage properties and lightweight nature.
2. Tennis et al. (2004) – Reported that pervious concrete reduces stormwater runoff and helps groundwater recharge.

3. Yang and Jiang (2003) – Found that higher porosity increases permeability but decreases compressive strength.
4. Chindaprasirt et al. (2008) – Studied fly ash in pervious concrete and observed improved workability and durability.
5. Ghafoori and Dutta (1995) – Concluded that pervious concrete is suitable for pavements, parking areas, and low-traffic roads.

III. OBJECTIVES

1. To enhance compressive strength of Permeable concrete.
2. To study water penetration property of Permeable concrete.
3. To study abrasion resistance property of Permeable concrete pavement.

IV. METHODOLOGY

The Methodology Adopted for This Project Involves the Design, Preparation, Testing, And Evaluation of Permeable Concrete for Road Pavement Applications. The Objective Is to Develop a Concrete Mix That Provides Adequate Strength While Allowing Rainwater to Pass Through the Pavement Surface.

1. Collection and Testing of Materials-
The Materials Required for The Preparation of Permeable Concrete Were Collected and Tested. Ordinary Portland Cement (OPC 53 Grade), Coarse Aggregates, Water, Fly Ash, Rice Husk Ash, And Fine Aggregates Were Used. Preliminary Tests Such as Specific Gravity, Sieve Analysis, And Water Absorption Were Conducted to Determine the Suitability of The Materials.

2. Mix Design of Permeable Concrete-
The Mix Proportion Was Designed According to The Requirements of Permeable Concrete. The Water-Cement Ratio, Aggregate Content, Cement Content, And Void Ratio Were Selected to Achieve Both Permeability and Strength. Different Trial Mixes Were Prepared by Varying the Percentage of Fine Aggregates and Supplementary Cementitious Materials.

3. Preparation of Concrete Mix
The Selected Materials Were Weighed According to The Mix Design. Dry Mixing of Cement, -, Fly Ash, And Rice Husk Ash Was Carried Out. Water Was Then Added Gradually, And the Concrete Was Mixed Thoroughly Until a Uniform Mix Was Obtained.

4. Casting of Specimens-
The Fresh Concrete Was Placed into Standard Cube Moulds. Proper Compaction Was Done to Avoid Segregation While Maintaining the Required Interconnected Voids. The Surface Was Finished and Levelled Properly.

5. Curing of Specimens-
After 24 Hours of Casting, The Specimens Were Removed from The Moulds and Immersed in Water for Curing. The Cubes Were Cured For 7 Days And 28 Days to Achieve the Desired Strength.

6. Compressive Strength Testing-
The Cured Concrete Cubes Were Tested Using a Compression Testing Machine (CTM). The Maximum Load Carried by The Specimen Before Failure Was Recorded, And the Compressive Strength Was Calculated for Both 7-Day And 28-Day Curing Periods.

7. Permeability Testing-
A Permeability Test Was Conducted Using the Variable Head Method. Water Was Allowed to Flow Through the Concrete Specimen, And the Rate of Infiltration Was Measured. This Test Helped Determine the Drainage Capacity of The Permeable Concrete.

8. Analysis of Results-
The Test Results Obtained from Compressive Strength and Permeability Tests Were Analyzed and Compared. The Effect of Fly Ash, Rice Husk Ash, And Fine Aggregate Content on The Performance of Permeable Concrete Was Studied.

9. Conclusion and Recommendations-
Based on The Experimental Results, The Optimum Mix Proportion Was Identified. The Suitability of Permeable Concrete for Road Pavement Construction Was Evaluated, And Recommendations Were Made for Its Practical Implementation in Sustainable Urban Infrastructure.

V. RESULT AND DISCUSSION

A) Material And Mix Design –	B) Laboratory Testing –
• The project uses opc 53 grade, cement, coarse aggregate, water, fly ash, and rice husk ash. • The optimized mix uses 20 mm aggregate, design void content and controlled water cement ratio. • The project report specifies cement content of 390 kg/m3 coarse aggregate 1669.3kg/m3 and water 117 liters per cubic meter for standard permeable concrete mix.	• Cube Specimens Were Prepared and Cured. • Compressive Strength Testing Was Performed After Different Curing Ages. • Permeability Testing Was Carried Out Using Variable Head Permeabilty Test.

Results And Discussion-

Laboratory Test	Mix / Condition	Result Section
1.Compressive Strength	Standard Permeable Concrete (0%Fines)	7-, 14- And 24-Days Test Value from Report Table
2.Fine Aggregate Study	5%,6%,7%,8%,9%,10% Fines	Comparison Of Strength and Unit Weight
3.Cement Replacement	10% Fly Ash 10%Rice Husk Ash 5%+5% Combination	Strength Comparsion
4.Permeability Test	0% Fines, 8% Fines, Fly Ash, Rice Husk Ash Mixes	28 Day Permeability Comparison

The result show that adding fine aggregate can improve compressive strength up to an optimum percentage while excessive fines reduce permeability. The study also evaluates fly ash and rice husk ash replacement mixes for sustainable concrete development.

VI. CONCLUSION

Permeable concrete provides a balance between structural performance and the drainage capcity and is suitable for sustainable urban road application.

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