An Experimental Study on Pervious Concrete with respect to its Strength

Prof. O.V. Sapate[1],

Gayathri Manilal[2], Pranav S. Shribas[3], Pranay F. Jamgade[4], Pratik K. Patil[5]

[1]Asst. Prof., Department of Civil Engineering, Priyadarshini J. L. College of Engineering, Nagpur
[2,3,4,5]Students, Department of Civil Engineering, Priyadarshini J. L. College of Engineering, Nagpur

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Abstract: Different properties of pervious concrete are investigated in this research work using porosity, compressive strength and density. The effect of admixture is studied for pervious concrete. Conclusions are made from observations and results of concrete cubes. The results imply that pervious concrete is a sustainable substitute for pavement uses since it can reach sufficient strength and guarantees permeability. The study emphasizes how different compressive strength, porosity and density depends on material composition, so supporting environmentally friendly building method.

Key Words: Pervious concrete, compressive strength, porosity, density, admixture

1. INTRODUCTION

One creative solution meant to improve water permeability while preserving structural integrity is pervious concrete. Its high porosity let the water enter, so lowering runoff and encouraging groundwater recharge unlike that of traditional concrete. This work aims to evaluate, especially strength and durability, the mechanical characteristics of pervious concrete by means of extensive testing of porosity, compressive strength, and density.

Aim: The aim of the research is to increase the strength of pervious concrete.

Objective of Research Work:

1. To develop High strength (Grade) Pervious Concrete.
2. To observe the changes in compressive strength of pervious concrete with respect to Water to Cement Ratio

Problem Statement

As porosity of pervious concrete is more than traditional concrete, the compressive strength is lower. The research gap is to increase the compressive strength of pervious concrete by various means.

2. METHODOLOGY

Literature Review: We explored past studies on pervious concrete, focusing on its strength, materials, and performance. This helped us understand what's already known and where our research can add value.

Material Selection: Cement, coarse aggregate, water, and additives were utilized without fine aggregates to maintain porosity.

Mix Proportions: Multiple mix designs were prepared and evaluated.

Testing Procedures:

Porosity Test: Measuring void content in hardened concrete specimens.

Compressive Strength Test: Conducted on (150 x 150 x 150) mm cube specimens at 7, 14 and 28 days.

Density Test: Determining the unit weight of hardened concrete to assess its compactness

Analysis of results: We tested our pervious concrete samples for strength, permeability, and durability. The results were compared with regular concrete and past studies to see how well our mix performed.

Conclusion: We summed up our findings, highlighting the strengths and potential uses of pervious concrete. We also pointed out any limitations and suggested areas for future research

3. MATERIAL TESTING

Testing of Cement

Various tests were conducted to evaluate the properties of cement, ensuring compliance with IS 4031 and IS 8112 standards.

1. Fineness Test
   - Purpose: Determines the fineness of cement, affecting hydration rate and strength.
   - Result: 3% retained on 90-micron sieve (Within the permissible limit of ≤10%, as per IS 4031 (Part-1):1988).
2. Setting Time Test
   - Purpose: Measures the time required for cement to set and harden.
   - Result:
     - Initial Setting Time: 35 min (≥30 min required as per IS 4031 (Part-5)).
     - Final Setting Time: 10 hrs (600 min) (≤600 min as per IS 4031 (Part-5)).
3. Normal Consistency Test
   - Purpose: Determines the water content required for standard consistency using the Vicat apparatus.
   - Result: 28% water content (Permissible range: 25%-35%, as per IS 8112:1989).
4. Soundness Test
   - Purpose: Evaluates the cement's resistance to volume expansion after setting.
   - Result: 0 mm change in dimension (Limit: ≤10 mm, as per IS 8112:1989).

Testing of Coarse Aggregate

To ensure the suitability of coarse aggregate (passing 20mm, retained on 10mm sieve) for pervious concrete, various tests were conducted as per IS 2386 (Part I-V): 1963.

1. Sieve Analysis (Grading Test)
   - Purpose: Determines the particle size distribution of aggregates.
   - Result: Within permissible limits as per IS 383:2016 for graded coarse aggregates.
2. Specific Gravity Test
   - Purpose: Measures the density of aggregate relative to water, influencing mix design calculations.

- Result: 2.65 (Permissible range: 2.5–3.0, as per IS 2386 (Part-3):1963).

3. Water Absorption Test

- Purpose: Assesses the aggregate's ability to absorb water, affecting the water-cement ratio.
- Result: 0.6% (Should not exceed 2%, as per IS 2386 (Part-3):1963).

4. WORK DONE

After completing material testing, pervious concrete specimens were casted and tested to evaluate strength and permeability characteristics. The process involved mix proportioning, batching, mixing, and curing, ensuring adherence to relevant IS codes.

Th

a) Mix Proportioning

e mix was designed following IS 10262:2019 (Concrete Mix Proportioning) and IS 456:2000(Plain and Reinforced Concrete). Variations in aggregate size, binder content, and water-cement ratio were considered to determine an optimal mix balancing strength and permeability.

b) Batching and Mixing

Weigh batching was used for precise proportioning of materials. A mechanical mixer ensured uniform material distribution. Special care was taken to maintain proper bonding between coarse aggregates due to the absence of fine aggregates.

Fig-1: Mixing of Concrete

c) Mix Proportions and Material Quantities

Batch 1 (Without Admixture)

For Batch 1 (Without Admixture), the pervious concrete mix was designed following IS 12727:1989, with a 1:7 mix ratio and a water-cement ratio of 0.38. We prepared a total of 69.863 kg of material. This included 8.732 kg of cement, 61.130 kg of coarse aggregate, and 3.351 litres of water, ensuring a well-balanced mix for casting nine test cubes.

Batch 2 (With Admixture)

For Batch 2 (Without Admixture), the pervious concrete mix was designed following IS 12727:1989(Code of Practise for No-Fines Cast In- Situ Cement Concrete), with a 1:7 mix ratio and a water-cement ratio of 0.38. We prepared a total of 69.863 kg of material. This included 8.732 kg of cement, 61.130 kg of coarse aggregate, and 2.60 litres of water with Admixture 87.32ml, ensuring a well-balanced mix for casting nine test cubes.

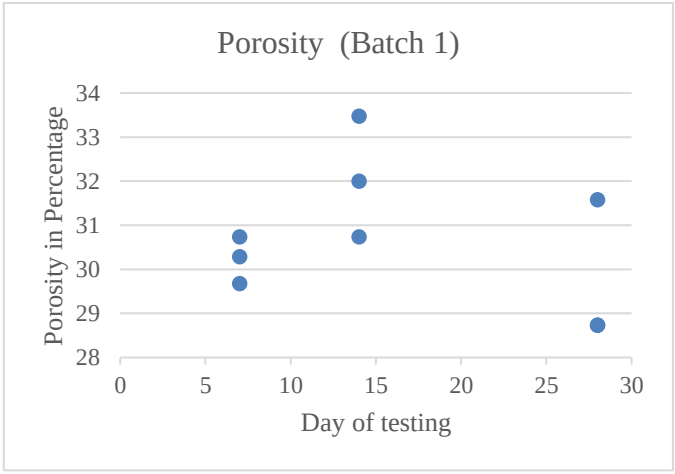
Batch 3 (Without Admixture)

For Batch 3 (Without Admixture), the pervious concrete was mixed using a 1:7 ratio, with a water-cement ratio of 0.38. The final density was recorded at 1900 kg/m³. We prepared a total of 73.743 kg of material, which included 9.216 kg of cement, 64.527 kg of coarse aggregate, and 3.351 litres of water. This mix was carefully measured to maintain consistency and reliability in the experimental results.

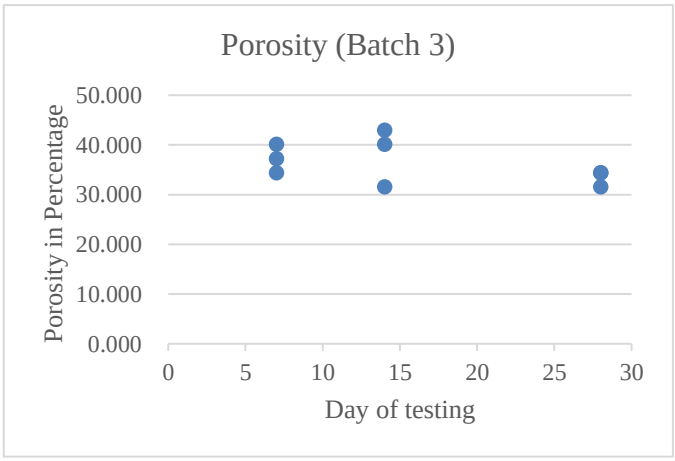
5. RESULT

Porosity Test:

In our research, for Batch 1, the average porosity is found to be 30.664%.

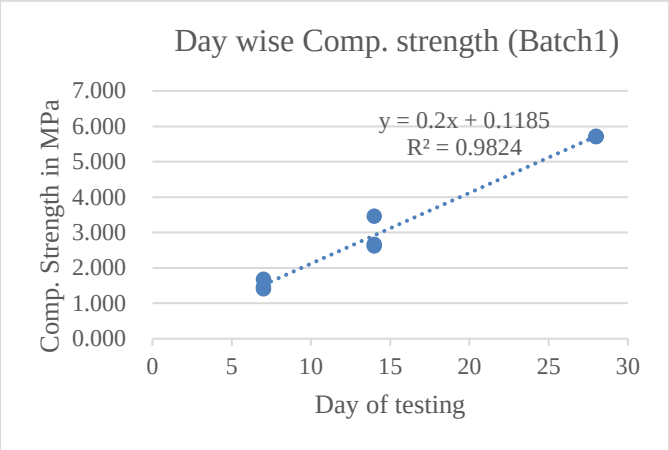


For Batch 3, the average porosity is found to be 36.335%.



Compressive Strength Test:

The average compressive strength after 28 days of curing is found to be 5.718N/mm²



The average compressive strength after 28 days of curing is found to be 5.942 N/mm^2

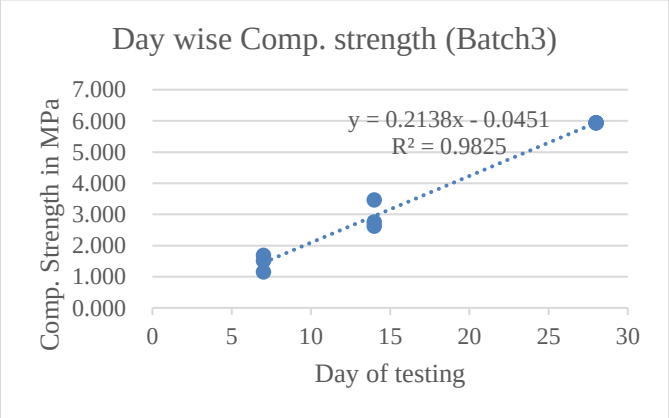
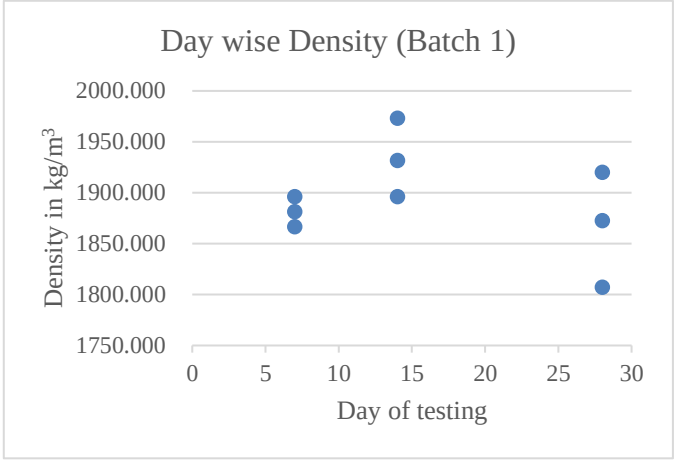


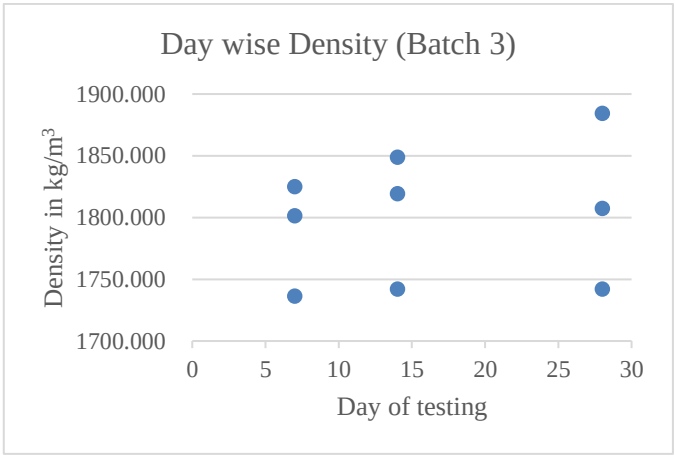
Fig -2: Testing of Cube

Density test:

The average density of Batch1is found to be 1893.992 kg/m^3.



The average density of Batch 1is found to be 1800.823kg/m^3



6. CONCLUSION

For pervious concrete if we have to increase the compressive strength, we have the restriction to add plasticizer or superplasticizer for increasing the strength. In our research work, we observed an extreme reduction in the water-cement ratio of pervious concrete. Hence, Traditional method of designing should be used for pervious concrete i.e., to reduce W/C ratio up to minimum limit.

In our research work, for Cement: Coarse Aggregate ratio 1:7 and W/C ratio 0.38, the 28th day compressive strength is found to be 5.83 N/mm^2 which is in consistent with values given by IS 12727:1989.

We also concluded that the average density is 1854.617 kg/m^3 and the average porosity is 36.335%.

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