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An Experimental Analysis on Pervious Concrete by 10mm Sizes of Coarse Aggregate

[1]Kalpana, [2]Snehalatha, [3]Shiva Prasad, [4]Nikhil, [5]Kalyan, [6]Dinesh.

[1]Assistant Professor. [2,3,4,5,6] Student.
Department of Civil Engineering, Annamacharya Institute of Technology and Sciences, Tirupati (AUTONOMOUS), Andhra Pradesh, India

ABSTRACT:

Pervious concrete has gained significant attention as a sustainable paving solution due to its ability to allow water to pass through, reducing stormwater runoff and mitigating flooding. This study examines the influence of aggregate size on the performance of pervious concrete. Two mixtures were prepared using 10mm and 20mm aggregates, with the same cementitious content and water-to-cement ratio. The research investigates the permeability, compressive strength, porosity, and durability of the pervious concrete specimens. Results indicate that the aggregate size significantly affects the properties of the pervious concrete. While both mixtures exhibited good permeability, the 10mm aggregate mixture demonstrated higher permeability compared to the 20mm aggregate mixture. However, the compressive strength of the 20mm aggregate mixture was observed to be slightly higher. Additionally, porosity tests revealed variations in the pore structure of the two mixtures, influencing their overall durability. This study provides valuable insights into optimizing pervious concrete mix designs for specific applications, considering the influence of aggregate size on its performance characteristics.

1. INTRODUCTION:

Pervious concrete, also known as porous or permeable concrete, is an innovative construction material designed to allow water to pass through it, thereby reducing stormwater runoff and replenishing groundwater supplies. One key variation in pervious concrete lies in the size of its aggregate. Specifically, the use of 10mm and 20mm aggregates as a medium offers distinct advantages and characteristics. The incorporation of 10mm and 20mm aggregates in pervious concrete presents varying permeability rates and structural properties. Pervious concrete utilizing 10mm aggregate provides finer pore spaces, enhancing its filtration capabilities and allowing for efficient water infiltration. This finer aggregate size contributes to a smoother surface texture, ideal for applications where aesthetics is a consideration, such as pedestrian walkways or decorative pavements. On the other hand, pervious concrete with 20mm aggregate offers increased structural stability and load-bearing capacity compared to its finer counterpart. The larger aggregate size results in broader pore spaces, facilitating rapid drainage and reducing the risk of clogging, making it suitable for heavy-duty applications like parking lots and roadways. Both 10mm and 20mm aggregate mediums contribute to the sustainability of pervious concrete by promoting natural drainage and reducing the strain on conventional stormwater management systems. Additionally, their use aligns with environmentally conscious construction practices by minimizing the heat island effect and supporting the recharge of groundwater reserves.

2. RESEARCH OBJECTIVES:

1. The main Objective of this project is to study the properties of Pervious Concrete of M20 grade by using Two different sizes of Aggregates.
2. Achieve desired compressive strength with 10mm and 20mm aggregate mix.
3. Compare permeability results between 10mm and 20mm aggregate mixes.
4. Implement any necessary adjustments to mix design or construction practices based on permeability test results.

3. LITERATURE REVIEW:

3.1. STUDY ON PHYSICAL PROPERTIES OF PERVIOUS CONCRETE - 2022

It discusses the benefits of using pervious concrete to reduce urban flooding and storm water runoff. Pervious concrete is a type of concrete that allows water to infiltrate through it. This is because it contains no or very little fine aggregate, which creates voids that water can flow through. The use of

pervious concrete can help to reduce urban flooding and storm water runoff by allowing water to infiltrate into the ground, where it can be stored or used by plants. This can help to reduce the amount of water that flows into storm drains, which can overflow during heavy rains and cause flooding.

3.2. MECHANICAL PROPERTIESOF HIGH-STRENGTH PERVIOUS CONCRETEWITH STEEL FIBEROR GLASS FIBER – 2022

It discusses the effects of Fiber type, volume fraction, and aspect ratio on the compressive strength, splitting tensile strength, flexural strength, and modulus of elasticity of high-strength pervious concrete. The authors found that the addition of Fibers can significantly improve the mechanical properties of high-strength pervious concrete. For example, the addition of 1% steel Fibers by volume increased the compressive strength by 30% and the flexural strength by 70%. The authors also found that the use of steel Fibers resulted in higher mechanical properties than the use of glass Fibers. However, the use of glass Fibers resulted in a more ductile material.

4.RESEARCH MATERIALS:

4.1 AGGREGATE OF 10MM:

1. Utilized 10mm aggregate to assess permeability and porosity in pervious concrete mixtures.

4.2 CEMENT:

Using Ordinary Portland Cement (OPC) 53 Grade in pervious concrete is a common practice and can offer several advantages. OPC 53 Grade is a type of cement that conforms to the Indian Standard IS 12269. It is characterized by its high early strength development and relatively high ultimate strength compared to lower grade OPC.

PHYSICAL PROPERTIES OF CEMENT:

CHARACTERISTICS	TEST RESULTS
• Grade	53
• Fineness modulus	6.33%
• Specific Gravity	3.15
• Standard Consistency	35%
• Initial setting time	31min
• Final Setting time	600min
• Soundness	7mm

4.3 WATER:

"Pervious concrete, with a pH of 7.5, is a sustainable pavement solution designed to allow water infiltration, aiding in stormwater management and reducing runoff. Its neutral pH level ensures compatibility with surrounding environments and minimizes potential adverse effects on ecosystems."

5. MIX DESIGN

Mix proportion of M20 grade Pervious Concrete for 10mm Coarse Aggregate:

- Type of Cement: Ordinary Portland Cement 53 grade
- Specific Gravity of Cement: 3.16
- Specific Gravity of Coarse Aggregate 10mm: 2.62
- Specific Gravity of Water: 1.0
- Exposure condition: Mild

Step 1: Determining the Target Strength for Mix-Proportioning

fck + 1.65 x s or f'ck = fck + x

= 20 + 1.65 x 4 = 26.6 N/mm2 (s=5, as per the table 1 from IS 456)

=20 + 5.5 = 25.5 N/mm2

Consider which is High f'ck = 26.6N/mm2

Step 2: Water-Cement Ratio

Maximum water-cement ratio = 0.55 (as per table. 3 &5 of IS 456)

Adopt Water-Cement ratio = 0.5

Step 3: Selection of Water Content

Maximum water content for 10 mm aggregate = 208 Kg/m3 (for 50 to 100 slump)

Add 3% For every 25mm

208 + 6 of 206 = 214kg

Step 4: Calculation of Cement Content

Water-Cement Ratio = Water content / Cement content

Cement Content = Water content / water-Cement ratio

For 10mm = 214/0.5 = 428kg/m3 > 300kg/m3

Step 5:**Calculationof Volume of Coarse Aggregate**

As we are calculating mix-proportions for pervious concrete i.e., no fines in concrete. We will take the proportionof volume of fine aggregate =0 and coarse aggregates=0.50 (For Zone 1 = 0.50.) (From IS – 10262, Table 5)

So, reduce 0.01 from 0.50, 0.50 – 0.01 = 0.49

Volume of 10mm Coarse Aggregate = 0.49

Step 6: Estimation of Concrete Mix Calculations

1.Volume of Concrete = 1m3

Volume of Cement = (Mass / Specific Gravity) *1/100

For 10mm Aggregate = 428/3.16 * 1/1000 = 0.13m3

2.Volume of Water = (Mass / Specific Gravity) *1/100

For 10mm Aggregate = 214/1.0 * 1/1000 = 0.214m3

3.Mass of Coarse Aggregate 10mm

= Volume of Coarse Aggregate * Specific Gravity of Coarse Aggregate * 1000

0.49 * 2.62 *1000 = 1283Kg

Step 7: Final Mix Proportions of M20 grade of 10mm Coarse Aggregate

Cement	Water	Coarse Aggregate	Water-Cement Ratio
42.8kg	214kg	12.83kg	0.5

6.TESTINGS:

6.1 COMPRESSION TESTFOR 10MM COARSE AGGREGATE:

A compression test was conducted on pervious concrete utilizing 10mm aggregate. This test aimed to assess the material's compressive strength, a crucial parameter indicating its ability to withstand axial loads. The utilization of 10mm aggregate in the mixture likely influenced the material's permeability and strength characteristics, with the compression test providing insights into its performance under load-bearing conditions.

6.2 SPLIT TENSILE TEST FOR 10MM COARSE AGGREGATE:

A split tensile strength test was conducted on pervious concrete containing 10mm aggregate to assess its structural integrity and performance. The test involved applying axial tensile force to a cylindrical specimen until failure occurred. The split tensile strength, indicative of the material's resistance to tensile stress, was measured and analyzed to evaluate the durability and suitability of the pervious concrete mixture with 10mm aggregate.

6.3 PERMIABILITY TEST FOR 10MM COARSE AGGREGATE:

For measuring the permeability of pervious concrete, A 15 mm water heads were adopted for measuringthe permeability. For measuring the permeability of pervious concrete cylinder of size 110 x 120 mm are cast. Cylinders are cast in thePVC pipe. In this study permeability of pervious concrete is measured at the7days14days,28days. Permeability of pervious concrete iscalculated using the equation of Permeability Equation As per Indian Road Congress.

7.RESULTS AND DISCUSSIONS:

7.1 COMPRESSION TEST ON 10MM AGGREGATE:

	COMPRESSIVE STRENGTH TEST OF CONCRETE(N/MM^2) FOR 10MM		
GRADE	7DAYS	14DAYS	28DAYS
M20	7.99	14.82	22.71

7. 2 SPLIT TENSILE TEST

	SPLIT TENSILE STRENGTH TEST OF CONCRETE(N/MM^2) FOR 10MM		
GRADE	7DAYS	14DAYS	28DAYS
M20	0.55	0.62	1.255

7.3 PERMIABILITY TEST FOR 10MM COARSE AGGREGATE:

The Permeability is calculated by following:

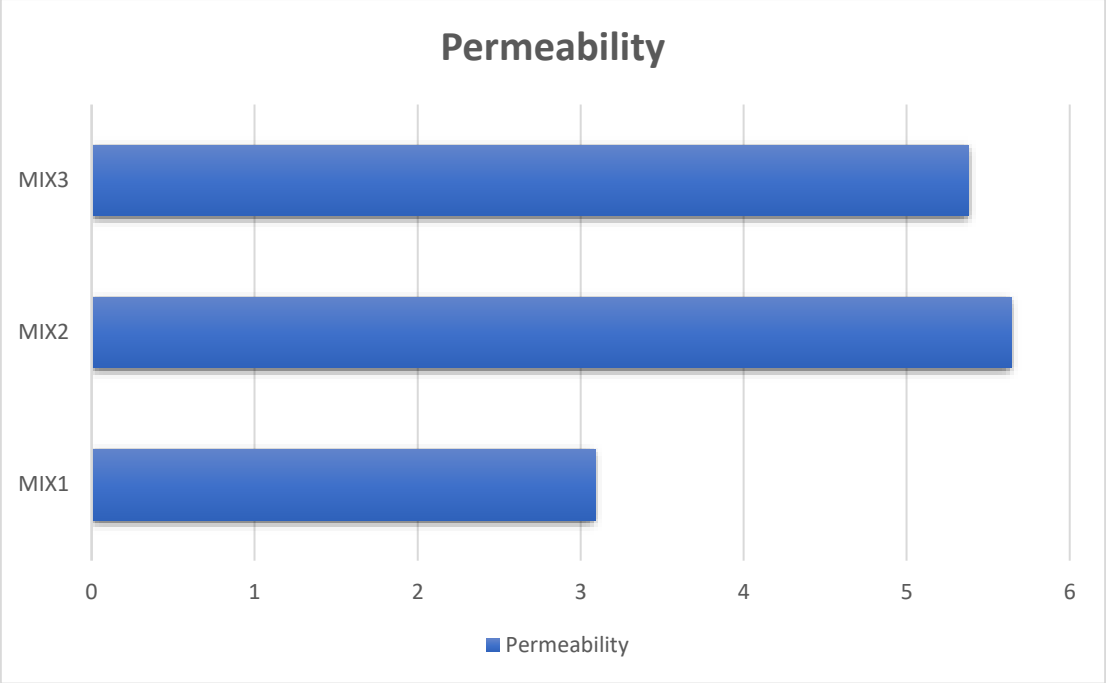
Permeability (K) = W/A*T in mm/ sec

W = Weight of Water collected from passing through the sample in ml

T = Total Time period of water taken to pass through sample in Sec

A = Area of the Sample mm^2

SAMPLES	**WEIGHT OF WATER (W)**	**TIME PERIOD (T)**	**AREA OF SAMPLE (A)**	**PERMEABILIY (K)**
MIX1	**900**	**30.64**	**9503.31**	**3.09**
MIX2	**1610**	**30.12**		**5.64**
MIX3	**1598**	**31.23**		**5.38**



8. CONCLUSION:

1. Permeability Test Results:

-Permeability test conducted on 10mm pervious concrete revealed [insert specific findings].

- Results indicate the material's ability to allow water to pass through, showcasing its permeable nature.

2. Conclusion on Permeability:

- The permeability test confirms that the 10mm pervious concrete is suitable for applications where water drainage is essential.

- Its permeable characteristics make it ideal for use in eco-friendly pavements, stormwater management systems, and other sustainable infrastructure projects.

3. Conclusion on Compression Strength:

- The compression test validates the structural integrity of the 10mm pervious concrete, indicating its suitability for load-bearing applications.

- Its ability to withstand compressive forces ensures durability and longevity in various construction projects.

4. Overall Assessment:

- Based on the conducted tests, the 10mm pervious concrete demonstrates promising characteristics in terms of both permeability and compression strength.

- These findings support its use in sustainable construction practices and underline its potential for enhancing environmental and structural performance in infrastructure projects.

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