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The Use of Permeable Concrete for Making of Pavement Blocks

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Abstract: Urbanization has replaced previous vegetative lands with impervious surfaces such as pavement, which reduces the area where infiltration to groundwater can occur, thus increasing surface runoff into streams or accumulation of stormwater that can lead to flooding. Stormwater must be drained from the roadway to protect pavement and travellers from water-related damage. The use of permeable pavement allows stormwater to move through the pavement layers (away from the road surface), where it can either infiltrate the soil and groundwater or drain to the road shoulder, where it is collected for treatment as needed. There is limited evidence, however, regarding any traffic safety issues associated with stormwater and the type of permeable pavement suitable for various traffic requirements.
Keywords: Waterlogging, stormwater, runoff, pavement, pervious concrete.

I. INTRODUCTION

In recent years stormwater management has become a fellow feeling for urban development. Most inexperienced fields are converted into pavements and buildings, reducing the groundwater and increasing the surface runoff. Its flow into natural bodies inflicting permeable pavement is parking, sidewalks, lawn tennis court, and low-volume paver primarily used in urbanized areas. They also have many environmental benefits, including reducing runoff, increasing water quality and improving drainage. Appropriately designed interlocking concrete block pavers may reduce the amount of pollutants reaching receiving waters by allowing water to infiltrate into the subsurface layers. Permeable pavement allows stormwater to quickly infiltrate the surface layer to enter a high-void aggregate base layer.

II. LITERATURE SURVEY

Permeable pavement is a paving alternative to traditional hardscape flooring materials, where water can filter through the surface to the underlying soils. Traditional pavers do not allow much water to infiltrate, especially if they are mortared in place.

Permeable concrete has zero slump, water and open-graded materials consisting of cement coarse aggregates admixtures. Permeable pavement has little or no fine aggregates like sands, sometimes called "no-fines" concrete. They reduce the need for expensive retention ponds; developers and other private companies also use it to free up valuable real estate for development while providing a paved park.

III. RELATED WORK

A. *To Study Waterlogging on the Pavement*

When rainwater cannot percolate through the pavement, water logging takes place. It is essential to increase the drainage capacity of pavement. For this permeability of regular concrete should be increased. In this project, we are working on designing such concrete blocks.

B. *To Study Mix Design of Concrete*

The mix is weighted and mixed separately without water in a concrete mixer or by hand using a concrete hand mixture until the dry mix is uniformly mixed (for mix proportion, see table.) Next, water was weighed and added to the dry mix. (for the amount of water, see table.)

The trail mix was mixed until the required cement slurry was not found. Finally, it was carried out, poured into a separate Mould, and left for 7 days to become hardened concrete. Now the desired Sample is ready for further testing.

IV. PROPOSED FRAMEWORK

Methodology for Studying Waterlogging and Identifying Best Methods for Making Concrete Permeable:

1) *Literature Review:* The first step in the methodology would be to conduct a thorough literature review of existing research and studies on waterlogging on pavements. Studies involve reviewing academic journals, reports, and government publications. This review aims to identify the causes of waterlogging and the existing methods for mitigating the problem.
2) *Data Collection:* The second step would be to collect data for designing a permeable concrete block. This includes the study of the mix design to be used, admixtures which can be used to strengthen the concrete, etc.
3) *Analysis of Data:* The third step would involve analyzing the data collected from various resources and tests. This step involves studying various techniques used in making permeable paving blocks.
4) *Identification of Methods for Designing Permeable Concrete:* The fourth step would involve researching and identifying methods for designing permeable paving blocks. This could include material composition, mix design, admixtures used, etc. This research aims to identify effective and sustainable methods that can be implemented to make concrete permeable.
5) *Evaluation of Methods:* The fifth step would involve evaluating the different methods for making permeable concrete blocks identified in step 4. This evaluation would consider factors such as cost-effectiveness and ease of implementation. This evaluation aims to identify the most effective and appropriate approach for permeable concrete.

V DESIGN AND ANALYSIS

A. *Modified Method of Design*

The strength is mainly influenced by the water-cement ratio. A low water-cement ratio is necessary to obtain good strength, affecting the mix's workability. Conventional concrete mix proportions and materials cannot be used as we work on permeable concrete. Hence, to make concrete permeable, we prohibited using sand; instead, we used small or medium-sized coarse aggregate. Only coarse aggregate is used to increase the void ratio of the concrete so that water can pass through it. The design mix we preferred for our project is M20, but the only change is we used coarse aggregate only. According to IS 12727 Cl.11.5 other strength, the minimum tensile strength of the porous paver block is 0.12fc, flexural strength is 0.23 fc, cylinder strength is 0.61fc, and bond strength is 0.19fc.

B. *Design Process*

The design process for the permeable concrete is as follows,
Grade of concrete: M15
Size of aggregate :20mm
Workability :75mm
Type of exposure :severe

C. *Test Data/Material*

Cement : Ordinary Portland Cement (53grade)
Specific gravity of cement : 3.15
Specific gravity of aggregate : 2.74
Specific gravity of fine aggregate : 2.65

Table:1 Water absorption & moisture content

Type of aggregate	Water absorption	Moisture
Fine aggregate	1.1%	1%
Coarse aggregate	1.2%	1.2%

- Target mean strength, f_{ck} $= f_{ck}+1.65 * s$
  $= 15+1.65*3.5$
  $f_{ck} = 20.78$ N/mm^2 and
  $f_{ck} = f_{ck} + x$
  $f_{ck} = 15+5=20$

take the greater of the above 2 values,

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Table:2 Water Binder ratio: 0.40 as per IS12727 1989,

Sr. no.	Maximum size of coarse aggregate (mm)	Cement concrete mix by volume	Optimum w/c ratio	Expected compressive strength after 28 days (N/mm^2)
1	20	1:8	0.40	5.5
2	20	1:9	0.42	4.9
3	20	1:10	0.45	3.5
4	20	1:12	0.48	3.5
5	40	1:10	0.48	3.5
6	40	1:12	0.50	2.6

- Selection of water content = 186 lit/cum.   as per IS 10262, 2019, table no. 7
- Superplasticizer and strength enhancer = Hydracet (contains calcium chloride)
  It reduces water content by 20%, therefore,
  Water content = 148.80 lit/cum.
- Calculation of cementitious material:

  Cementitious material= water content/ (w/c ratio)
  = 148.80/0.40
  = 372 kg/cum

- Calculation of Volume of cement:
  The volume of cement = (mass of cement/sp.gr. of cement)* 1/1000
  = (372/3.15) * 1/1000
  = 0.118 cum.
- Calculation of volume of water:
  The volume of water = (mass/ sp.gr. of water)* 1/1000
  = (148.8/1)* 1/1000
  = 0.149 cum.
- 1% superplasticizer:
  i.e. 372*1/100 = 3.72kg/cum
  the volume of admixture = (mass/sp.gr. of admixture)*1/1000
  = (3.72/1.1)*1/1000
  = 0.0034 cum.
- Calculation of volume of aggregate:
  Total Volume of aggregate = 1-(0.118+0.149+0.0034)
  = 0.7296 cum.
  We need to produce porous concrete for paver blocks, so we decided to use 60% 20mm aggregate and 40% 6 to 10 mm aggregate and excluded fine aggregate.
- Calculation of aggregate content:
  Mass of aggregate content = volume of aggregate * sp.gr. of aggregate *1000
  = 0.7296*2.74*1000
  = 1999.110 kg/cum.= 2000 kg/cum
  Therefore,
  Coarse aggregate = 1200 kg/cum
  6 to 10mm aggregate = 800 kg/cum.
- The ratio of cement : aggregate is 1:8

Figure 1Concrete Pavement Mould

Figure 3 Permeable Concrete pavement block after curing.

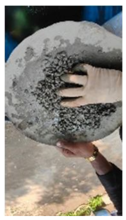

Figure 2 Concrete placing

Figure 4 Compressive Strength of Concrete

VI CONCLUSION AND FUTURE SCOPE

1) The smaller sizes of coarse aggregate can produce a high compressive strength, and coarse aggregate has a high permeability rate.
2) The permeability of the designed paving block is greater than conventional paving blocks, which helps the water to percolate from the surface to the sub-surface layers.
3) Using this permeable paving block, issues related to water logging in areas like footpaths, walkways and porch regions are resolved.
4) Admixtures containing calcium chloride can be used to increase the Compressive strength of concrete.

A. Results

Table:3 The compressive strength of permeable paver blocks

Samples	Compressive strength (N/mm^2)
Sample 1	7.52
Sample 2	6.36
Sample 3	6.65

Therefore, compressive strength of permeable paver block is, 6.84 N/mm^2

VII FUTURE SCOPE

The permeable pavement application has been limited to specific applications, like parking lots and low-volume roads. Future research may prefer new and innovative applications like village roads and airport runways. Permeable pavements are mainly low strength, but by increasing their strength and improving their properties, they are often used for heavy traffic roads, including urban roads, Highway Shoulders, etc.

Generally, in densely urban areas, less land space exists. So that roads are not properly arranged, and surface drainage facilities are not provided properly. So in rainy seasons, the issue of water clogging arises. So For these areas, permeable pavement can become the best option. We can see that jogging tracks or walkways are generally constructed of compacted soils in parks or gardens. But in rainy seasons, these roads become muddy, which cannot be used for our intended purpose. This causes various problems for pedestrians. So for this sort of situation, permeable pavements are often proven advantageous.

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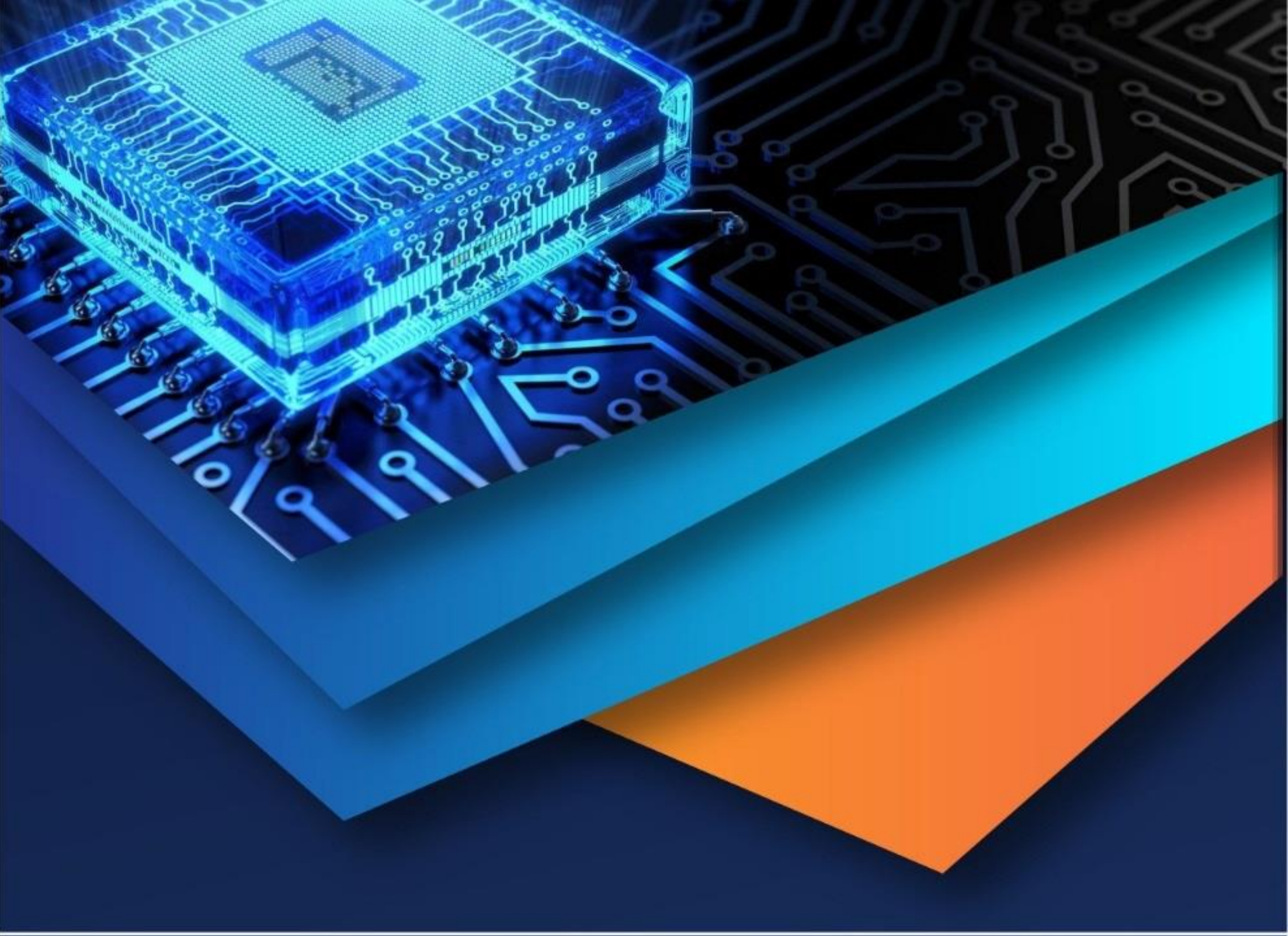

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