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An Experimental Study On Performance Of Permeable Concrete

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Abstract: Permeable Pavements is a comprehensive resource for the proper design, construction, and maintenance of permeable pavement systems that provide a transportation surface and a best management practice for storm water and urban runoff. A cornerstone for low impact development and sustainable site design, permeable pavements are considered a green Infrastructure practice. They offer many environmental benefits, from reduced storm water and improved water quality to better site design and enhanced safety of paved surfaces. Commonly used for walkways, driveways, patios, and low – volume roadways as well as recreational areas, parking lots, and plazas, permeable pavements are appropriate for many different land uses, particularly in highly urbanized locations.

I. INTRODUCTION

Not only in India also in other countries there is a great demand and usage of transportation is very high. The mostly used transportation is roadway. But now a day it is very difficult problem in the rainy seasons. The water gets stagnated on the road and due to this reason the surface of the roads gets slippery and the tires of the vehicles gets slippery and may lead to small accidents. And to reduce the problem or to overcome this problem the only best method can be used is the construction of permeable pavement surfaces.

Permeable pavements can be an important tool for retention and detention of storm water runoff. Permeable pavement may provide additional benefits, including reducing the need for de–icing chemicals, and providing a durable and aesthetically pleasing surface. Permeable pavements have been used for areas with light traffic at commercial and residential sites to replace traditionally impervious surfaces such as low – speed roads, parking lots, driveways, sidewalks, plazas, and patios. Permeable pavements allow storm water runoff to filter through surface voids into an underlying stone reservoir where it is temporarily stored or infiltrated.

The use of permeable pavements is rapidly increasing as the acceptance and desire to use green infrastructure methods for storm water management continues to grow. The uses, installation methods, and types of permeable pavement is also rapidly expanding. New technical recourses for improving the design and construction of pavements are emerging.

II. LITERATURE REVIEW

Wilson et al (2003) said that permeable pavement structure should be constructed with an impermeable membrane, and the treated storm water should subsequently be discharged into a suitable drainage system. And he also said that the common application of permeable pavement structures are slope stabilization erosion control, golf courses, paths and parking's, pedestrian access, land irrigation.

Tennis et al (2004) has said that the percentage of voids be of 15 to 25 % in the hardened concrete. And the flow rates for water through the pervious concrete are generally in the range of 2 to 8 gallons /min/ft2. He also stated that with high levels of permeability, pervious concrete can be effectively capture the "first flush" of rainfall and allow it to percolate into the ground where it is filtrated and treated and other major benefits provided by pervious concrete include reduction in heat, reduction in standing water on pavements and reduce tire-pavement noise emission.

III. OBJECTIVES OF PROJECT STUDY

- ✓ To investigate the characteristic properties such as compressive strength and split tensile strength of the permeable concrete.
- ✓ To prepare strong and durable permeable concrete with different sizes of coarse aggregate and cement.
- ✓ To compare the properties of permeable concrete with conventional concrete.
- ✓ To define and prove the permeability nature of pervious concrete.
- ✓ To prompt the usage of permeable concrete in all applicable places for its aesthetic appearance and eco friendly advantages.

IV. METHODOLOGY

The various steps involved in our project are explained briefly in the following flow chart.

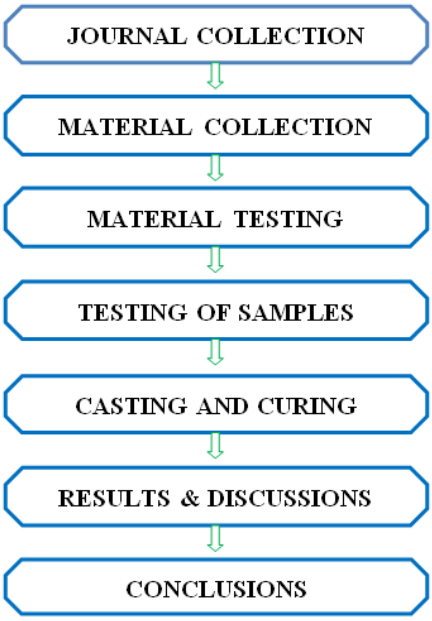

Figure 1: Methodology

A. MATERIALS

a. CEMENT

Here we used Ordinary Portland Cement is used. The grade of the cement is 53.

Properties	Test results	Standard values
Specific gravity	3.12	
Initial settings time (min)	33	>30
Final setting time (min)	430	<650
Fineness	9.0 (91%)	<10

Table 1: Properties of Cement

b. COARSE AGGREGATE

The coarse aggregate with angular shape of 10mm and 20mm size is used.

S. No	Property	Test results
1	Specific gravity	3.62
2	Water absorption	0.9%
3	Fineness modulus	-

Table 2: Properties of Aggregates

c. WATER

The water which is used in mixing and curing of pervious concrete is potable water, which was colorless, fresh, odorless and tasteless. the water contains a ph value of between 6 to 8.

B. PREPARATION OF SPECIMENS

a. MIXING

As this is a special type of concrete, the machine mixing process couldn't be adopted due to its low W/C ratio and elimination of fine aggregate. Even mixing of concrete in mixer can be done, it results in increase of cost due to high wastage should be consider. Hand mixing should be preferable for small works and when coming to huge works like pavements etc., machine mixing is preferable. The individual mix ingredients are weighed with their proportions exactly and then the materials are placed on a non absorbent sheet one by one. The materials are thoroughly mixed in their dry condition before water is used. The prepared mix ix then mixed by adding water the entire mix is mixed thoroughly for three minutes.

b. CASTING

The cast iron moulds are cleaned of dust particles and applied with oil on all inner sides before concrete is poured into the moulds. The moulds are placed on a level platform and concrete is filled in three layers. Each layer is tamped with a tamping rod for 25 times. The top surface is leveled with a trowel and kept a side for setting of concrete.

c. CURING

After casting, the moulds are stored in room temperature for 24 hours. After that period the specimens are removed from the moulds and should be kept in fog room for curing. If fog room is not available then specimens should covered in a gunny bag and kept for moisture curing by spraying water for every three hours. The specimens are cured for 7 days, 14 days, 28 days

Figure 2: curing of specimens

C. TESTING OF SPECIMENS

a. COMPRESSIVE STRENGTH TEST

Concrete cubes of size 150mmx150mmx150mm are used to determine the compressive strength of concrete and were tested as per IS 516-1959. The test setup for conducting cube compressive strength is shown in below fig. the compressive strength test is conducted in compression testing machine (CTM). The testing surface is cleaned and specimen is placed in machine and load is applied until the failure of specimen happens and the ultimate load is noted. Then cube compressive strength of concrete is computed.

Figure 3: compressive strength test

b. SPLIT TENSILE STRENGTH TEST

The concrete specimens used for split tensile strength are cylinders of size 15cm dia and 30cm length. These are tested according to IS 516-1959. The testing procedure is same as above but placing of specimen is different i.e., shown in below figure.

Figure 4: split tensile strength

V. RESULTS AND DISCUSSIONS

A. COMPRESSIVE STRENGTH TEST

Tests are conducted for compressive strength and results are computed and plotted bellow

Days	Trails	Load 'P' (KN)	Area 'A' (mm^2)	Strength P/A (N/mm^2)	Average (N/mm^2)
7 days	1	367	150x150	16.31	12.7
	2	269		11.95	
	3	210		9.83	
14 days	1	435	150x150	19.53	14.9
	2	327		14.53	
	3	240		10.67	
28 days	1	545	150x150	24.22	21.7
	2	515		22.89	
	3	395		18.0	

Table 3: compressive strength test

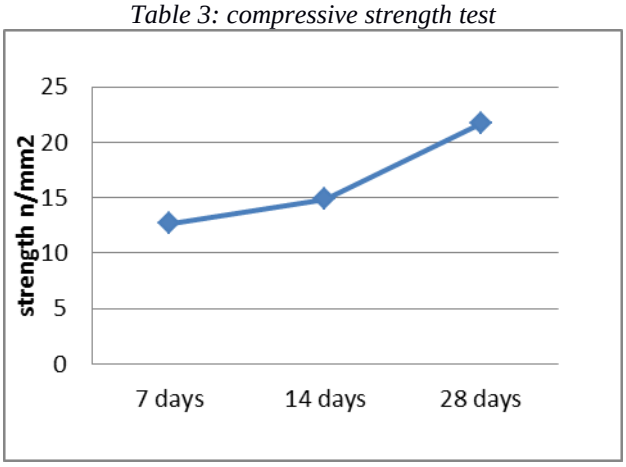

Figure 5: graph showing compressive strength test

B. SPLIT TENSILE STRENGTH TEST

Tests are conducted to get spilt tensile strength and results are calculated and plotted below

Days	Load 'P' (KN)	Area (a) IIdl/2 (mm^2)	Strength (2p/πdl) (N/mm^2)
7 days	133	141371.67	1.81
14 days	149	141371.67	2.10
28 days	162	141371.67	2.29

Table 4: split tensile strength test

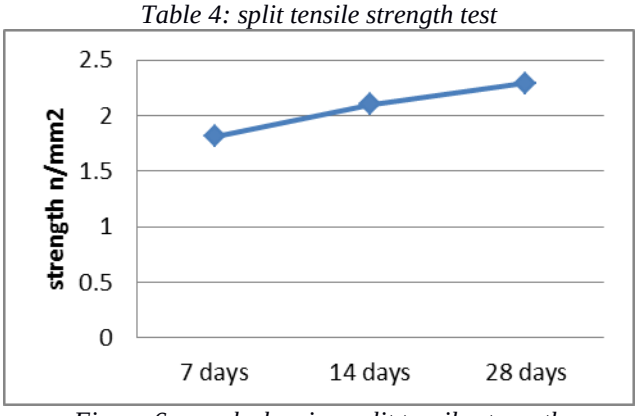

Figure 6: graph showing split tensile strength

C. DESCRIPTION OF RESULTS

- ✓ From fig.5 compressive strength of pervious concrete at age of 7 days of curing period it is obtained 12.7 N/mm^2, at age of 14 days of curing period it obtained 14.9 N/mm^2 and at the age of 28 of curing period it obtained at strength of 21.7N/mm^2
- ✓ At age of 7 days of curing period compressive strength is obtained 12.7 N/mm^2.

- ✓ At an age of 14 days compressive strength increased by 17%.
- ✓ At an age of 28 days compressive strength increased by 70% when compared with the strength at age of 7 days
- ✓ From fig.6 split tensile strength of pervious concrete at age of 7 days of it attained to 1.81N/mm^2, at an age of 14 days 2.10 N/mm^2 and at age of 28 days it attained to a strength of 2.29 N/mm^2
- ✓ In our work we attained the required strength of M15 grade conventional concrete according to IS code.
- ✓ We can state from the experimental observations, it can be used for pavements like for parking lots, residential roads, parks etc.

VI. CONCLUSIONS

Based on the results obtained on experimental investigation carried on pervious concrete. The following are the observed conclusions & recommendations.

- ✓ It was observed from experimental investigations, the various tests were carried out to determine the compressive strength, split tensile strength, and permeability behavior of pervious concrete.
- ✓ It was observed that from compressive strength test; the compressive strength of pervious concrete was obtained as 12.70 N/mm^2 at an age of 7 days of curing period, and at an age of 14 days of curing period it is increased by 17% i.e. 14.80 N/mm^2 and at an age of 28 days of curing period it is increased by 70% i.e. 21.70 N/mm^2.
- ✓ It is observed that from compressive strength test; the compressive strength of pervious concrete was obtained as 1.81 N/mm^2, 2.10 N/mm^2, 2.29 N/mm^2 for at an age of 7 days, 14 days, and 28 days of curing period respectively.
- ✓ We can state from the experiment, that the permeability nature of the pervious concrete will be defined and showed.
- ✓ When compared with conventional concrete of M15 grade, the target strength of pervious concrete was attained as such; & it would preferable in similar recommendations.
- ✓ However, the scarcity of binding material can be reduced by opting this type of special concretes i.e. by adopting no fine aggregate particles; thus it leads to economical growth.
- ✓ It can stated that, the pervious concrete can generate a self-drained method and it reduces the project cost to not to construct a separate drain system. Though, it leads to maintain gardening and improves aesthetic view of pavement.
- ✓ Hence, it can be stated that the pervious concrete of M15 grade can be used for pavements of low traffic volume and low speed routes

Based on experimental results, it can be concluded that, when runoff collection is of primary concern and strength, wear off is not a governing issue, the use of pervious concrete can be regarded as a suitable and sustainable choice in various storm water management applications.

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