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Experimental Study on Strength Assessment Of Porous Concrete Pavement by Using Geogrid

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Abstract: The pervious concrete system and its corresponding strength are as important as its permeability characteristics. The strength of the system not only relies on the compressive strength of the pervious concrete but also on the strength of the soil beneath it for support. Pervious concrete as a paving a material has seen renewed interest due to its ability to allow water to flow through itself to recharge ground water level and minimize storm water runoff. This introduction to pervious concrete pavement reviews its application and engineering properties including environmental benefits, structural properties, and durability. The usage of water to the various purpose and lot of urbanization leads to the decrease of water content on and off the soil surface. The pervious pavement consists of concrete with reduction of fine aggregate. The reduction of fine aggregate in the concrete is to introduce the pores for the drain of water which is up held on the surface. In our project, the fine aggregate is reduced in the percentages of 40%, 50%, 60% with the infiltration rate is studied using infiltrometer. Finally the pavement is laid with the introduction of geogrids to enhance the tensile property and to strength the pavement against external loads. Later the infiltration of water through the finally laid pavement was also checked.

Key words: Porous concrete, Geogrid, Compressive strength, Split Tensile Strength, Infiltrometer.

1. Porous Concrete Pavement

Porous concrete is a unique cement-based product whose porous structure permits free passage of water through the concrete and into the soil without compromising the concretes durability or integrity. Porous concrete is a subset of a broader family of pervious pavements. Portland cement pervious concrete is a discontinuous mixture of coarse aggregate, hydraulic cement or other cement materials, and water. The porosity of the pervious pavements is provided by emitting all or most of the fine aggregates. Typically, Portland cement pervious concrete has a void content of about 15 to 25%, which imparts the necessary percolation characteristics to the concrete. The recent interest in porous materials as a substitution for impervious surfaces can be attributed to desirable benefits of storm water retention and structural features of conventional pavement which Portland cement pervious concrete offers. Highly urbanized areas have a drastic impact on the ratio of impervious to pervious surface areas within a region and increase the volume of storm water in surface discharge. By substituting impervious pavement with pervious paving surfaces water is given access to filter through the pavement and parent soil, allowing for potential filtration of pollutants in the storm water.

2. Materials and Mix Design

2.1 Cement

Ordinary Portland cement of 53 grade was used in this study.

2.2 Fine Aggregates

The fine aggregate taken for this work is, locally available Natural River Sand and it was collected and cleaned for impurities. Sand particles passing through IS sieve 4.75 mm were used in this work.

2.3 Coarse Aggregate

The material whose particles are of such size are on 4.75mm is termed as aggregates. Aggregate are the important constituents in concrete, they give body to concrete, reduce the shrinkage and affect economy; they also exhibit chemical bond at the interface of aggregate and paste. In our project we used 20 mm and 40 mm size coarse aggregates. The materials tested in the laboratory as per specifications recommended by IS: 383-1970

2.3 Geogrid

A geogrid is geosynthetic material used to reinforce soils and similar materials. Geogrids are commonly used to reinforce retaining walls, as well as subbases or subsoils below roads or structures. Soils pull apart under tension. Compared to soil, geogrids are strong in tension. This fact allows them to transfer forces to a larger area of soil than would otherwise be the case.

2.4 Infitrometer

Infiltrometer is a device used to measure the rate of water infiltration into soil or other porous media. Commonly used infiltrometers are single ring or double ring infiltrometer, and also disc perimeters.

Table 2.1: Mix proportion of Normal Materials

Materials	Quantity of materials / m^3 of concrete	Mix proportion
Cement	316 kg/m^3	1
Fine aggregate	316 kg/m^3	1
Coarse aggregate	316 kg/m^3	2
Water	191.6 liters	191.6
W/C ratio	0.4	0.4

Table 2.2: Sand Reduction Levels

Mix	Coarse Aggregate (%)
1	40
2	50
3	60
4	Conventional

III. Results and Discussion

3.1 Test Results on Cement

The results of various tests conducted on cement are discussed below.

Table 3.1: Test Result of Cement

Initial setting time	40 mints
Consistency	31%
Specific gravity	3.15
Fineness	5.32%

The results of various tests conducted on fine aggregate are discussed below.

Table 3.2: Test result of Fine Aggregate

Fineness modulus	2.68%
Water absorption	1.23%
Specific gravity	2.65

3.3 Test Results on Coarse Aggregate

The results of various tests conducted on fine aggregate are discussed below.

Table 3.3: Test results of Coarse Aggregate

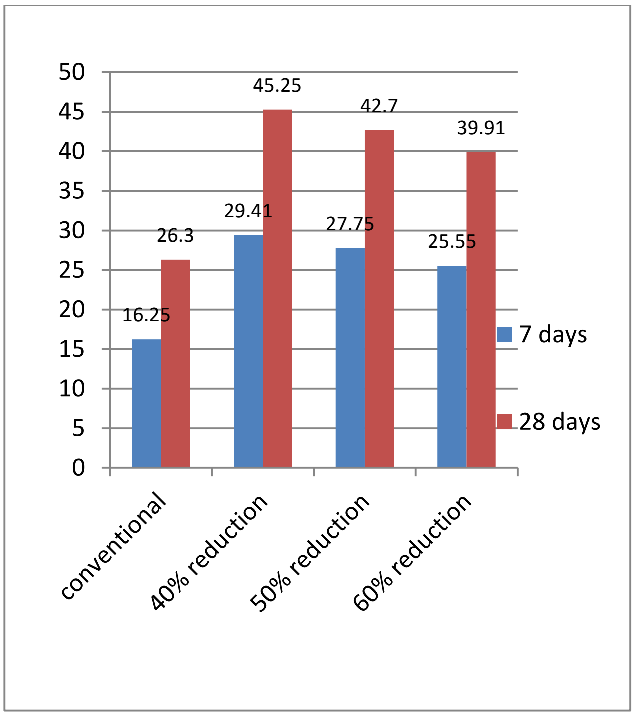
Abrasion test	3.12%
Specific gravity	2.66
Water absorption	0.97%

3.4 Compression Strength Test Result

The150 x 150 x 150 mm cubes were tested at the age of 7and 28 days after curing using Compression Testing Machine (CTM). The ultimate load divided by the cross-sectional area of the specimen is equal to the cube compressive strength.

Table 3.4: Compression Strength Test Result

S. No.	Specimen details	Compressive strength at (N/mm^2)	
		7 days	28 days
1	Conventional concrete mix	16.25	26.30
2	40% reduction	29.41	45.25
3	50% reduction	27.75	42.70
4	60% reduction	25.55	39.91



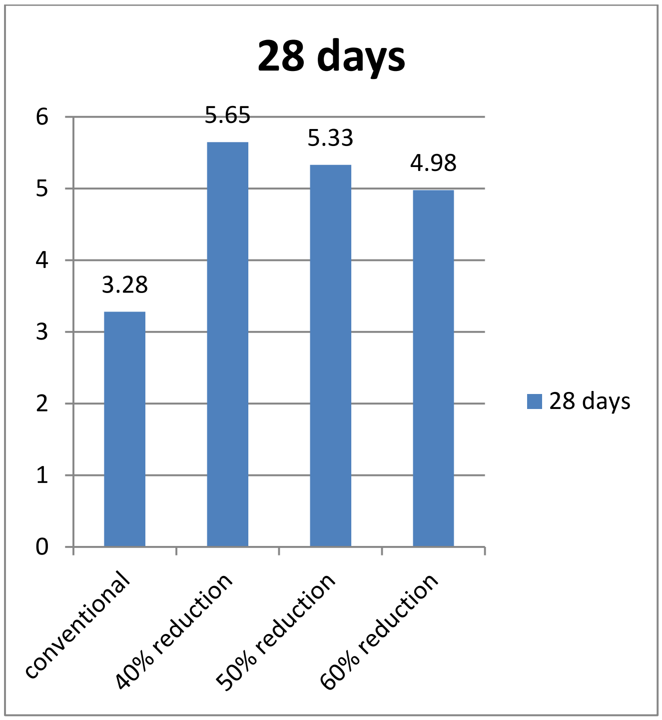
***Summary*: By comparing the result of compressive strength of the cube with the ratio of 1:1:2, the greater strength is obtained in the mix with reduction of sand for about 40%**

3.5 SPLIT TENSILE STRENGTH RESULT

Split tensile strength test was carried out on cylindrical specimens of size 150 mm Dia (D) and 300 mm Long (L) at the age of 7 and 28days after curing using CTM. The split tensile strength of concrete was found using ($2P/\pi LD$).

Table 3.5: Split Tensile Strength Result

S.NO.	Specimen details	Split tensile strength at (N/mm^2)
		28 days
1	Conventional concrete mix	3.28
2	40% reduction	5.65
3	50% reduction	5.33
4	60% reduction	4.98



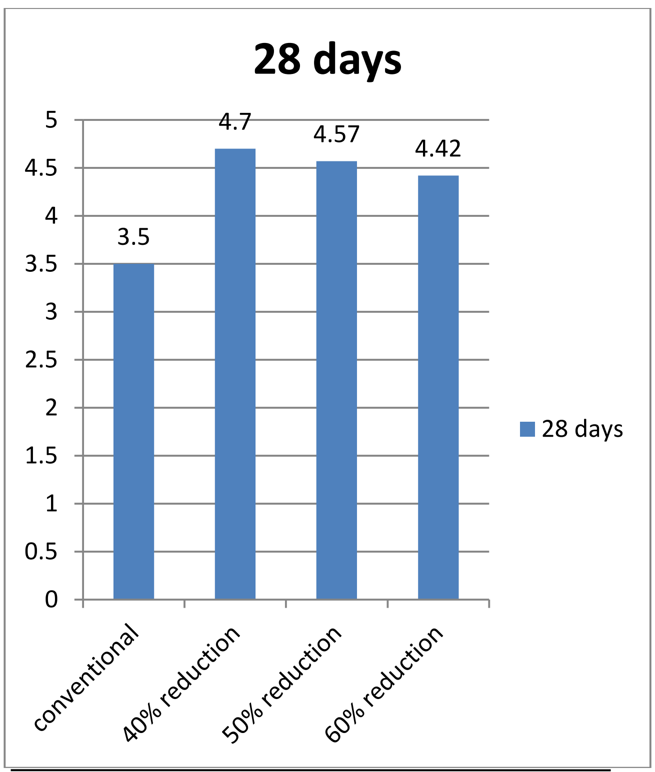
***Summary*: By comparing the result of split tensile strength of the cylinder with the ratio of 1:1:2, the greater strength is obtained in the mix with reduction of sand for about 40%.**

3.6 FLEXURAL STRENGTH RESULT

Flexural strength test was carried out on beam specimens of size 10 x 10 x 50 cm using FTM. The flexural strength of concrete was found using $\mathbf{PL/bd^2}$ or $\mathbf{3Pa/ bd^2}$ where, **P** is the maximum .load on the cylinder and '**a**' is the distance of crack from nearest support of a>20 cm and a<20 cm respectively.

Table 3.6: Flexural Strength Test Result

S. No.	Specimen details	Flexural Strength at (N/mm^2)
		28 days
1	Conventional Mix	3.5
2	40% reduction	4.70
3	50% reduction	4.57
4	60% reduction	4.42



***Summary*: By comparing the result of flexural strength of the beam with the ratio of 1:1:2, the greater strength is obtained in the mix with reduction of sand for about 40%.**

3.7 COMPRESSIVE STRENGTH FOR GEOGRID BASED CUBE SPECIMEN

After Geogrid

Table 3.7: Strength Results for Geogrid based Cube Specimen

S. No.	Specimen	Days	Compressive Strength N/mm^2			
			40%	50%	60%	conventional
1	Cubes	28	50.32	51.55	54.78	29.31

3.8 CONSTRUCTION OF PAVEMENT

The porous concrete layer consists of an open-graded concrete mixture usually ranging from a depth of 4 to 8 inches. To provide a smooth riding surface and to enhance handling and placement, a coarse aggregate of 3/8-inch maximum size is normally used. The filter layer consists of a crushed stone, which serves to stabilize the porous asphalt layer and can be combined with the reservoir layer using suitable stone. The reservoir layer is a gravel base, which provides temporary storage while runoff infiltrates into underlying permeable soils and is typically made up of washed, bank-run gravel or limestone fragments of 1.5 to 3 inches in diameter with a void space of about 30% (EPA, 1999). The depth of this layer depends on the desired storage volume, which is a function of the soil infiltration rate and void spaces. Special care must be taken during construction to avoid undue compaction of the underlying soils, which could affect the soils infiltration capability. In, a typical porous pavement cross section.

Table 3.8: Infiltration Rate –Without Pavement

S. No.	Time(s)	Water Discharge(cm)
1	5	15 to 13
2	10	13 to 12
3	15	12 to 11
4	20	11 to 10
5	25	10 to 9.5
6	30	9.5 to 8.7
7	35	8.7 to 7.8

8	40	7.8 to 7
9	45	7 to 6.4
10	50	6.4 to 5.5
11	55	5.5 to 4.9
12	60	4.9 to 4.2

Table 3.9: Infiltration Rate – With Pavement

S. No.	Water Discharge (cm)	Time (mins)
1	15 to 13	30
2	13 to 12	45
3	12 to 10	60
4	10 to 8.4	75

IV Conclusion

Finally it is concluded that the porous concrete pavement has greater influence in the surcharge of water in water clogged areas. And also it is estimated that the porous concrete pavements shows better economical conditions when compared to pavers block with the percent of saving the cost of construction is about 23.4%.

The compressive strength is increased by 72% when compared with the conventional concrete and the maximum strength is obtained in the concrete with 40% of sand reduction.

The split tensile strength is increase by 72.92% when compared with the conventional concrete and the flexural strength is increase by 34.28% when compared with the conventional concrete.

The increase in the strength is due to the reduction of sand content in the concrete.

This research confirms that previous concrete does in fact provided a lower compressive strength than that of conventional concrete.

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