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EXPERIMENTAL INVESTIGATION ON EFFECT OF SAND CONTENT IN PERVIOUS CONCRETE

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Abstract - In many developed countries, the use of pervious concrete for the construction of pavements, car parks and driveways is becoming popular. In order to develop material specification for pervious concrete, it is necessary to conduct testing to evaluate the performance of this new type of high performance concrete. The pervious concrete is produced by using conventional cementitious materials, aggregates, and water. This concrete is tested for its properties, such as compressive strength, split, tensile test, flexural test, and water permeability. The most important property of pervious concrete is its water permeability. Currently, there is no standard experimental procedure to determine to this property. A method was therefore developed to determine the water permeability, and also investigate Effect of sand content in compressive strength and water permeability of pervious concrete. In this paper the compressive strength and permeability using various mix designs were determined and analysis was done graphically.

KEYWORDS: Porous, Pervious concrete Permeability, Slump, Compressive strength, split tensile strength, flexural strength.

1. INTRODUCTION

Pervious concrete can be noticed as permeable, gap-graded, enhanced porosity or no fines concrete, this concrete is treated as new way to control, manage and treat storm water runoff. Porous concrete thus allow the excess of water to infiltrate into the ground by effectively capturing and retaining the storm water and there by recharging ground water. Pervious concrete comprises little or no fine aggregate (sand) and carefully measured amounts of cementations materials and water. The paste binds the aggregate particles together to develop a system of interconnected and highly permeable voids that encourage the quick drainage of water.

By definition, pervious concrete is a mixture of cement, granite stone, little to no sand (fine aggregate), water. When pervious concrete is used for pavements the open cell structures permit storm water to pass tough the pavement and into the underlying ground. Apart from this it is used to eliminate the need for expensive retention ponds. Pervious concrete is also an important and effective means to address ecological issues and sustainable growth. Pervious concrete acts as a drainage system in the regions of heavy rainfall, thereby placing water back where it belongs. Pervious concrete is rough surface and has a honeycombed texture, with reasonable amount of surface ravelling which occurs on heavily traffic roadways. During mixing and placing process, to prevent the over flow the paste forms a dense coating around aggregate particles. Due to absence of sand in the porous concrete harsh mix is obtained which adversely affects batching, transporting and placing. It is light in weight due to the presence of high voids.

When compared to normal concrete, pervious concrete has a lower unit weight & compressive strength and greater permeability. However, pervious concrete has a better advantage in many fields. Nevertheless, it has its own draw backs which must be given proper attention when planning its use.

2. LITERATURE SURVEY

2.1 M SULEIMAN AND J.KEVERN (2006) : This paper summarizes a study performed to investigate the effects of compaction energy on pervious concrete void ratio, compressive strength, tensile strength, unit weight, and freeze thaw durability. Laboratory results show that compaction energy affects pervious concrete compressive strength, split tensile strength, unit weight and freeze-thaw durability.

2.2 Biji .U.I 1 etal (2004): The paper determines the possibility of achieving maximum compression strength and permeability in concrete by replacing fine aggregate with coarse aggregate and cement along with the addition of admixture in order to increase the permeability of concrete. In this study, the pervious concrete is obtained by removing the fine aggregate wholly (0%) and partially as 10% and 20% replacing the coarse aggregate. From the results, we came to know that, the mix M3 with 20% fine aggregate yields good compressive strength and flexural strength. The permeability rate is higher for mix M1 with 0% fine aggregate. The mix M2 with 10% fine aggregate yields good compressive strength and flexural strength.

2.3 K. Nagababu, E. V. RaghavaRao, D. Satheesh (2005): This paper explains in detail about the use of pervious concrete as pavement material. In this study, we considered mix proportion of pervious concrete from

reference mix of M40 in that by changing the fine aggregate content to 0-18% by replacement method. i.e. the fine aggregate volume is replaced by coarse aggregate volume in mix proportion, there will be no change in volume of aggregate hence we had difficulty in finding volume of cement paste occupying volume of voids, because volume of aggregate and volume of cement paste will be constant in proportions, therefore we found relationship of varying fines with permeability, porosity(without cement paste), failure load and compressive strength. As it satisfies the criteria of using it of sub-base for concrete pavement as permeable and dry lean concrete sub base.

3. MATERIALS USED

In the present investigation the following materials were used

i. Ordinary Portland Cement of 43 Grade cement conforming to IS: 8112-1989
ii. Fine aggregate and coarse aggregate conforming to IS: 2386-1963.
iii. Water

3.1 CEMENT

Ordinary Portland Cement of 43 Grade of brand name BIRLA-A1 Company, available in the local market was used for the investigation. Care has been taken to see that the procurement was made from single batching in air tight containers to prevent it from being effected by atmospheric conditions. The cement thus procured was tested for physical requirements in accordance with IS: 8112-1989. The physical properties of the cement are listed in Table –3.1

SL-NO	PROPERTY	VALUES OBTAINED	REQUIREMENTS AS PER IS: 8112-1989
1	Specific gravity	3.12	Not less than 2.50
2	Fineness (%)	3%	Not greater than 10%
3	Normal consistency	33%	----------
4	Initial setting time (min)	45 min	Not less than 30 min
5	Final setting time (min)	370 min	Not more than 600 min

3.2 Natural Coarse Aggregate

The coarse aggregate used in the experiment is 20mm .The physical properties for procured aggregate have been evaluated as per IS: 2386-1963. The obtained results are presented in Table3.2.

Table 3.2: Physical Properties of Natural Coarse Aggregate

SL.NO	PROPERTY	VALUES OBTAINED
1	Specific gravity	2.69
2	Water absorption (%)	0.4%
3	Bulk Density(kg/m^3)	1688 kg/m^3

3.3 FINE AGGREGATE

Sand is a natural granular material which is mainly composed of finely divided rocky material and mineral particles. The most common constituent of sand is silica (silicon dioxide, or SiO2), usually in the form of quartz, because of its chemical inertness and considerable hardness, is the most common weathering resistant mineral.

Table 3.2: Physical Properties of Fine Aggregate

SL.NO	PROPERTY	VALUES OBTAINED
1	Fineness modulus	2.4
2	Specific Gravity of fine aggregate	2.55

3.4 Water: Portable water was used for experimental work. The used water is satisfying the requirements of IS: 456-2000.

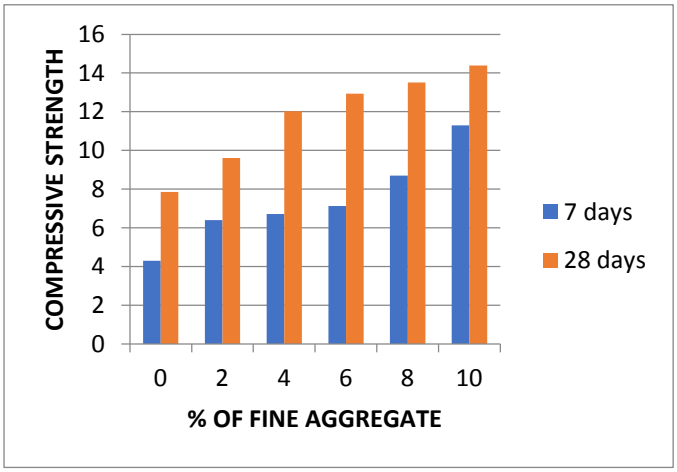
4. RESULTS AND DISCUSSIONS

The compressive strength, split tensile strength and flexural strength test were conducted for pervious concrete. The results obtained for the curing periods of 7 and 28 days

4.1 COMPRESSIVE STRENGTH TESTS

Table 4.1: Final Results of Compressive strength Test

Sl no	% of fine aggregate by the weight of coarse aggregate	Compressive Strength of 7days (N/mm^2)	Compressive Strength of 28days (N/mm^2)
1	0	4.5	7.86
2	2	6.3	9.60
3	4	6.72	12.03
4	6	7.12	12.93
5	8	8.7	13.52
6	10	11.3	14.39



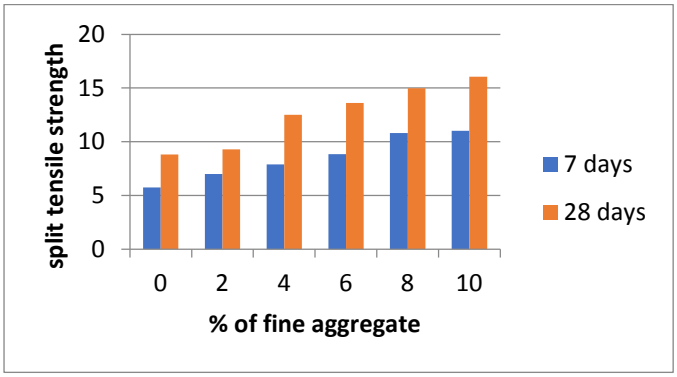
Graph 4.1: comparison of compressive strength Vs % of fine aggregate

By this we conclude that permeability of pervious concrete decrease with increase of sand content and strength of pervious concrete increase by increase in sand content in the compressive strength and at a certain percentage it act as pervious concrete and next it act as normal concrete

4.2 SPLIT TENSILE STRENGTH TEST

Table 4.2 Final results of Split tensile strength

Sl no.	% of fine aggregate by the weight of coarse aggregate	Split tensile Strength of 7days (N/mm^2)	Split tensile Strength of 28days (N/mm^2)
1	0	5.73	8.80
2	2	7.00	9.30
3	4	7.90	12.50
4	6	8.85	13.60
5	8	10.80	14.98
6	10	11.03	16.05



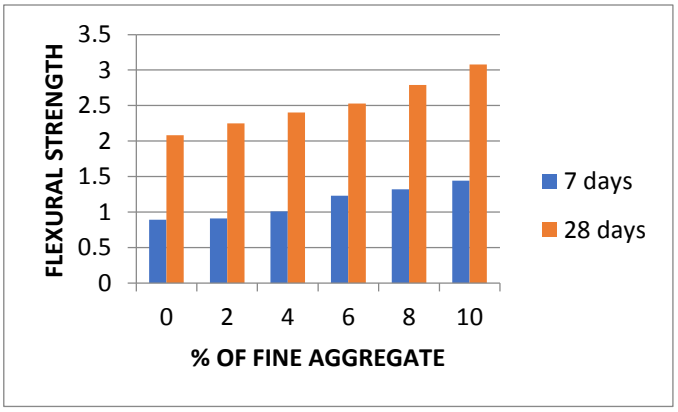
Graph 4.2: comparison of Split tensile strength Vs % of fine aggregate

From this graph we can conclude that permeability of pervious concrete decrease with increase of sand content and strength of pervious concrete increase by increase in sand content in the split tensile strength and at certain point it act as a pervious concrete. In split tensile strength test as get the pervious concrete for some percent sand increases and next if we increases the sand then it act as normal concrete

4.3 FLEXURAL STRENGTH TESTS

Table 4.3 Final results of flexural strength

Sl no.	% of fine aggregate by the weight of coarse aggregate	Flexural Strength of 7 days (N/mm^2)	Flexural Strength of 28 days (N/mm^2)
1	0	0.89	2.08
2	2	0.91	2.25
3	4	1.01	2.40
4	6	1.23	2.53
5	8	1.32	2.79
6	10	1.44	3.08



Graph 7.3: comparison of flexural strength Vs % of fine aggregate

By this we conclude that permeability of pervious concrete decrease with increase of sand content and strength of pervious concrete increase by increase in sand content in the flexural strength

4.4 Permeability test

Permeability of porous concrete for various mixes was determined by using constant head Permeability meter

K= QL/AHt

K = co-efficient of permeability (cm/sec)

Q = volume of water collected in t (sec)

H = head causing the flow (mm)

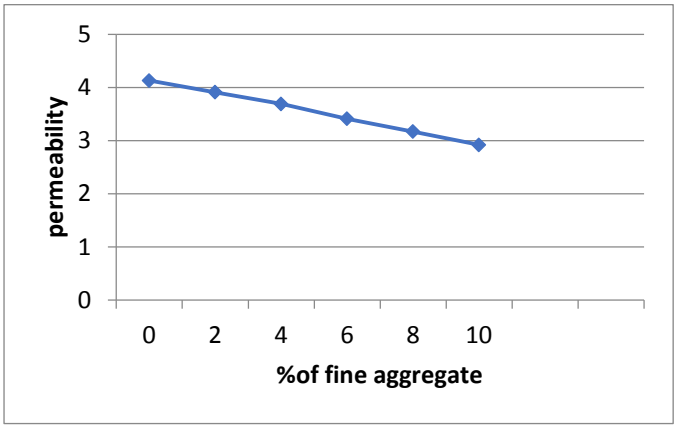
A = cross-sectional area of sample (cm2)

L = height of sample (mm)

t = time in sec.

TABLE 4.4 PERMEABILITY TEST VALUES

Sl no	% of fine aggregate by the weight of coarse aggregate	Co-efficient of Permeability (cm/s)
1	0	4.13
2	2	3.91
3	4	3.69
4	6	3.41
5	8	3.17
6	10	2.92



Graph 4.4: Relationship between sand content and permeability of pervious concrete

By this we conclude that permeability of pervious concrete decrease by increase in sand content. So, that sand content affects strength and permeability of pervious concrete.

5. CONCLUSIONS

I. When the sand content is 10% the compressive strength of the pervious concrete will be more and when the sand content is 0% the compressive strength of the concrete will be less.

II. When the sand content is 10% the split tensile strength of the pervious concrete will be more and when the sand content is 0% the split tensile strength of the concrete will be less.

III. When the sand content is 10% the flexural strength of the pervious concrete will be more and when the sand content is 0% the flexural strength of the concrete will be less.

IV. Thus the experimental study concludes that by increasing the sand content it will increases the strength of the pervious concrete.

V. When the sand content is 0% the permeability will be more and when the sand content is 10% the permeability will be less.

VI. Thus the experimental study concludes that by increasing the sand content it will decreases the permeability of the pervious concrete.

VII. So the sand content affects the strength and permeability of pervious concrete.

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