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EXPERIMENTAL STUDY ON STEEL FIBER-REINFORCED PERVIOUS CONCRETE

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Abstract - *Pervious concrete may be a form of concrete with high porosity. It is used for concrete flatworks application that allows the water to pass through it, thereby reducing the runoff from a site and allowing ground water recharge. The high porosity is earned by a extremely interconnected void content. The mixture is composed of cementitious materials, coarse aggregates and water with minimum or no fine aggregates. Addition of a small amount of fine aggregates will generally reduce the voids content and increases the strength. Generally pervious concrete is used in parking areas, areas with light traffic, residential areas. It is an important application for ground water recharge. The present project deals with the Study of workability and strength characteristics of steel fiber reinforced pervious concrete and To develop the M30 grade of pervious concrete by adopting the IS code method. It has been seen that % supplanting of fine aggregate (5%,10% and 15%) with coarse aggregate and addition of crimped steel fibers (0%,1.5%,and 2%) has acquired greatest quality in serious condition for evaluation M30 are demonstrating increment in compressive strength. So the percentage addition of crimped steel fiber will be 2%, with replacement of fine aggregate by 15% which showed good strength parameters by analyzing the overall results.*

***Key Words*: Concrete, Crimped steel fiber (CSF), Compressive Strength, Normal pervious concrete (NPC), crimped steel fiber (CSFPC).**

1. INTRODUCTION

The term Pervious concrete generally refers to open grain material consisting of little or no fine aggregate. Pervious concrete has different names as no-fines, porous, gap-graded, permeable concrete. Pervious concrete was first used in the 1800s in Europe as pavement surfacing and in India it became popular in 2000. Previous concrete is an open graded structure with interconnected voids through which rain and storm water is permitted to percolate into the aquifer. It consists of cement, coarse aggregate, some percentage of fine aggregate and water with or without admixtures. At the point when pervious concrete is utilized for paving .open-cell structures allow rainwater to enter through the pavement and into underlying soils. It means pervious concrete helps protect the pavement surface and its environment. Pervious concrete has the basic constituents as 15% to 30% of its volume consists of a network of interconnected voids, allowing the water to cross the concrete. Pervious concrete can enable the passage of 0.014 to 0.023 m3 of water per minute through its open cells for each square foot (0.0929 m2) of surface area which is far greater than most rain occurrences. It is also used to eliminate the need for costly retention ponds. Pervious concrete is also a unique and effective way to address important environmental issues and sustainable growth. When it rains, permeable concrete automatically acts as a drainage system, returning water where it has a place. The Pervious concrete has a rough texture, a honeycomb surface. Carefully controlled quantities of water and cementing materials are used to create a paste. The paste then forms a thick layer around the aggregate particles, so that the paste is not hung on the mixture and on placement. Using paste for the particles, maintain a system of interconnected connections for water and air to pass. It also results in a highly permeable concrete that empties quickly

1.1 LITERATURE REVIEW

Mithun Sawant, Daksha Dhande et.al 2017[1]: Pervious concrete is consists of cement, coarse aggregate, some percentage of fine aggregate and water. Pervious concrete is referred as zero-slump concrete. It has a lower compressive strength and therefore cannot be used on roads with heavy traffic. In this thesis, glass fiber is used as a small substitution for cement to increase the strength of Pervious concrete. The cement is partially replaced by glass fibers with a volume of 1%, 1.5% and 2%. A large number of test mixtures are needed to select the desired optimum replacement of the cement with recovered glass fiber.

M. Uma Maguesvari, V.L. Narasimha 2014[3]: This study introduces the impact of variation in cement content on coarse aggregates uniformly classified on the properties of pervious concrete. The materials used are of the type I OPC type and uniformly sized aggregates of sizes between 19.5 mm and 9.5 mm and 9.5 mm and 4.75. The mixes were set up with a w/c ratio of 0.34 and the varying cement content from 200 kg / m3 to 450 kg / m3 by increasing the cement content by 50 kg/m3. Their mechanical properties and their coefficient of permeability were determined using the method of falling head. The relationship between resistance

and permeability with voids is discussed and the optimal mixtures arrived.

B. Miloud 2005[4]: Steel fibers became more popular in recent decades to use in concrete at relatively low volume fractions. They are mainly used to enhance the compressive strength flexural strength and resistance to shrinkage cracking. In this paper, an experimental study is conducted to examine the effects of the addition of steel fibers on the permeability and porosity of concrete made primarily from local concrete materials. The results of the tests are discussed in this paper, the translation of which is accounted for, as well as the conclusions concerning the effects of steel fibers on the water and gas permeability of concrete.

Kiang Hwee TAN, Emiko LAM and Tien Fang FAW[5]: This study examined the use of discrete cross-stitched steel fibers to improve the flexural strength of permeable concrete without compromising permeability and porosity. The target force was 3.6 MPa and the permeability and porosity were 10 mm/sec and 20%, respectively. The incorporation of 1.5% by volume of steel fibers into concrete has proved sufficient to obtain the desired characteristics. Clogging tests carried out with soil residues and construction sand ranging from 600 μm to 1.18 mm showed that permeable concrete was less likely to clog than porous asphalt of the same porosity and that incorporation of steel fibers did not affect the results.

1.2 APPLICATIONS

a. Low-volume pavements

b. Slope stabilization

c. Noise barriers

d. Swimming pool desks

e. Tennis courts

f. Parking area

2. OBJECTIVE OF THE STUDY

1. To develop the M30 grade of pervious concrete by adopting the IS code method, this method is considered the simplest.
2. To Study the workability characteristics of pervious concrete incorporated with and without steel fiber.
3. To Study the strength characteristics of pervious concrete incorporated with and without steel fiber.
4. To study the effect of infiltration rate in pervious concrete incorporated with and without steel fiber.
5. To compare the strength (compressive strength) parameters of normal pervious concrete and steel fiber reinforced pervious concrete by varying % of steel as well as the strength parameters of the pervious concrete with a varying % of fine aggregate.

3. SCOPE OF THE STUDY

The scope of this study is limited to following

1. Design the pervious concrete mix using the IS code-10262:2009
2. To study the workability of steel fiber reinforced pervious concrete at varying % of steel fiber using slump cone test.
3. To determine the compressive strength of pervious concrete incorporated with and without steel fiber by varying % of fine aggregate for 7 and 28 days of curing.
4. To determine the infiltration rate of pervious concrete incorporated with and without steel fiber at 5% of fine aggregate

4. MATERIALS AND METHOD

The study evaluate the effect of addition of Crimped Steel Fibers (0, 1.5, 2%) in concrete. workability of the mix was tested with slump cone test. For evaluating the compressive strength, cubes of standard-size 15cmx150cmx150cm were cast and tested afte7&28 days, and to study the infiltration rate specimen of size 30cm x30cm x10cm were casted The change in these parameters corresponding to the percentage addition of CSF were discussed.

4.1 Materials Used

Cement: - In this project ordinary Portland cement of 43 grade Jk super cement is used in the concrete mix for casting different specimen.

Fine aggregate: - IS: 383-1970, defines the fine aggregate as the aggregate, the most of which will pass the 4.75 mm IS sieve.. Locally available clean river sand is used. The specific gravity of sand is 2.43.

Coarse Aggregate: In This experimental study coarse aggregate passing 20mm and retained on 12.5mm are used. The various test are carried out and results are tabulated as shown below Specific gravity of coarse aggregate was 2.83.

Water: - The strength of concrete depends water cement ratio in a concrete mixture, provided that it is fully compacted and well matured. Water used must be clean, fresh and free from any dirt, unwanted chemicals or rubbish that may affect concrete.

Crimped Steel Fibers: - Steel fibers are obtained of a local industry. Aspect ratio is the most important parameter describing a fiber."Aspect ratio" is that the length of the fiber divided by identical diameter of fiber. Where the equivalent diameter is the diameter of the circle with a surface equal to the transverse surface of the fiber. The properties of fiber

concrete are strongly influenced by the type of fiber. Steel, carbon, asbestos, plant materials, polypropylene and fiber glass have been tried to reinforce the concrete. In this study, round crimped steel fibers about 50 mm in length with an aspect ratio of 50 are used.

4.2. Material Properties

Physical properties of cement are given in below table.

Table.1 Physical properties of cement

S.NO	PROPERTIES	OBTAINED VALUES
1	Fineness	2%
2	Initial Setting Time	32 min
3	Standard consistency	32%
4	Specific gravity	2.66
5	Final Setting Time	580 min

Physical properties of Fine aggregate are given in below table.

Table.2 Physical properties of Fine aggregate

S.NO	PROPERTIES	OBTAINED VALUES
1	Specific gravity	2.43
2	Bulk Density	2112.64 kg/m3
3	Fineness modulus	2.85
4	% Voids	12.75%

Physical properties of Coarse Aggregate are given in below table

Table. 3 Physical properties of Coarse Aggregate.

S.NO	PROPERTIES	OBTAINED VALUES
1	Specific gravity	2.83
2	Fineness	7.75
3	Bulk Density i) Loose State ii) Compacted State	 1752.871kg/m3 2008.96 kg/m3
4	Impact strength	18%

Some of the properties of the crimped steel fibers used in the present experimental work that are supplied by the manufacturer are presented in the table below.

Table.4 Physical properties of crimped steel fibers

S.NO	PROPERTY	VALUES
1	Diameter Equivalent, mm	1
2	Density, kg/m3	7840
3	Tensile Strength, MPa	345 to 3000
4	Young's Modulus. GPa	200
5	Ultimate Elongation, %	4 to 10
6	Thermal Conductivity, 1%	2.74
7	Aspect Ratio	50

4. 3 Mix design

Cement = 437 kg/m3
Fine aggregate = 683.21 kg.
Coarse aggregate= 1012.68 kg.
Water = 197 liters
In other words 1:1.56:2.31, which is in the order of Cement: fine aggregate: coarse aggregate.

4.4 Details of mix proportion (kg/m3)

Table.5 Details of mix proportion (kg/m3 (quantity for one cube)

Specimen	% of FA	Cement (kg)	FA (kg)	CA (kg)	w/c ratio
NPC	5	1.85	0.212	6.91	0.45
	10	1.85	0.425	6.70	0.45
	15	1.85	0.637	6.49	0.45
$CSFPC_1$	5	1.85	0.212	6.91	0.45
	10	1.85	0.425	6.70	0.45
	15	1.85	0.637	6.49	0.4
$CSFPC_2$	5	1.85	0.212	6.91	0.45
	10	1.85	0.425	6.70	0.45
	15	1.85	0.637	6.49	0.45

Description:-

NPC = Normal pervious concrete

$CSFPC_1$ = Crimped Steel Fiber Pervious Concrete cube having 1.5% Fiber.

$CSFPC_2$ = Crimped Steel Fiber Pervious concrete cube having 2% Fiber.

4.5 Quantity estimation and planning of testing work

Table .6 Quantity estimation and planning of testing work

Description	Compressive strength test
Specimen	Cube
Specimen size (mm)	150*150*150
No. of specimen	54
Days of testing	7, 28
Total no. of specimen for one series	6
Volume of each specimen (m3)	0.003375
Volume for all specimen (m3)for one series	0.02025
Specimen	9*6=54

4.6 Tests on Hardened Concrete

Compressive Strength Test:- Compressive strength is defined as the capacity of a material or the structure to withstand axial loads which tend to reduce the size. The moulds are tested under the Compression testing machine of capacity 2000 KN as shown in Fig.1 Mechanical behavior of concrete was studied for M30 grade of concrete, cubes were casted with variation in percentage of Sand and percentage of Crimped Steel fiber and curing is done for 7 days to check c the gain in initial strength of concrete and 28days curing to get the final strength of concrete.

Table 8.Compressive strength after 7 and 28 days of curing.

Specimen	% of FA	7 days strength N/mm²	28 days strength N/mm²
NPC	5	3.29	6.22
	10	4.73	8.45
	15	8.82	12.22
$CSFPC_1$	5	3.74	6.95
	10	5.8	9.07
	15	9.59	13.03
$CSFPC_2$	5	4.48	7.62
	10	6.22	9.69
	15	10.4	14.02

Fig.1 Compressive Strength test

4.7 Infiltration Test:

Table 9. Infiltration rate (in/hr) for 5% of fine aggregate

Specimen	M (lb)	D (inch)	K (inch)	t in sec	I (in./hr)
NPC	22.05	8	126870	13	3362.3
$CSFPC_1$	22.05	8	126870	14	3122.1
$CSFPC_2$	22.05	8	126870	15	2914.0

5. RESULTS AND DISCUSSIONS

In this study, the Strength behavior obtained was studied by measuring Compressive strength after curing period of 7 days and 28 days for specimens.

The results obtained in the study are the tests which were carried on pervious concrete with and without steel fiber which I got by the writing audit of work done previously, In this present study experiment is carried out to bring the correlation between properties of pervious concrete and pervious concrete reinforced with steel fiber and the concrete with in which fine aggregate are used in sure rates

(5%, 10% and 15%) of coarse aggregate total and remaining percentage of fine aggregate is replaced by 20mm downsize coarse aggregate.

A. Graph showing compressive strength of concrete for 7 Days of curing.

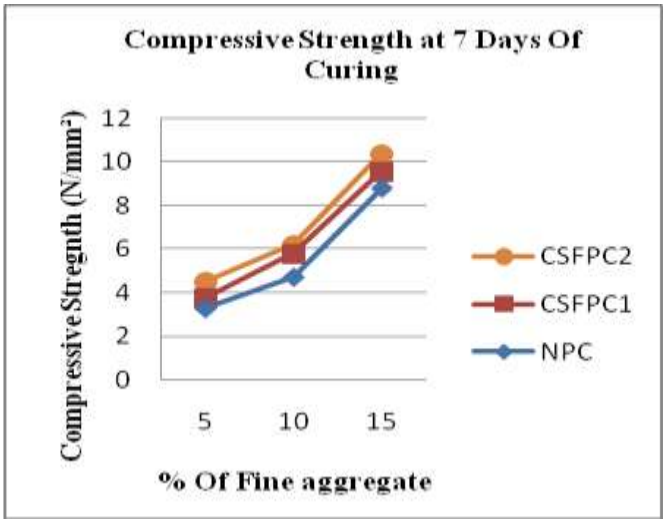

Fig.2 Compressive Strength at 7 Days of Curing

The graph indicate values for the normal pervious concrete and crimped steel fiber reinforced pervious concert for 5% fine aggregate, for 10% fine aggregate and for 15% fine aggregate for 7 days of curing shows increase in percentage of crimped steel fiber the compressive strength of pervious concrete increases because of the increase in crimped steel fiber due to which interconnection between void are reduced**.**

B. Graph showing compressive strength of concrete for 28 Days of curing.

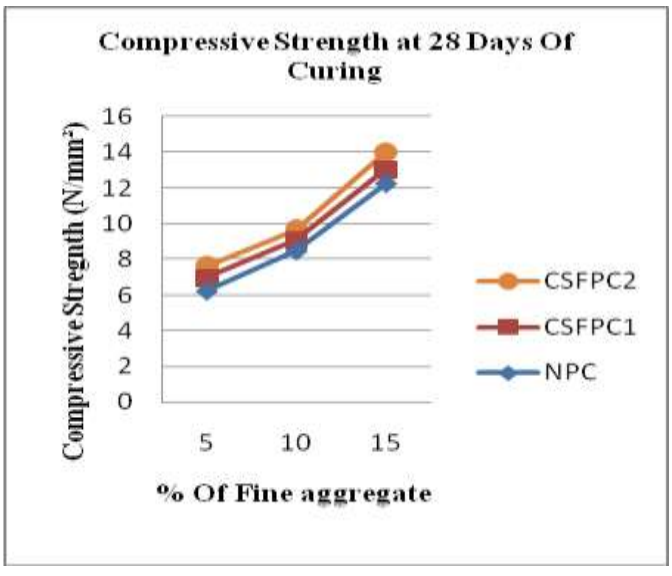

Fig.3 Compressive Strength at 28 Days of Curing

The graph indicate values for the normal pervious concrete and crimped steel fiber reinforced pervious concert for 5% fine aggregate, for 10% fine aggregate and for 15% fine aggregate for 28 days of curing shows increase in percentage of crimped steel fiber the compressive strength of pervious concrete increases because of the increase in crimped steel fiber due to which interconnection between void are reduced.

It has been seen that % supplanting of fine aggregate with coarse aggregate and addition of crimped steel fiber has acquired greatest quality in serious condition for evaluation M30 are demonstrating increment in compressive strength. So the percentage addition of crimped steel fiber will be 2%, which showed good strength parameters by analyzing the overall results.

6. CONCLUSIONS

From the present experimental study on M30 grade of pervious concrete few conclusions are obtained based upon the results which are obtained during the test carried out on pervious concrete

Conclusions

- For The present experimental study, concrete mix has been prepared by utilizing ingredients like cement, fine aggregate, coarse aggregate, crimped steel fiber and water. slump flow test for Pervious concrete with variation in percentages of crimped steel fiber has been carried out and found that the values obtained are within the permissible limits as mentioned in IS code.
- The orkability decreases with an increase of crimped steel fiber percentage with the same W/c ratio.
- The workability decreases with an increase in percentage of fine aggregate with the same W/c ratio.
- The compressive strength of pervious concrete increases with increase in percentage of fine aggregate.
- The compressive strength was found to be increasing with increase in the percentage of crimped steel fiber
- The infiltration rate of concrete was found to decreasing with increase of % of steel fiber

7. SCOPE OF FUTURE WORK

The present experimental study is carried out for compressive strength of cubes and rate of infiltrations in pervious concrete. Definitely there are still many factors of pervious concrete which are must be studied before it is normalized.

The study can be continued by taking into account the following parameters:

- The strength characteristics of previous concrete can be further studied by using some little amount of super plasticizers, by using recycled coarse aggregates in the concrete mix as replacement of coarse aggregates.
- To develop IS code for pervious concrete mix design
- Further studies to review the volumetric changes of concrete structures due to the loss of moisture by evaporation.
- To study binding properties of pervious concrete after incorporating with crimped steel fiber.
- To study effect of the corrosion property of crimped steel fiber on pervious concrete.
- To study stability of pervious concrete.

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