Special Issue on Research and Innovations in Science and Engineering
Volume: 5 Issue: 12s
ISSN: 2454 - 4248
159 - 163

"Strength Improvement of Pervious Concrete by using Polypropylene Fiber"

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Abstract: Pervious concrete is the form of concrete with high porosity. It is used for concrete flatwork application that allows the water to pass through it, thereby reducing the runoff from a site and allowing ground water recharge. The porosity is earned by extremely interconnected voids content. The mixture is composed of cementations materials, coarse aggregate, water with minimum or no fine aggregate. Addition of small amount of fine aggregate will generally reduce the voids content and increase the strength. Generally pervious concrete is used in parking area, area with light traffic, residential area. It is important application for ground water recharge. The present project deals with the study of workability and strength of characteristics of polypropylene fiber reinforced pervious concrete. To develops the M20 grade of pervious concrete by adopting a IS code method. It will been seen that % addition of polypropylene fiber (0.2%, 0.4%, 0.6%) has acquired greatest quality for evaluation of M20 grade are demonstrating increase in compressive strength. So the % addition of polypropylene fiber will be 0.2%, 0.4% and 0.6% with replacement of cement by which showed the good strength parameter by analyzing the overall results.

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Introduction: Pervious concrete is a mixture of gravel or granite stone, cement, water, little to no sand (fine aggregate). When pervious concrete is used for paving, the open cell structure allows Strom water to filter through the pavement and into the underlying soils. In other words, pervious concrete helps in protecting the surface of the pavement and its environment. Pervious concrete has the same basic constituents as conventional concrete that is 15% - 30% of its volume consists of interconnected void network. This allows water to pass through the concrete. High range water reduce and thickening agent are introduced in the concrete to improve its strength and workability. It can allow the passage of 0.014- 0.023 m3 of water per minute through its open cells for each 0.0929 m2 of surface area which is far greater than most rain occurrences. Pervious concrete pavement have become popular as an effective Strom water management tool to reduce the volume of storm water runoff and concentration of pollutant. It is used at parking areas, low traffic areas, pedestrian pathway etc., because of its attractive storm water mitigation capabilities, and also in other applications. Apart from this, pervious concrete may be used as a well concrete in structure application for light weight or better thermal insulation, surface course for parking lots, tennis courts, zoo areas, stalls etc., and for greenhouse floors to keep the floor free of standing water.

Application

1)Low volume traffic pavement.
2)Side walk and pathways
3)Parking areas
4)Driveways
5)Tennis courts
6)Swimming pool decks

Materials used:

1)Cement: Ordinary Portland cement (53 grade)
2)Fine aggregate: Nil
3)Coarse aggregate : Locally available coarse aggregate passing 20 mm and retained on 12 mm Is sieve are used, having specific gravity 2.74, complying with Is 383-1970 was used.
4)Water: The Strength of concrete depends water cement ratio in concrete mixture, provided that it is fully compacted and well matured. Water is used must be

ISSN: 2454 - 4248
105 - 108

clean, fresh and free from any dirt, unwanted chemicals that may affect concrete.
5)Polypropylene fiber: 33 micron (6 denier), 12mm length

Mix design
Mix design for M20 grade concrete
Reference – IS 10262: 1982 and IS 10262:2009 & various papers of mix design of pervious concrete.

Design Stipulations:
•Characteristics compressive strength = 20N/mm
•Max. Size of coarse aggregate = 12.5mm
•Degree of quality control = Good
•Min. Cement content = 320kg/m3 (IS- 456)
•Max. W/c ratio = 0.6

Table : Summary of concrete Mix Design

1	Characteristic compressive strength	20 N/mm
2	Degree of quality control	Good
3	W/C ratio	0.32
4	Type of cement	OPC
5	Nominal size of course aggregate	12.5 mm
6	Specific gravity of cement, Sc	3.15
7	Specific gravity of course aggregate, Sca	2.78
8	Water content per m3 of concrete	151.87 kg/m3
9	Cement content for W/C 0.32	474.61 kg/m3
10	Total coarse aggregate per m3 of concrete, Ca	1964.07Kg/m3
11	Mix proportion	01:04.1

Mix proportion = 1: 4.14 with W/C ratio 0.32

Investigation program: During the investigation, they have casted cubes, beams & cylinders of concrete with polypropylene fibre added to the weight of cement to check the compressive and flexural strength of concrete and permeability of concrete. The varying percentages of polypropylene fibers were used as 0.2%, 0.4%, and 0.6% to the weight of cement.

As they have to check properties of pervious concrete when polypropylene fibers are added to the weight of cement, two types of concrete were used in this experiment.

- Normal pervious concrete
- Fiber reinforced pervious concrete

Table : Details of Casting

No.		Description	Number of Cubes			Total
			For 7th day test	For 14th day test	For 28th day test	
1	Cubes	Normal Pervious Concrete	3	3	3	9
2		0.2% PP fiber	3	3	3	9
3		0.4% PP fiber	3	3	3	9
4		0.6% PP fiber	3	3	3	9
		Total No of cast	12	12	12	36
5	Cylinder	Normal Pervious Concrete	0	0	3	3
6		0.2% PP fiber	0	0	3	3
7		0.4% PP fiber	0	0	3	3
8		0.6% PP fiber	0	0	3	3
		Total No of cast	0	0	12	12

Test:
Compressive strength of pervious concrete:

Compressive strength of a concrete is a measure of its ability to resist static load, which tends to crush it.

ISSN: 2454 - 4248
159 - 163

Most common test on hardened concrete is compressive strength test' It is because the test is easy to perform. Furthermore, many desirable characteristic of concrete are qualitatively related to its strength and the importance of the compressive strength of concrete in structural design. The test is carried out on the cube specimen. Cast iron molds are used to cast the cubes having leak proof metal base plate. The joints between the sections of the mould are thinly coated with the mould oil to prevent adhesion of concrete to the mould surface.

Flexural strength of pervious concrete:
Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 150 x 150 mm concrete beams with a span length at least three times the depth. The flexural strength is expressed as Modulus of Rupture (MR) in psi (MPa) and is determined by standard test methods ASTM C 78 (third point loading). Flexural MR is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used. However, the best correlation for specific materials is obtained by laboratory tests for given materials and mix design.

Permeability test of pervious concrete by constant head method:

Permeability of pervious concrete can be calculated by using following equation k = VL/Aht
Where, K = Coefficient of permeability V = Collected volume of water
L = Length of pervious concrete column
A = Area of the pervious concrete column h = Head difference
t = Time required to get V volume

RESULTS
Workability of Pervious Concrete:
There are no fine aggregates in pervious concrete. Pervious concrete is also called as zero slump concrete since it has zero slump.

P fiber percentage	Slump (mm)
Normal pervious concrete	0
0.2% PP Fiber	0
0.4% PP Fiber	0
0.6% PP fiber	0

Compressive strength: It was observed that there was increase in compressive strength with increase in percentage of polypropylene fibers. The result of compressive strength test is shown below.

Table : Results of compressive strength

Batch	7 Days	14 Days	28 Days	% Increase
Normal pervious concrete	7.77	8.44	13.43	-
0.2 % PP fiber	9.93	11.23	14.56	8.41
0.4% PP fiber	12.84	13.20	17.42	29.70
0.6% PP fiber	12.89	13.67	18.95	41.10

ISSN: 2454 - 4248
105 - 108

Flexural strength:It was observed that there was increase in Flexural strength with increase in percentage of polypropylene fibers.

Table : Results of Flexural strength

Batch	28 Days	% Incense
0% fiber	7.77	-
0.2% fiber	9.38	17.16
0.4% fiber	11.02	29.50
0.6% fiber	12.10	35.78

Permeability test of pervious concrete by constant head method: It was observed that there was decrease in permeability with increase in percentage of polypropylene fibers. The result of permeability test is shown below.

Table : Discharge of Permeability

specimen	10 sec	20 sec	30 sec
Normal pervious concrete	380	750	1150
0.2% fiber	370	730	1135
0.4% fiber	350	710	1120
0.6% fiber	320	700	1110

• Sample calculations k = VL/Aht
Where, K = Coefficient of permeability V = Collected volume of water
L = Length of pervious concrete column = 15 cm
A = Area of the pervious concrete column = 88.331 cm2 h = Head difference = 120 cm
t = Time required to get V volume k = VL/Aht
= 380*15/ (88.331*120*10)
= 0.053 cm/sec

Table : Average Coefficient of Permeability of Pervious Concrete

Specimen	Average coefficient of permeability (K)
Normal pervious concrete	0.053
0.2% fiber	0.052
0.4% fiber	0.050
0.6% fiber	0.048

ISSN: 2454 - 4248
159 - 163

Conclusion

1. The following conclusions are made from the study on properties of pervious concrete with the replacement of cement by 0.2%, 0.4% and 0.6% of polypropylene fiber.
2. The use of polypropylene fiber in pervious concrete enhances the bonding between the coarse aggregate and cement paste.
3. Higher content of polypropylene fiber in pervious concrete decreases workability of concrete.
4. Increment in compressive strength , flexural strength of pervious concrete when compare with similar normal pervious concrete mix.
5. The coefficient of permeability decreases with increase in % PP fiber. Future scope:
6. Pervious concrete can be used as pavement or pathway in high rise apartment to increase the ground water and also it can be used in the side of highway pavement to save runoff water.
7. Implementation of pervious concrete in village road can be very useful in Strom drainage system and storing of Strom water for agriculture.
8. Implementation of these road for Indian conditions is very essential for a beneficial town planning with efficient collection system for runoff water.
9. By using efficient collection system in apartment and high rise building to save the water problems.

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