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Enhancement of pervious concrete properties by using polypropylene fiber

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ABSTRACT- Pervious concrete is a composite material consisting of coarse aggregate, Portland cement, and water. It is different from conventional concrete in that it contains no fines in the initial mixture. The aggregate usually consists of a single size and is bonded together at its points of contact by a paste formed by the cement and water. The result revealed that interconnecting voids in the concrete are increases which permit the rapid percolation of water through the concrete. In this manuscript polypropylene fiber are utilized in pervious concrete at 0.2, 0.4 and 0.6%. It was observed that compressive strgneth has been enhanced by 21.87% with addition of 0.6% PP. The flexural and split tensile strength boosts by 10.79 % and 35.78% respectively. The coefficient of permeability decreases with increase in % PP fiber. Compared to conventional concrete, pervious concrete has a lower compressive strength, higher permeability, and a lower unit weight, approximately 70% of conventional concrete.

Keywords: Pervious Concrete, polypropylene fiber, coefficient of Permeability, compressive strength, split tensile Strength, flexural strength.

INTRODUCTION

Pervious concrete has been implemented in Europe firstly. In the 19th century pervious concrete was employed in a variety of applications such as prefabricated panels, load bearing walls, and paving [1-3]. In the United Kingdom in 1852, two houses were constructed using gravel and concrete [4]. Pervious concrete is advantageous for a number of reasons are its increased permeability compared with conventional concrete [4-7]. Pervious concrete shrinks less, has a lower unit weight, and higher thermal insulating values than conventional concrete [8-11]. Although advantageous in many regards, pervious concrete has limitations that must be considered when planning its use [12-14]. Pervious concrete characteristics differ from conventional concrete in several other ways. Compared to conventional concrete, pervious concrete has a lower compressive strength, higher permeability, and a lower unit weight, approximately 70% of conventional concrete. To improve the mechanical properties of pervious concrete polypropylene fiber is being added.

Figure 1. Pervious concrete

Figure 2. Conventional Concrete

To develop preliminary specifications for high quality pervious concrete suitable for use in Maryland State Highway Administration (SHA) projects. The study utilized aggregates that are used in SHA projects and the durability studies that were conducted assumed Maryland weather conditions. Investigations were conducted to enhance the structural and durability characteristics of pervious concrete through the use of different admixtures. Application of Pervious Concrete as a new era for rural road pavement. Pervious concrete is a relatively new concept for rural road pavement, with increase into the problems in rural areas related to the low ground water level, agricultural problem. Pervious Concrete samples with void ratios ranging from 15% to 20% have 7-day compressive strengths of about 3,000 psi and permeability of about 300 in. /hr.; both values have been shown suitable for pervious concrete applications. Our studies show that samples with 15% to 20% voids have unit weights around 129 pcf, which suggests the development of a unit weight QC/QA check to be promising. The construction technology of PCPC is evolving, but the correlation between laboratory and field placement will allow standard QC/QA checks to be developed for producing permeable, strong, durable, and long-lasting pervious concrete. Characterization of Pervious Concrete for Pavement Applications" they stated the influence of fine aggregate and coarse aggregate quantities on the properties of pervious concrete. "Pervious Concrete Pavements" has explain concrete as a paving material has seen renewed interest due to its ability to allow water to flow through itself to recharge groundwater and minimize storm water runoff. This introduction to pervious concrete pavements reviews its applications and engineering properties, including environmental benefits, structural properties, and durability. Both hydraulic and structural design of pervious concrete Pavements are discussed, as well as construction techniques.

METHODOLOGY

Casting of members is done same as Conventional Hand placing. And all members are casted at same time in three layers.

Fig.3. Mixing of polypropylene fiber in concrete

Method of curing: Curing of concrete done by covering the concrete surface by plastic up to7 days, and then after immersed in curing tank, in which all concrete cubes, beams and cylinders are placed for different period of curing, like 14 days, 21 days and 28 days.

Figure 4. Curing of concrete

Material and grade of concrete mix:-

Grade of concrete: - M20

Following are the materials used in concrete mix:-

- Cement: - OPC 53 grade
- Course Aggregate: - 12.5mm sized crushed angular aggregate.
- Fine aggregate :- nil
- Polypropylene fibers-33micron(6 denier), 12mm length
- Admixture- Super Plasticizer: conplast SP 430 (Accelerator)
- Water :- Normal potable water

Table no.1. Quantity of Materials per Cubic Meter of Concrete Grade M20.

Material	Weight (Kg/m^3)
Cement	474.61
Coarse Aggregate	1964.07

Water	151.875
Admixture	4.75
W/C ratio	0.32

During this investigation cubes, beams & cylinders of concrete were casted with polypropylene fibre added to the weight of cement to check the compressive, flexural and split tensile strength 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. Cubes were casted to test after 7, 14, 21, 28 days and beams, cylinder were casted to test after 28 days. For convetional pervious concrete and pervious concrete with polypropylene fibre.

RESULTS AND DISCUSSIONS

Pervious concrete is known as zero slump concrete since it has no fine aggregates.

Compressive strength

To find the strength of concrete test is conducted on cube of size 150 x 150 x 150 mm.

Fig. 5. Compressive strength test

It was observed that there was increase in compressive strength with increase in percentage of polypropylene fibers. Highest compressive strength test found to be 19.75 N/mm^2 for 28 days. By addition of 0.6 % polypropylene fibers around 21.87% compressive strength enhanced as compare to normal pervious concrete. Figure 6, elaborates compressive strength for 7, 14, and 28 days respectively.

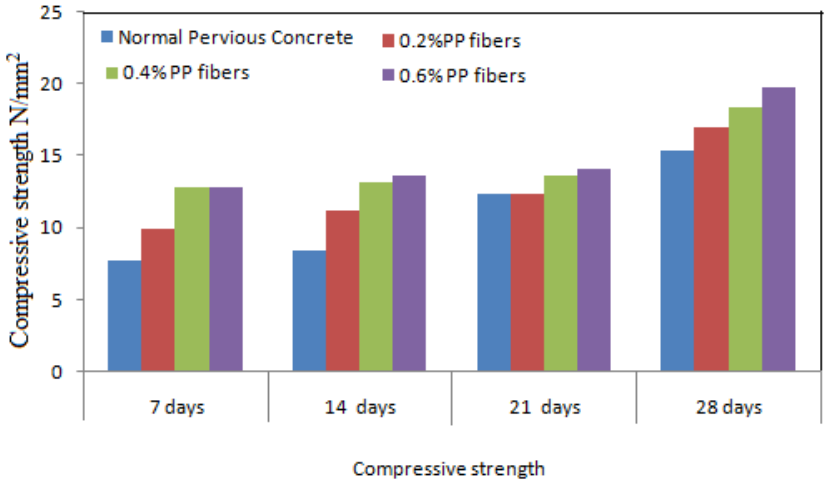

Fig. 6. Compressive strength

Split tensile strength

Split tensile strength conducted on cylinder of dia.150 mm and 300 mm length

Fig.7. Split Tensile strength test

It was observed that there was increase in Split tensile strength with increase in percentage of polypropylene fibers. Fig. 8 represents results of Split tensile strength. Split tensile strength found to be 10.79 % increased as compare to normal pervious concrete.

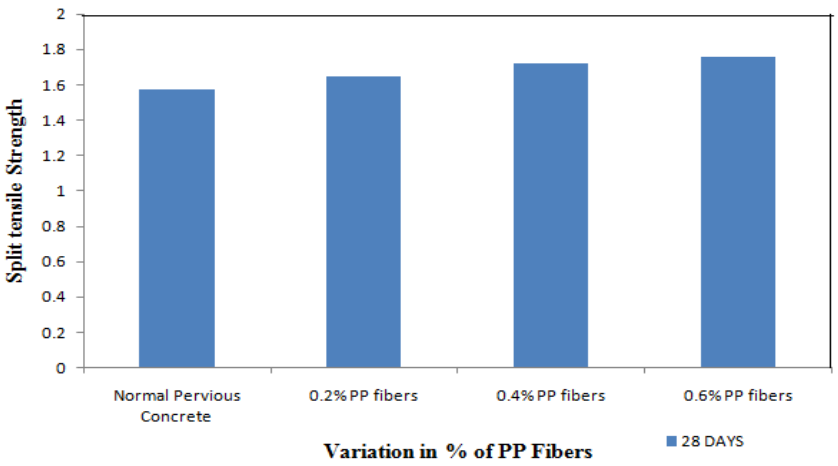

Fig. 8.Comparative split tensile strength of different PP fibre %

Flexural strength

Test was performed on beam of size 100 mm x 100 mmx 500 mm.

Fig. 9. Flexural Strength Test

It was observed that there was increase in Flexural strength with increase in percentage of polypropylene fibers. The result of Flexural strength test is shown in fig. 10. Around 35.78% flexural strength enhanced due to addition of 0.6 % polypropylene fibers. Figure also elaborates the variation of percentage polypropylene fibre and flexural strength variation.

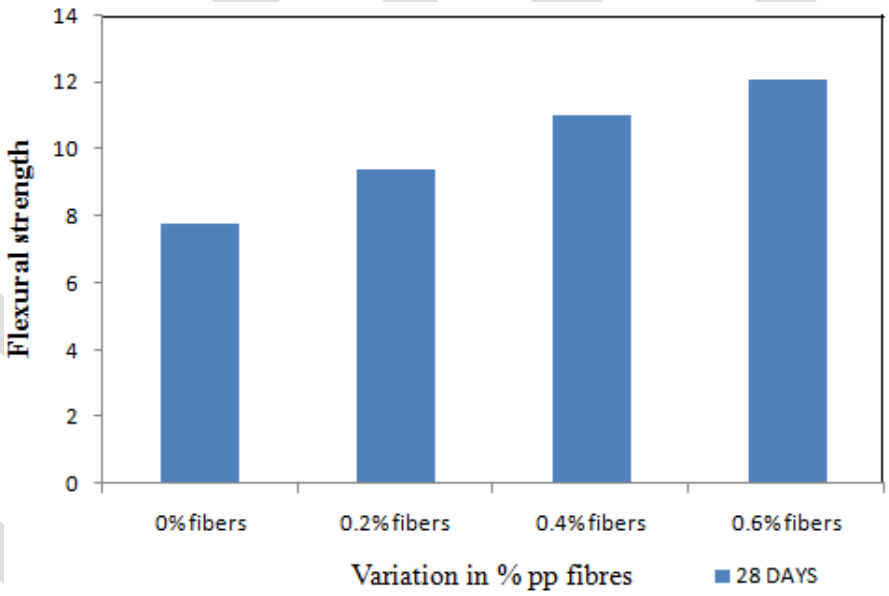

Fig. 10. Flexural Strength

Permeability Test of Pervious Concrete by Constant Head Method

Fig. 11. Permeability Test moulds

It was observed that there was decrease in permeability with increase in percentage of polypropylene fibers. The result of permeability test is shown in fig. 12.

$$K = \frac{V x\ L}{A\ x\ H\ x\ t}$$

$$Where, K\ =\ Coefficient\ of\ permeability$$

$$V\ =\ Collected\ volume\ of\ water$$

$$L\ =\ Length\ of\ pervious\ concrete\ column\ =\ 15\ cm$$

$$A\ =\ Area\ of\ the\ pervious\ concrete\ column\ =\ 88.331\ cm2$$

$$H\ =\ Head\ difference\ =\ 120\ cm$$

$$t\ =\ Time\ required\ to\ get\ V\ volume$$

$$k\ =\ VL/AHt$$

$$=\ 380 * 15/(88.331 * 120 * 10)$$

$$=\ 0.053\ \ cm/sec$$

Table 2. Coefficient of Permeability

Specimen	Average coefficient of Permeability (K)
Normal pervious concrete	0.053
0.2% pp fibers	0.052
0.4% pp fibers	0.050
0.6% pp fibers	0.048

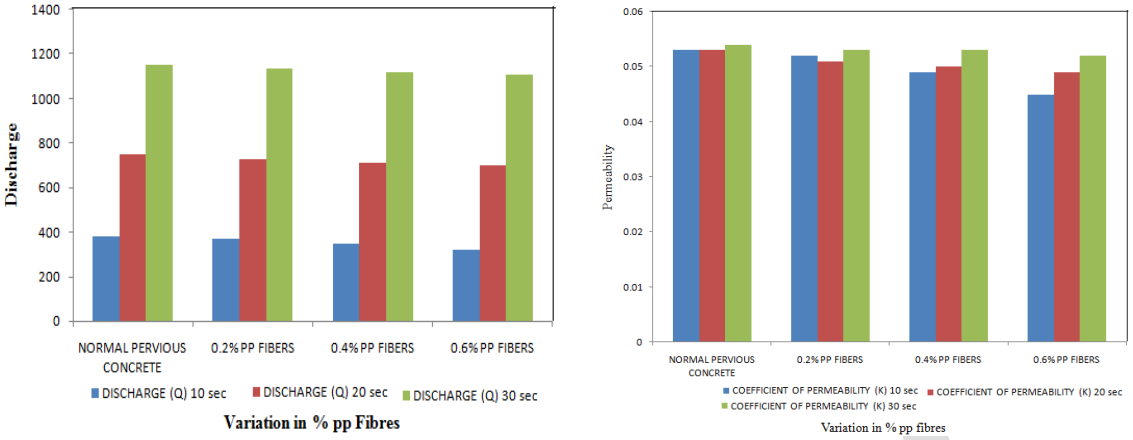

Fig. 12. Permeability test

CONCLUSION

- The utilization of polypropylene fiber in pervious concrete boosts the bonding among the coarse aggregate and cement paste.
- Workability of concrete reduces, due to higher content of polypropylene fiber in pervious concrete.
- It was observed that, there was percentage increase in compressive strength, flexural strength and split tensile strength of pervious concrete using polypropylene fiber in pervious concrete at various percentages 0.2%, 0.4% and 0.6%.
- It was observed that, the coefficient of permeability decreases with increase in % polypropylene fiber.

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