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Enhancing the Strength of Pervious Concrete Using Polypropylene Fibre

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ABSTRACT: Pervious concrete pavement is an effective means to address important environmental issues and support green and sustainable growth. By capturing storm water and allowing it to seep into the ground, pervious concrete is instrumental in recharging ground water, reducing storm water runoff, and meeting U.S. Environmental Protection Agency (EPA) storm water regulations. Infact, the use of pervious concrete is among the Best Management practices recommended by EPA. This report provides the information obtained from a literature search, site visits, and a laboratory study of Polypropylene Fibres in pervious concrete. The literature search yielded information from numerous laboratory studies of the material properties of Polypropylene Fibres reinforced concrete (PFRC). The literature showed that, for the low fibre volumes recommended by most manufacturer, there was marginal improvement in toughness, fatigue, Impact resistance, permeability, shrinkage and wear resistance. Limited construction has taken place on PFRC suitable for airport construction. Most construction has been of slabs on grade and structural slabs. The laboratory study showed that, at 0.15 % of volume of fibres, the reinforced concrete enhances the strength of pervious concrete.

KEYWORDS: Pervious concrete, Polypropylene fibers, Compressive strength, Ground water recharge.

I. INTRODUCTION

Pervious concrete is a special concrete that contains continuous voids which are intentionally incorporated into concrete, allows water from precipitation and other sources to pass through, which in turn reduces the runoff from a site and recharging ground water levels. Porous concrete also called pervious concrete, no-fine concrete, gap graded concrete, enhanced porosity concrete is a micro-porous concrete. Urbanization and the resulting increase in urban storm water led to an increase in runoff and pollution. The natural process of rainfall infiltration has been diverted and decreased. Decreasing the infiltration rate causes deduction in recharging groundwater which has led to a number of environmental concerns, decreasing the base flow in streams and drying up of small streams.

Pervious concrete is made by omitting the fine aggregate from the concrete mixture. Porous concrete can be used in numerous applications such as permeable concrete for pavement, base course, concrete bed for vegetation or living organism, noise absorbing concrete, thermal insulated concrete and other civil engineering and architectural applications. Porous concrete is made of attached single-size aggregate by Portland cement. Aggregate is the main part of the concrete volume. Chemical properties of porous concrete are similar to the dense concrete. In porous concrete sufficient paste, which is created by controlled amounts of water and cementation materials, coats and binds the aggregate particles and create a highly permeable and well drained system. Since the aggregate strength is usually high, the strength of the thin paste around the aggregate particles and the strength of the interface between the aggregate and the paste are relatively weak. The pervious concrete strength therefore depends primarily on the properties of the paste and the interface between the paste and the aggregate. Optimum range of water cement ratio for both strength and permeability point of view ranges from 0.28 to 0.40. High range Water reducer and thickening agent are introduced in the concrete to improve its strength and workability. Pervious concrete, three components must be improved, the strength of the paste, the paste thickness around the aggregate, and the interface between the aggregate and the paste.



II. REVIEW OF LITERATURE

Darshna shah, Prof. Jayeshkumar Pitroda and Prof. J.J. Bhavsar published a research paper “Pervious Concrete: New Era for Rural Road Pavement” in 2013. Object of the study was to evaluate the cost effectiveness of the pervious concrete compared to normal concrete. In this study, Normal concrete was used as per IS design of M20 grade, which was constituted by 59.25 kg of cement (300rs/50kg), 88.88 kg of Fine aggregate (600rs/1 ton) and 177.8 kg of coarse aggregate (1000rs/1ton). Pervious concrete was used as per NRMCA guideline, which was constituted by 46.5 kg of cement (300rs/50kg) and coarse concrete (1000rs/1ton). They conclude that the pervious concrete reduce the storm water runoff to increase the ground level water to eliminate the costly storm water management practices. And there is considerable saving in amount about 29rs/m³ or 18rs/ft².

Maguesvari M.U. and Narshima V.L., (2013) have Studies on characterization of pervious concrete for pavement application. The study gives a preliminary idea about the influence of fine aggregate and coarse aggregate on the properties of pervious Concrete. The raw materials used are OPC type-1 and fine aggregate size between 4.75 -9mm , 9-12.5 mm, 12.5 16 mm, 16-19.5 mm . The mixes were made by maintaining water cement ratio of 0.34, cement content is 400 kg/m³ and aggregate cement ratio is 4.75:1. The study concluded that, the compressive strength is noted 10-26 N/m² when the angularity number varied from 8 to 4. Similarly coefficient of permeability increases form 0.4 cm/sec to 1.26 cm/sec when the angularity number is in the range of 4 to 8

Husain N Hamdulay, Roshni J. John and D R Suroshe published an experiment in 2015 named „Effect of Aggregate Grading and Cementitious by Product on Performance of Pervious Concrete“. Object of the study was to replace the cement with industrial by-product such as fly ash, GGBFS which have been used successfully as supplementary Cementous material. In this study, cement of 53 grade (specific gravity 3.15), coarse aggregate (passed through 20 mm and retained on 10 mm sieve), GGBFS (specific gravity 2.88), fly ash and water are used. Now maintaining the W/C ration constant, following mix proportions are used. FA are used in 85:15 and 65:35 proportions and GGBFS are used in 75:25 and 50:50 proportion. They concluded that the compressive strength of concrete was increased by using GGBFS as supplementary material and grading of aggregate is equally important to get strength and permeability, grater size have law compressive strength and high permeability vice versa.

III. METHODOLOGY

The steps followed while designing:

- 1 preparation of specimen
- 2 compressive strength test
- 3 permeability test
- 4 void ratio
- 5 density

1 specimenspecifications:

Experimentation involved the study of flexural strength of concrete cubes after expose to atmospheric temperature.

The mix proportion of 1:3.5 concrete cubes were tested.

Size of TestSpecimens-

For cube test two types of specimens either cubes of 15cm ×15cm ×15cm or 10cm×10cm×10cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15cm×15cm×15cm are commonly used. The size of specimen is 150×150×150 (all dimension in mm).

Moulds-



Fig.1 Compressive Strength testing mould

2 Compressive strength test:

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently. Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures.

The specimen after a fixed curing period of 7 days, 14 days and 28 days were tested for compressive strength in compressive testing machine (UTM). The specimen is placed on bearing surface of the testing machine and compressive load was applied on opposite face axially and slowly at the rate of 5.2KN/sec.





Fig.2 Universal Testing Machine

In pervious concrete we are performing two conditions as;

- A. Without polypropylene fibres.
- B. With polypropylene fibres (x % of weight of one cube)

3. Permeability test results:

The property of the concrete which permits water (fluids) to percolate through it continuously connected voids is called its permeability.

We check the permeability of plain pervious concrete cube. **1000 ml** water which is passed through the voids of the plain pervious concrete cube and the water is retained to another pan that stored water measures it is 860 ml.

1. The permeability of 0.05% of polypropylene fibre mixed pervious concrete cube. 1000 ml water which is passed through the voids of the polypropylene fibre mixed pervious concrete cube and the water is retained to another pan that stored water measure 860ml.
2. The permeability of 0.10% of polypropylene fibre mixed pervious concrete cube. 1000 ml water which is passed through the voids of the polypropylene fibre mixed pervious concrete cube and the water is retained to another pan that stored water measure 870ml.
3. The permeability of 0.15% of polypropylene fibre mixed pervious concrete cube. 1000 ml water which is passed through voids of the polypropylene fibre mixed pervious concrete cube and the water retained to another pan that stored water measure is 890ml.
4. The permeability of 0.20% of polypropylene fibre mixed pervious concrete cube. 1000 ml water which is passed through the voids of the polypropylene fibre mixed pervious concrete cube and the water is retained to another pan that stored water measure 900ml.

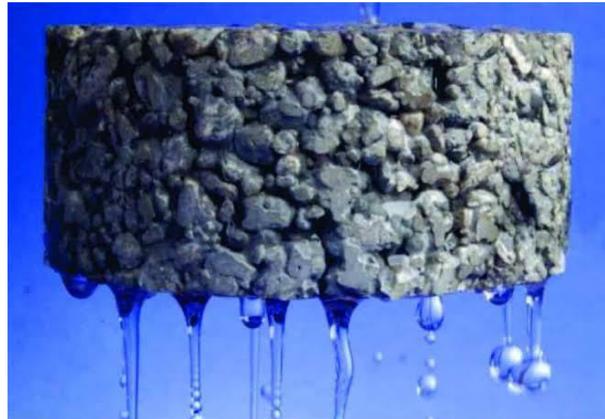


Fig.3 Permeability testing on pervious concrete patch

4. Void ratio

The void content was evaluated based on ASTM C1688 [5]. The void content is defined as total percentage of voids available by volume in specimen. The void content of the pervious concrete is determined by using equation.

$$\text{Void content (\%)} = \{(T - D)/T\} \times 100$$

$$\text{Where, } D = (M_c - M_m)/V_m \text{ (Density)}$$

$$V_s = \text{Total absolute volume of materials}$$

$$V_m = \text{Volume of measure}$$

$$M_m = \text{Net mass of concrete by subtracting mass of measure}$$

$$M_c = \text{Mass of measure filled with concrete}$$

$$T = M_s/V_s \text{ (Theoretical density)}$$

$$M_s = \text{Total mass of material batched}$$

5. DENSITY

The density was determined by ratio of weight of cube to volume of cubes.

$$D = (\text{weight of cube}/\text{volume of cube})$$

V. CONCLUSION

The conclusions from the above study are as follows:

1. Compressive strength test :-The test carried out at 7 days, 14 days and 28 day, the comparison is made between the plain pervious concrete and polypropylene fibre mixed pervious concrete.
2. The use of polypropylene fiber in pervious concrete enhances the bonding between the coarse aggregate and cement paste.
3. Using polypropylene fiber in pervious concrete at 0.2, 0.4 and 0.5% ,It was observed that, there was increment in compressive , flexural and split tensile strength of pervious concrete when compare with similar normal pervious concrete mix.
4. Permeability test..



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