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Experimental study on partial replacement of structural fiber in porous pavements

Prabhanjan Neduri [a,*], Swamy Yadav Golla [a], Sahithi G [a], Sravanthi Bojjam [b], Sravanthi Mamidala [c]

[a] SR University, Ananthasagar, Warangal 506371, India
[b] KITS Warangal, 506015, India
[c] ST Martins College of Engineering, Hyderabad, Telangana 500100, India

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ABSTRACT

Day to Day construction increases rapidly in developing countries like India. Usage of Cement Concrete pavement plays a vital role in carrying heavy traffic means over 10–150 Mean Standard Axles. The design life of the concrete pavement is also high when compared to the bituminous pavement. The maintenance cost for concrete pavements is low. Nowadays porous concrete usage is increasing high. Pervious concrete can be used in pavements to allow rainwater to percolate into the ground and to reduce stormwater runoff and recharge groundwater. Pervious concrete is a new trend of concrete used for flatwork applications with porosity. The present study aims to increase the strength of porous concrete by adding structural fiber as an admixture that can be used for pavements and parking. The results are impressive for the Parking facilities in organizations or any commercial buildings.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Advanced Materials and Modern Manufacturing.

1. Introduction

The basic need in rural areas was providing pavements. Porous concrete pavements were the type of roads constructed in these rural areas as well [11]. Different names of these pavements were Gap graded, Enhanced-Porosity, No-fines, and Permeable concrete. These types of pavements were used for other purposes like sidewalks, parking slots, etc.[12]. These porous concrete pavements consist of zero slumps, Open-graded materials consist of coarse aggregate, cement, admixtures, and water [12]. There are no fine particles or fine aggregate like sand[1]. Severe problems were arising in managing waste management in developing and developed countries[3]. In this situation, there were a lot of requirements for building materials like cement, aggregates. When the ingredients mix with water, it hardened and cured. After the workability of the porous concrete will give sufficient permeability with other mechanical properties of the concrete[2]. Many research works were going on to use the waste materials effectively which are considered environmentally friendly and viable [4,13]. Several research works have been done to make rainwater drain at pavements. Porous concrete pavements were new technologies to drain off and reduce the runoff on pavements. This is a more suitable method of the way compared to the normal concrete pavements [5]. There are no media required to drain. Piping System and Costly stormwater detention were also eliminated [11,12]. This is the best method for roadways even it helped in the reduction of economic, Maintenance and Safety aspects [14]. Because of the unavailability of construction materials in India, these types of pavements would help for reduction the other elements which used in normal concrete pavements[6]. The wide range of applications of the porous concretes were low volume pavements, driveways, residential roads, alleys, sub-base for conventional concrete pavements, tennis courts low water crossings, pathways, parking areas, sidewalks, and slope stabilization, etc[17]. These types of pavements have less unit weight, compressive strength but greater permeability. Based on the user can apply in different places[3]. Because of the unavailability of materials like fine materials, these types of pavements can help[8]. Recent trends were aiming to reduce the consumption of virgin materials and to increase the usage of waste materials[7]. Several experiments were already conducted by using waste materials in the construction of various elements like buildings, roadways, and other types of cement used structures[910]. Ceramic waste, fly ash, silica fume, glass powder, hypo sludge type of materials were already used to increase the permeability and strength of porous concrete[4]. Many recent works were done for the reduc-

* Corresponding author.

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tion of waste and to increase the mechanical and durable properties of porous concrete[4]. Therefore the main objective of this study is to use Structural fiber to increase the structural performance of the pavements and can lead to mechanical properties of the concrete pavements [2,13,14].

2. Objectives of the study

The present study is to increase the strength of porous concrete using structural fiber.

- To increase groundwater recharge.
- Providing Parking facility.
- Decreases in the runoff.
- Reduction in the erosion of soil due to flooding.
- Reduce coastal water and pollution.

3. Methodology

The following figure Fig. 1. represents the flow of work in various stages.

4. Advantages of the proposed system

- It reduces the stormwater runoff.
- Allow more efficient land development.
- Prevent water from entering into the stream and also prevents it from being polluted.
- Recharge of the local aquifer.
- Water budget retention and pollution removal.
- Less need for storm sewers.
- Natural runoff allows rainwater to drain directly to the subbase.

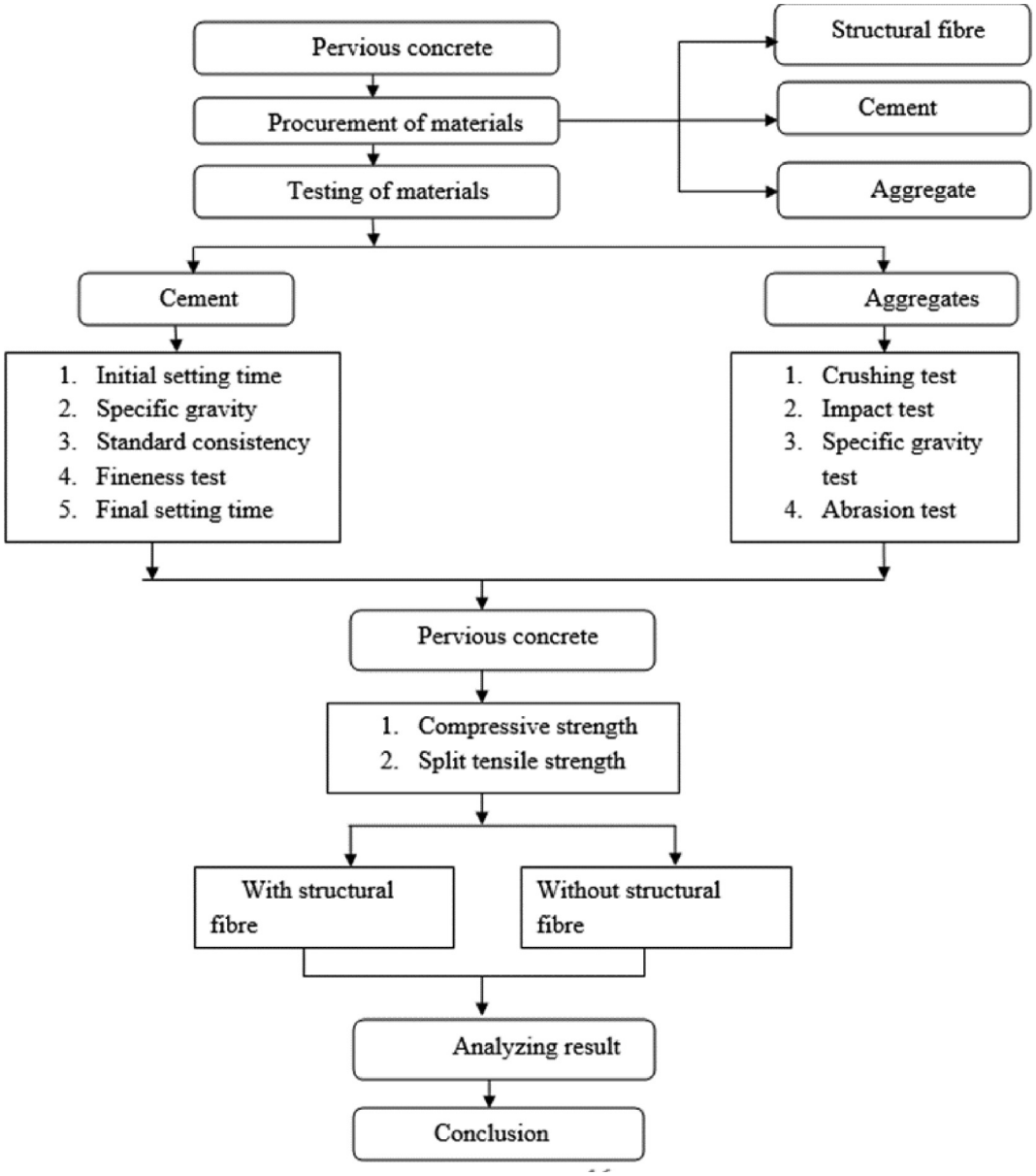

Fig. 1. Methodology Chart for Experimental Work.

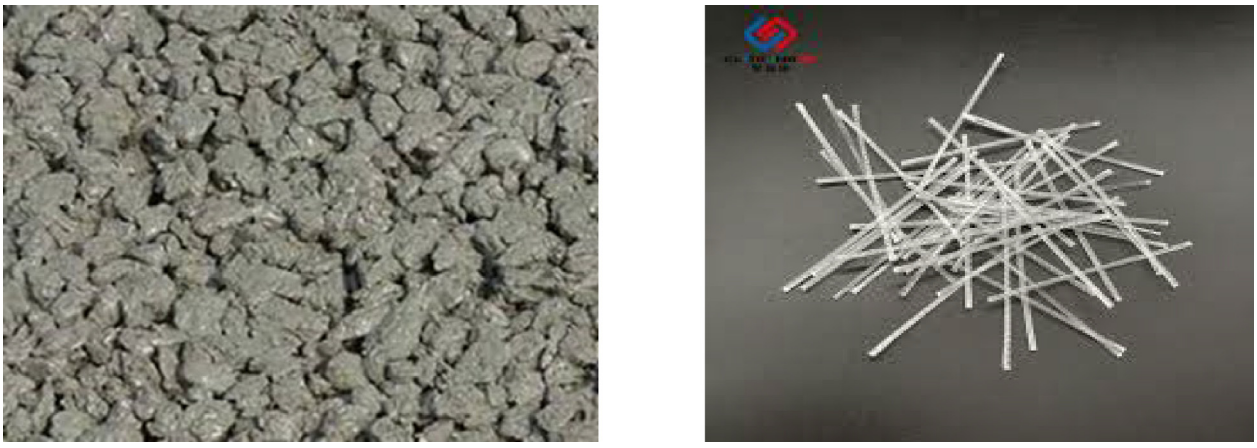

Fig. 2. (a) Porous Concrete; (b) Structural Fibre.

Fig. 3. (a) Porous Concrete cube; (b) Pervious concrete cylinders.

Table 1
Compressive strength of porous concrete normal and Fibre added concrete.

Specimen	7 days Compressive strength(N/mm2)	21 days compressive strength(N/mm2)	28 days compressive strength(N/mm2)
Normal pervious concrete	6.90	11.23	13.41
Structural fibre pervious concrete	8.12	14.89	19.04

5. Applications

- It can be used for low road-bearing roads.
- Parking areas.
- Low water crossings.
- Sub-base for conventional concrete pavements.
- Sidewalks and pathways.
- Tennis courts.

6. Materials

7. Mix design of pervious concrete

7.1. Aggregate

In pervious concrete generally singular size of coarse aggregates are used. For design of pervious concrete we used 16 mm of coarse aggregates as per code **IS 10262–2009**. The composition and mixing of porous concrete are mentioned in Fig.2 and additive material structural fibre is mentioned in Fig. 2.

After the casting, the composition is made into cubes and cylinders mentioned in Fig. 3.

7.2. Cementitious material

53 Grade of OPC cement is used which is having 3.15 specific gravity.

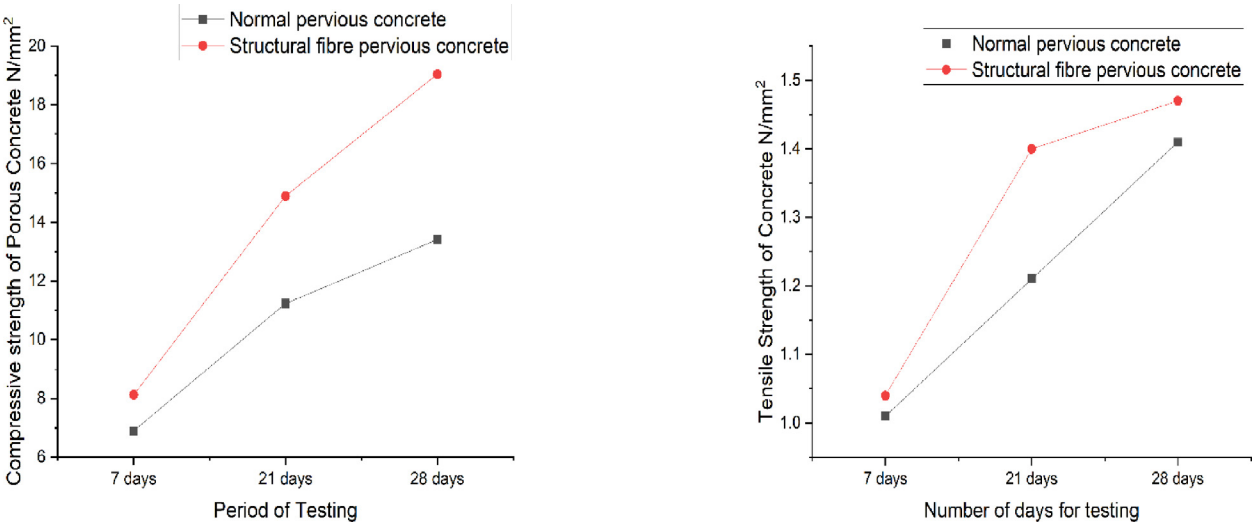

Fig. 4. Comparison of Compressive and Tensile Strengths.

Table 2
Tensile strength of porous concrete normal and Fibre added concrete.

Specimen	7 days Tensile strength(N/mm2)	21 days Tensile strength(N/mm2)	28 days Tensile strength(N/mm2)
Normal pervious concrete	1.01	1.21	1.41
Structural fibre pervious concrete	1.04	1.40	1.47

8. Results and discussions

From the experimental results, the compressive strength values for and 28- day strengths were Compared as shown in Tables 1&2 and Fig. 4. Compared with normal pervious concrete compressive strength, the Structural fibre of pervious concrete has increased (See Table 2.).

9. Conclusions

Based on the above experimental study we conclude that,

- The workability decreases with an increase of structural fibre percentage with the same W/c ratio.
- The compressive strength of pervious concrete increases with increase in percentage of structural fibre.
- There is 15% of increase in the porous concrete strength by adding 10% structural fibre.
- The tensile strength was found to be increasing with increase in the percentage of structural fibre.
- Almost 5% of increase in split tensile strength with variation of structural fibre at 10%.
- Instead of economy, the performance of porous pavements were increased by adding fibres.
- By adding structural fibre as admixture, the strength of sub surface layer has increased.

It is concluded that reduction in aggregate size decreases the porosity because of its inter relation with no fine aggregate property.

CRediT authorship contribution statement

Neduri Prabhanjan: Resources, Supervision, Writing – review & editing. **Swamy Yadav Golla:** Resources. **Sahithi G.:** . **Sravanthi Bojjam:** . **Sravanthi Mamidala:** .

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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