International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 06 | Jun 2023 www.irjet.net p-ISSN: 2395-0072

IMPROVEMENT IN PROPERTIES OF POROUS CONCRETE USING FIBER

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***Abstract** - Pervious concrete is a different type of concrete with highly porous structure used for concrete flatwork applications that allow water from precipitation and other sources to pass directly through, this reducing the runoff from a site and allowing to recharge ground water . This porosity is attained by a highly interconnected void content. In pervious concrete, the amount of fine aggregate is little or no fine aggregate such as sand, because of that it is referred as "No fine or less fine concrete". The use of pervious concrete is significantly increasing due to reduction of road runoff and absorption of noise. This concrete is being used as paving material in the United States for the construction of parking lots, sidewalks and secondary roads. The production of better quality pervious concrete is necessary to meet specification requirements for the construction of durable pervious concrete pavements. Till now many researchers have used different materials in the pervious concrete like flyash, rice husk, geogrids etc. Fibers can also be used to strengthen the pervious concrete, so it can easily be used for higher loads.*

Key Words- Pervious concrete, Compressive strength, Permeability, Split tensile strength.

1.INTRODUCTION

Conventional cement concrete is generally used as building material in construction projects. The impervious nature of concrete leads to the increased water runoff into drainage system, over-burdening the infrastructure and causing excessive uncontrollable flooding in built-up areas. Pervious concrete has become substantial popular during recent decades, because of its potential share in solving environmental issues. Pervious concrete is a highly efficient concrete which has relatively high water permeability compare to conventional concrete due to interconnected void structure. Pervious concrete is also called as porous concrete and permeable concrete. It can be prepared by using conventional concrete-making materials, namely cement, cement supplementary materials, all types of coarse and no fine aggregates, and water. Pervious concrete is a type of concrete with considerable high water permeability compared to normal weight concrete. It has been mainly used for draining water from ground surface, so that storm water runoff is minimized. Due to high water permeability as compared to normal concrete, pervious concrete has very less compressive strength.

Pervious concrete also referred to as "No-fine Concrete" or "Porous Concrete" is material comprised of narrowly graded coarse aggregates, cementitious materials, water and admixture and in some cases fibers. Pervious concrete has been in use for more than 50 years in a variety of applications, recent EPA regulations are causing many owners and designers to reexamine applications of this unique material. Pervious concrete pavement is recognized as a structural infiltration BMP by the EPA for providing storm water management and first flush pollution control. The US green building council (USGBC) through its Leadership in Energy and Environmental design (LEED) Green Building rating system promotes sustainable construction of buildings. A pervious concrete pavement qualifies for LEED credits and is therefore sought by owners desiring for a high LEED certification. Pervious concrete paving reduces the runoff from paved areas, which allows the use of smaller capacity storm sewers and reduces the need for separate storm water retention ponds.

Massive urbanization in Indian cities is causing the ground water to go deeper and is causing water shortage. For example; Cherrapunji suffers drought while the monsoons bring flooding Chandigarh city taps ground water from deep confined aquifers which do not get naturally recharged. Further the rain water falls on the concrete and asphalt surfaces tends to carry a high level pollution and this pollution ends up in waterways ultimately .So, sustainable technologies like pervious concrete are likely to become more popular in India.

In recent years, pervious concrete is widely gaining popularity as a viable paving material and a tool of sustainable development because of its environmental merits. Concern has been growing in recent years among public agencies, planners and developers, toward reducing the pollutants in water supplies and the environment. Recharging of the ground water supplies, reducing the quantity of storm water generated from developed areas, improving the storm water quality, reducing the discharge of pollutants in water supplies and minimizing the effect of development on watersheds have become the primary focus area while developing a natural land.

Although, when compared to conventional concrete, pervious concrete has a lower compressive strength, greater permeability, and a lower unit weight . However, pervious concrete has a greater advantage in many regards. Nevertheless, it has its own limitations which must be put into effective consideration when planning its use.

In both developed and developing countries waste management problem has already become severe. The problem is compounded by the rapidly increasing amounts of industrial wastes of a complex nature and composition. Energy plays a crucial role in the growth of developing countries like India. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building Materials like cement, the importance of using industrial waste cannot be underestimated. Many research organizations are practicing extensive work on waste materials concerning the viability and environmental suitability. Recent researchers aimed at the conservation in the cement and the concrete industry focused on the use of waste materials waste glass such as glass powder, hypo sludge, ceramic waste, rice husk ash such as fly ash, slag, silica fume in pervious concrete to increase the strength and permeability of pervious concrete. Many researchers have made attempts to use the waste materials to reduce the disposal problems and to improve the mechanical properties of pervious concrete.

2. Material

2.1 Cement

Ordinary Portland cement (Ultratech) of 53 grade (confirming to IS 12269) is used throughout the experiment project i.e. after the curing of 28 days the compressive strength should not be less than 53 N/mm^2.

2.2 Coarse Aggregate

Aggregates can have a direct influence in the permeability, surface texture and appearance of the slab. A uniform large aggregate size will increase the permeability and decreased strength as compare to the smaller size aggregates.

Locally available crushed angular coarse aggregate (conforming to IS:2386-1963 and IS:383-1970). Sizes of crushed angular aggregates with 100% passing through 10mm sieve and 100% retained on 6mm size sieve to be used in experiments.

Fig. 1 Aggregate

2.3 Fiber

Drip irrigation is used in fields by using different sizes of flexible pipes. Every year there is enormous amount of pipes get damaged and to be replaced by new one to continue the proper irrigation in the fields, it becomes scrape. It can be used to reinforce the pervious concrete by making its fibers. Using this fiber can be advantageous to increase the durability and strength of pervious concrete. The fibers used are of drip pipes produced by Kisan pvt ltd. All the Drip Irrigation components manufactured by Kisan pvt ltd are from virgin materials to withstand UV radiation & meets the specification of 'BIS'

Fig. 2 Fiber

2.4 Flyash

Fly ash is fine powdered particle with spherical shape. It exists either solid or hollow and amorphous (glassy) in nature like silt. Its chemical properties of fly ash depend upon the type of coal used in ignition and the techniques used for handling. Flyash used is of class B.

Fig. 3 Flyash

2.5 Water

Water used in concrete mix and for curing should conform to IS 456:2000. Water used for curing and mixing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic material or other substances that may be deleterious to concrete or steel. Potable water is considered satisfactory for mixing concrete.

3. METHODOLOGY

Desired strength of pervious concrete is equivalent to plain concrete of grade M15 (1:2:4) i.e. for pervious concrete proportion of cement and coarse aggregate used is 1:4 respectively. Fine aggregates are removed to make the no fine concrete i.e. pervious concrete.

- Proportion cement: coarse aggregate = 1:4
- Water cement ratio = 0.3
- Coarse aggregate size used 6mm to 10mm.
- Cement used is OPC53 grade (Ultratech)
- Sample one with fly ash content 20% of cement weight.
- Sample two with fiber content 3% of cement weight.

3.1 Compressive Strength Test

Compressive strength tests were conducted on a cube of size 150*150*150 mm at age of 7 days & 28 days curing. Standard testing machine with a most capability of 2000 KN was used at commonplace rate of loading as per IS 516-1959. Compressive strength,

C = P/A.

Its unit is N/mm^2.

Fig. 4 Compressive strength test

3.2 Split Tensile Strength Test

Tests were conducted on cylindrical specimen with diameter 100 mm & length 200 mm on a standard testing machine with a maximum capacity of 2000 KN at standard rate of loading as per IS 516-1959. Tests shall be made at the recognized ages of the test specimens, the most usual being 7 and 28 days.

Split Tensile strength = 2P/(πDL).

Its unit is N/mm^2.

Fig. 4 Split tensile strength test

3.1 Permeability Test

Permeability of pervious concrete can be tested by a falling head apparatus as recommended by code. Different apparatus outlines can be used but the mechanism of this pressure-decay method is the same. A pipe supplies sufficient water in the inlet and allows water flow through the sample and finally drains from the outlet. The water head in the inlet is allowed to lift to desired level and then maintained a steady flow through the pipes. When the test starts, the water-supplied valve is closed to free the water head in the inlet dropping progressively to level the water head at the outlet. The time interval 't' (s) during which the water head falls from 'h_1'(cm) to 'h_2' (cm) is recorded and the apparent permeability 'k' (cm/sec) of the sample can be computed by

$$K = 2.303 \times \frac{AL}{at} \times \log\left(\frac{h1}{h2}\right)$$

Where,

A = cross section area of the specimen (in sq cm)

L = length of specimen (in cm)

a = cross section area of stand pipe (in sq. cm)

t = time interval between head falls from h_1 to h_2 (sec)

Fig. 6 Permeability Test

4. RESULTS

4.1 COMPRESSIVE STRENGTH TEST RESULTS

4.1.1Porous concrete (with flyash)

Table 1

Compressive strength (7th day) (in N/mm²)	Density (in Kg/m³)
6.53	2127.629
7.04	2149.62
7.25	2139.32

Table 2

Compressive strength (28th day)(in N/mm²)	Density (in Kg/m³)
13.298	2130.32
12.123	2149.92
12.511	2135.45

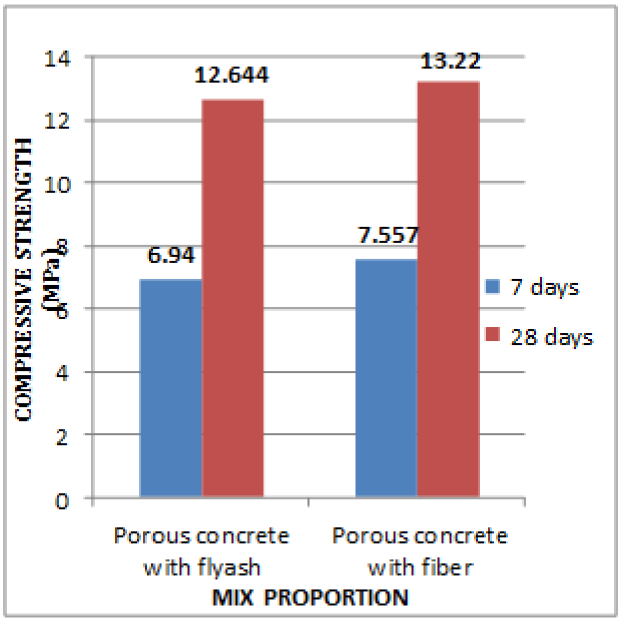
4.1.2 Porous concrete (with fiber)

Table 3

Compressive strength (7th day) (in N/mm²)	Density (in Kg/m³)
7.089	2013.03
8.232	2136.88
7.350	2070.22

TABLE 9

Compressive strength (28th day) (in N/mm²)	Density (in Kg/m³)
13.51	2080
12.208	2163.25
13.95	2097.25



Graph 1 Compressive Strength

4.2 SPLIT TENSILE STRENGTH TEST RESULTS

4.2.1Porous concrete (with flyash)

Table 6

Split tensile strength (28th) (N/mm²)	Density (Kg/m³)
1.55	2160.55
1.21	2140.92
1.11	2142.22

4.2.2 Porous concrete (with fiber)

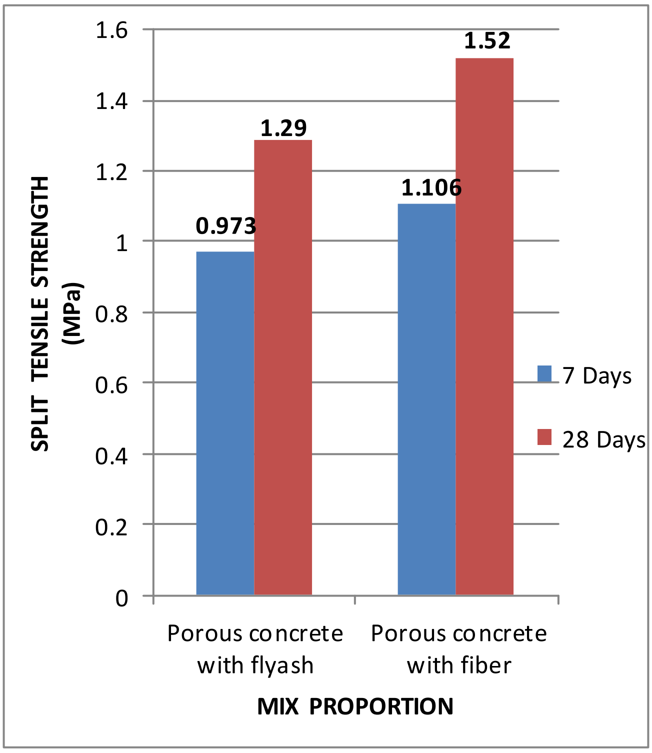
Table 7

Split tensile strength (7th) (N/mm²)	Density (Kg/m³)
1.26	2160.35
1.02	2130.93
1.04	2231.65

Table 8

Split tensile strength (28th) (N/mm²)	Density (Kg/m³)
1.77	2160.546
1.52	2139.98
1.27	2212.98

Split tensile strength (7th) (N/mm²)	Density (Kg/m³)
1.01	2161.35
0.909	2135.93
1.001	2140.22



Graph 2 Split Tensile Streng

5. CONCLUSIONS

From the various tests conducted the following conclusions can be made:-

- Use of fibers leads to increase in compressive strength, split tensile strength of porous concrete.
- It has been concluded from the research that permeability of porous concrete increases by using fibers.
- Comparative study on both the samples i.e. flyash and fiber, it is found that using fiber is beneficial to improve the properties of porous concrete.
- Average compressive strength of porous concrete using fibers after 7 days and 28 days is 7.557N/mm² and 13.22N/mm².
- Average compressive strength of porous concrete using flyash after 7 days and 28 days is 6.94N/mm² and 12.644N/mm².
- Average split tensile strength of porous concrete using fiber after 7 days and 28 days is 1.106N/mm² and 1.52N/mm².

- Average split tensile strength of porous concrete using flyash after 7 days and 28 days is 0.973N/mm^2 and 1.29N/mm^2.
- Average permeability coefficient of porous concrete using fiber is 2.80cm/sec.
- Average permeability coefficient of porous concrete using flyash is 1.241cm/sec.

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