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Experimental Study on Behavior of Pervious Concrete in Strength and Permeability by Using RHA, SCBA, Nylon and Polypropylene Fiber

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Abstract
There is lot of research work is going in the field of pervious concrete. The compressive strength of pervious concrete is less when compared to the conventional concrete due to its porosity and voids. Hence, the usage of pervious concrete is limited even though it has lot of advantages. If the compressive strength of pervious concrete is increase, then it can be used for more number of applications RHA, SCBA and nylon fiber and pervious concrete with RHA, SCBA and polypropylene fiber. For now, the usage of pervious concrete is mostly limited to light traffic roads only. If the properties are improved, then it can also be used for medium and heavy traffic rigid pavements also. Along with that, the pervious concrete eliminates surface runoff of storm water, facilitates the ground water recharge and makes the effective usage of available land. This project was to improve the compressive strength characteristics of pervious concrete. But it can be noted that with increase in compressive strength the void ratio decreases. Hence, the improvement of strength should not affect the porosity property because it is the property which serves its purpose. In this investigation work the compressive strength of pervious concrete is increase by a maximum % age of RHA, SCBA and nylon fibre and pervious concrete with RHA, SCBA and polypropylene fibre. Were added to standard pervious concrete. When we used the 6 % RHA and 6 % SCBA with nylon fibre and polypropylene fibre in pervious concrete in various proportion of 0.1%, 0.15%, 0.2%, 0.25% and 0.3% of the weight of concrete, the result obtained by the compressive strength of nylon fibre with 6 % RHA and 6 % SCBA and polypropylene fibre 6 % RHA and 6 % SCBA is up-to 0.2 % of used result get increased.Comparative research in nylon fibre with 6 % RHA and 6 % SCBA and polypropylene fibre with 6 % RHA and 6 % SCBA used in pervious concrete, the result of polypropylene fibre with 6 % RHA and 6 % SCBA is more.

Key Words: Pervious Concrete, sugarcane bagasses ash, rice husk ash compressive strength, fine aggregates, nylon fibre, polypropylene fibre.

Introduction

Pervious concrete is also widely used in Europe and Japan for roadway applications as a surface course to improve skid resistance and reduce traffic noise. However, the strength of the material is relatively low because of its porosity. The compressive strength of the material can only reach about 20 - 30MPa. Such materials cannot be used as pavement due to low strength. The pervious concrete can only be applied to squares, footpaths, parking lots, and paths in parks. Using selected aggregates, fine mineral, admixtures, organic intensifiers and by adjusting the concrete mix proportion, strength and abrasion resistance can

improve the pervious concrete greatly Concrete is a composite building material made from the combination of aggregate and cement binder. The most common form of concrete is Portland cement concrete, which consists of mineral aggregate (generally gravel and sand), Portland cement and water. It is commonly believed that concrete dries after mixing and placement. Actually, concrete does not solidify because water evaporates, but rather cement hydrates, gluing the other components together and eventually creating a stone-like material. When used in the generic sense, this is the material referred to by the term concrete. Concrete is used to make pavements, building structures, foundations, highways & roads, overpasses, parking structures, bases for gates/fences/poles, and cement in brick or block walls. An old name for concrete is liquid stone.

Even though few researches have reported slump values for pervious concrete, the standard slump is not suitable for pervious concrete to assess its workability because of light weight nature of pervious concrete. It has been established that workability for pervious concrete should be assessed by forming ball with the hand to establish the mould ability of pervious concrete. Mould ability of pervious concrete is quite sensitive to the water content; hence the amount of water should be strictly controlled.

(A) Too little water **(B) proper amount of water** **(C) too much water**

Figure 1: Workability assessments for pervious concrete.

2. Literature Review

Literature survey was done related to the study which is given as: Literature survey was done related to the study which is given as:

Rohit Patidar and Sonam Yadav- For test of water permeability, we used falling head method. The experimental research has been done to compute void ratio, water permeability, density and compressive strength. If we increase in W/C ratio found in compressive strength pervious concrete. Compressive strength of conventional concrete is greater than pervious concrete. The void ratio that has to be found in range of 25% to 32% of pervious concrete is sufficient. Similarly if we use small size of aggregate, permeability of pervious concrete will decreases. According to investigation it was observed that with using mix (50%) aggregate and 0.30 W/C ratio gives better result for pervious concrete. In this study used of polypropylene fiber gives better result for compressive strength of pervious concrete and does not effect on water permeability of pervious concrete.

Rohit Patidar et al. The trial research has been done to figure void proportion, water porousness, thickness and compressive quality. In the event that we increment in W/C proportion found in compressive quality pervious cement. Compressive quality of ordinary cement is more prominent than pervious cement. The void

proportion that must be found in scope of 25% to 32% of pervious cement is adequate. Thus on the off chance that we utilize little size of total, porousness of pervious solid will diminishes. As indicated by examination it was seen that with utilizing blend (half) total and 0.30 W/C proportion gives better outcome for pervious cement. In this examination utilized of polypropylene fiber gives better outcome for compressive quality of pervious cement and does not impact on water penetrability of pervious cement.

D.Dinesh kumar et al. Pervious cement has low establishment costs. Moreover, it channels the tempest water hence decreasing the quantity of contaminations entering the streams and lakes. Pervious cement additionally improves the development of trees. In the present investigation the conduct of pervious cement has been considered tentatively. The water-concrete proportion was kept at various proportions 0.35, 0.40, and 0.45. Various properties of pervious cement for example functionality, compressive quality, split elasticity, flexural quality test at 7, 14 and 28 days have been considered tentatively. The blend extents with totals measure (4.75 mm to 10 mm) gives higher quality when contrasted with blends with totals estimate (10 mm to 20 mm).

3. Experiments and Material Used in Concrete

❖ **Nylon Fibre**

1) Strength: Nylon has good tenacity and the strength is not lost with age. Nylon has a high strength to weight ratio. Nylon has excellent abrasion resistance.

2) Elasticity:-

- Nylon has good elasticity.
- Nylon like other fibres has its own limit of elasticity.
- Excellent abrasion resistance.
- Durability: its high tenacity fibre.
- High elongation.

Nylon is a generic name that identifies a family of polymers. Nylon fibre properties are imparted by the base polymer type, addition of different levels of additive, manufacturing conditions and fiber dimensions. The principal application of nylon fibres is for reduction of fissuring, due to plastic contraction of concrete, including: slabs, elevated decks, pavements, sports arenas, roads, parking lots, façades, etc. Other applications include repair of pre-cast walls, pools and mortars for walls.

Figure 2: Nylon fibre.

❖ **Polypropylene Fiber**

Polypropylene fibres are tough but have low tensile strength and modulus of elasticity. They have a plastic stress-strain characteristic. Polypropylene fibres are hydrophobic and therefore have the disadvantages of poor bond characteristics with cement matrix, a low melting point, high combustibility and a relatively low modulus of elasticity. Long polypropylene fibres can prove difficult to mix due to their flexibility and tendency to wrap around the leading edges of mixer blades.

Figure 3: Polypropylene fibre.

4. Specification Of Material Used

1) Cement:-Cement is a fine, grey powder. It is mixed with water and material such aggregates. The cement and water form a paste that binds other materials together as concrete hardens. In the present work 53 grade cement was used for casting of cubes for all concrete mixes. The cement was uniform colour i.e. grey with a light greenish shade and was free from lumps. Pozzolana Portland Cement and ordinary Portland cement ULTRA TECH 53 GRADE was used.

2) Aggregates

In the absence of the usage of proper alternative aggregates becoming possible in the near future, the concrete industry globally will consume 8-12 billion tons annually of natural aggregates after the year 2010 (Tsung et al 2006). Aggregates are inert granular materials such as sand, gravel or crushed stone which, along with water and Portland cement, constitute an essential ingredient in concrete. Good concrete mix aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of the concrete. Aggregates which account for 60 to 75 percent of the total volume of concrete are divided into two distinct categories fine and coarse. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 4.75 mm sieve. Coarse aggregates are particles retained in 4.75 mm sieve. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

3) Sugarcane Bagasse Ash (SCBA)

Sugarcane bagasse ash which is utilized in this project is taken from Shakti Sugar (Mill) Pvt Ltd Kodia, Gadarwara, Narsinghpur (M.P). The burning of bagasse of sugarcane produces bagasse ash which is a waste material. Presently in sugar factories bagasse is burnt as a fuel so as to run their boilers. This bagasse ash is generally spread over farms and dump in ash pond which causes environmental problems also research states that Workplace exposure to dusts from the processing of bagasse can cause the chronic lung condition pulmonary fibrosis, more specifically referred to as bagassosis. So there is great need for its reuse, also it is found that bagasse ash is high in silica and is found to have pozollinic property so it can be used as substitute to construction material.

4) Rice Husk Ash (RHA)

RHA is taken from in this research work, natural soil was stabilized using the Rice husk ash is obtained from Sawstikkrishi farm in Mandideep (Near the Bhopal). India is one of the world's largest producers of white rice, accounting for 20% of all world rice production. Rice is India's preeminent crop, and is the staple food of the people of the easterly and southern regions of the state. The country's rice output of 89.13 million tonnes

in 2016-17 crop year. India could achieve a record rice production of 100 million tonnes in 2017-18 crop years on the back of better monsoon this year. The India's rice production reached a record high of 104.32 million tonnes in 2018-2019 crop years. Disposal of rice husk ash is an important issue in these countries which cultivate large amounts of rice. Rice husk has a very low nutritional value and as they take very long to decompose are not appropriate for composting or manure. Hence the 100 million tons of rice husk produced globally begins to affect the environment if not disposed of properly.

5. Use of Materials and Testing of Specimens

1) IS 456:2000 and IS 1343:1980 recommend that nominal size of the aggregate should be as large as possible.
2) Sample preparation of cube moulds is used as per IS: 516:1959.
3) Casting of test specimens cubes is used as per IS: 516:1959.
4) Compaction of test specimens is used as per IS: 516:1959.
5) Curing of test specimens are used as per IS: 516-1959.

1. Calculation for volume of cube

a) Volume of one cube= (0.15x0.15x0.15) m^3 = 0.003375 m^3
b) Weight of one cube= 0.003375x2362 = 7.972 kg

2. Calculation of volume of concrete for M20 grade

1. Volume of cement for one meter cube = 1/ (1+4) = 0.2 m^3
2. Weight of cement per meter cube = 0.2 x 1200 = 240 kg
3. Weight of RHA per meter cube (6% weight of cement) = 0.06 x 240 = 14.4 kg
4. Weight of SCBA per meter cube (6% weight of cement) = 0.06 x 240 = 14.4 kg
5. Total cementitious materials = Cement + RHA + SCBA = 211.2+14.4+14.4 = 240 kg
6. Volume of aggregate for one meter cube = 0.2 x 4 =0.8 m^3
7. Weight of aggregate per meter cube = 0.8 x 1450 = 1160 kg
8. Water cement ratio = 0.36
9. Weight of water = 258.16 x (1/0.36) =717.11 kg
10. Density of concrete = (weight of (cement + sand + aggregate + water)) per meter cube
    = (240+1160+717.11) = 2117.11 kg/m^3
11. Weight of concrete for one cube = 2117.11 x 0.003375 = 7.145 kg

3. Weight of Polypropylene fibre

a) 0.1% Polypropylene fibre = 7.145 × 0.1= 71.45 gm
b) 0.15% of Polypropylene fibre = 7.145 × 0.15 =107.1 gm
c) 0.2% of Polypropylene fibre = 7.145 × 0.2 =143.1 gm
d) 0.25% of Polypropylene fibre = 7.145 × 0.25 =178.6 gm
e) 0.3% of Polypropylene fibre = 7.145 × 0.3 =214 gm

a) Batching:--Batching is the process of measuring and combining the ingredients of concrete. Careful procedure was adopted in the batching, mixing and casting operations.

Figure 4: Casting.

b) Curing

The specimens were allowed to remain in iron mould for 24 hours under ambient condition. After that, these were remoulded with care so that no edges were broken and were placed in curing tank at the ambient temperature for curing. The ambient temperature for curing was 27± 2 degree Celsius.

Figure 5: Curing.

6. Testing of Specimen

1. Details of Slump Test

Fill the cone with concrete in three layer and taper 25 blows evenly in each layer with 5/8 inch diameter and 24-inch long hemisphere steel rod. Remove the excess concrete from top of the cone, using tapering rod, clean overflow from base of cone. Lift the cone vertically with slow and even motion. Lay a straight edge across the top of the slump cone. Measure the amount of slump in inches from the bottom of straight edge to top of slump concrete at a point over original center of base. Discrete concrete and do not use it in any other tests.

2. Compressive Test

The specimen after a fixed curing period of 7 days and 28 days were tested for compressive strength on 2000 KN compressive testing machine (CTM). The specimen is placed on bearing surface of the testing machine and compressive load was applied on opposite face axially and slowly.

Figure 6: Compressive Strength Machine.

6. Result and Analysis

3. Permeability Test

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

Case: 1

I have heck 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 in 60 sec.

Case:-II

1. The permeability of 0.1% fibre and 6% RHA+6% SCBA mixed pervious concrete cube. 1000 ml water which is passed through the voids of the fibre mixed pervious concrete cube and the water is retained to another pan that stored water measures it is 880 ml in 60 sec.

2. The permeability of 0.15% fibre and 6% RHA+6% SCBA mixed pervious concrete cube. 1000 ml water which is passed through the voids of the fibre mixed pervious concrete cube and the water is retained to another pan that stored water measures it is 900 ml in 60 sec.

3. The permeability of 0.2% fibre and 6% RHA+6% SCBA mixed pervious concrete cube. 1000 ml water which is passed through the voids of the fibre mixed pervious concrete cube and the water is retained to another pan that stored water measures it is 920 ml in 60 sec.

4. The permeability of 0.25% fibre and 6% RHA+6% SCBA mixed pervious concrete cube. 1000 ml water which is passed through the voids of the fibre mixed pervious concrete cube and the water is retained to another pan that stored water measures it is 940 ml in 60 sec.

5. The permeability of 0.3% fibre and 6% RHA+6% SCBA mixed pervious concrete cube. 1000 ml water which is passed through the voids of the fibre mixed pervious concrete cube and the water is retained to another pan that stored water measures it is 960 ml in 60 sec.

Figure7: Permeability testing of plain and SCBA, RHA and fibre mixed pervious concrete cube.

7. Analysis of Results

Table 1: Comparison of Ordinary Portland cement and Portland Pozzolona Cement.

Pervious concrete	7 Days Strength	28 Days Strength
OPC	5.49 N/mm^2	12.05 N/mm^2
PPC	3.48N/mm^2	7.18N/mm^2

Table 2: Pervious concrete with 6% RHA + 6% SCBA and %age of Nylon fibre.

Strength of Pervious concrete	Pervious concrete with 6% RHA + 6% SCBA and 0.1% Nylon fibre	Pervious concrete with 6% RHA + 6% SCBA and 0.15% Nylon fibre	Pervious concrete with 6% RHA + 6% SCBA and 0.2% Nylon fibre	Pervious concrete with 6% RHA + 6% SCBA and 0.25% Nylon fibre	Pervious concrete with6% RHA + 6% SCBA and 0.3% Nylon fibre
Average 7 Days (N/mm^2)	3.51	3.83	3.71	3.1	3.7
Average 28 Days (N/mm^2)	7.19	7.15	8.1	7.75	7.73

Table: 3. Pervious concrete with 6% RHA + 6% SCBA and %age of Polypropylene Fibre.

Strength of Pervious concrete	Pervious concrete with 6% RHA + 6% SCBA and 0.1% Polypropylene fibre	Pervious concrete with 6% RHA + 6% SCBA and 0.15% Polypropylene fibre	Pervious concrete with 6% RHA + 6% SCBA and 0.2% Polypropylene fibre	Pervious concrete with 6% RHA + 6% SCBA and 0.25% Polypropylene fibre	Pervious concrete with 6% RHA + 6% SCBA and 0.3% Polypropylene fibre
Average 7 Days (N/mm^2)	6.55	8.18	10.88	10.36	6.75
Average 28 Days (N/mm^2)	10.95	10.99	15.52	12.43	11.13

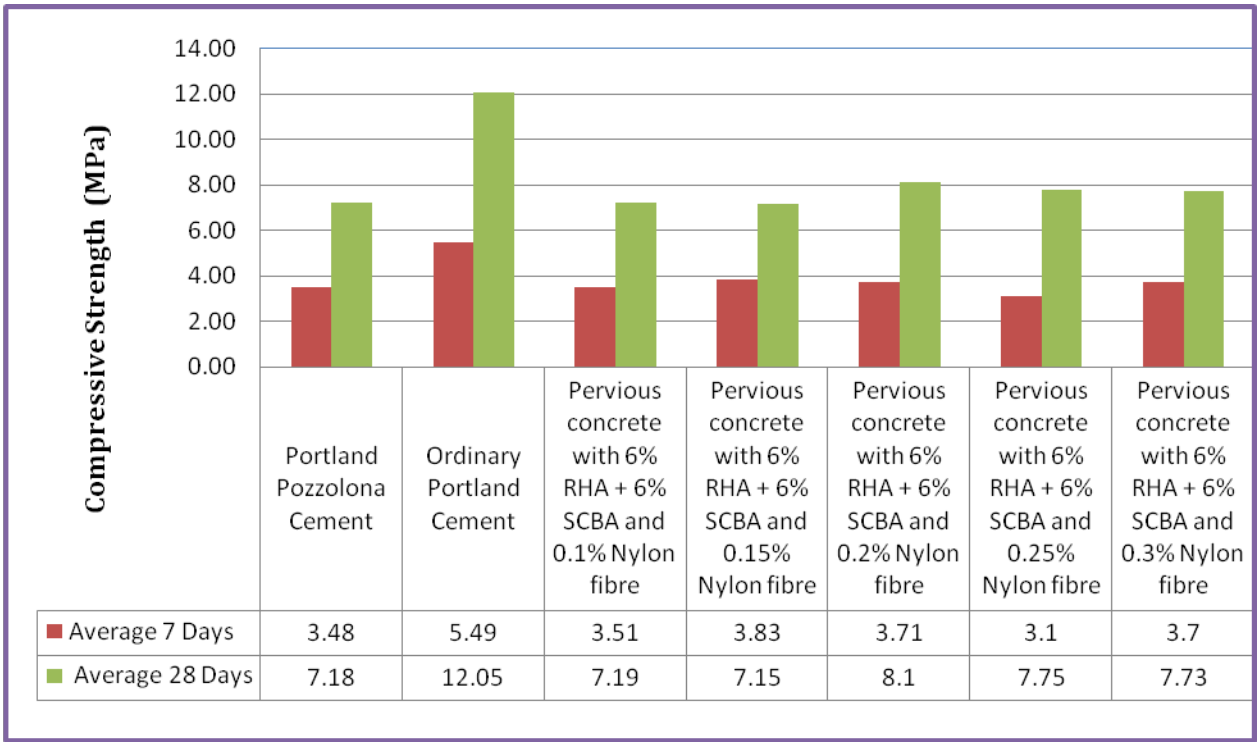

Figure 8: Bar Chart Presentation of 6% RHA + 6% SCBA and %age of Nylon Fibre used in Pervious Concrete.

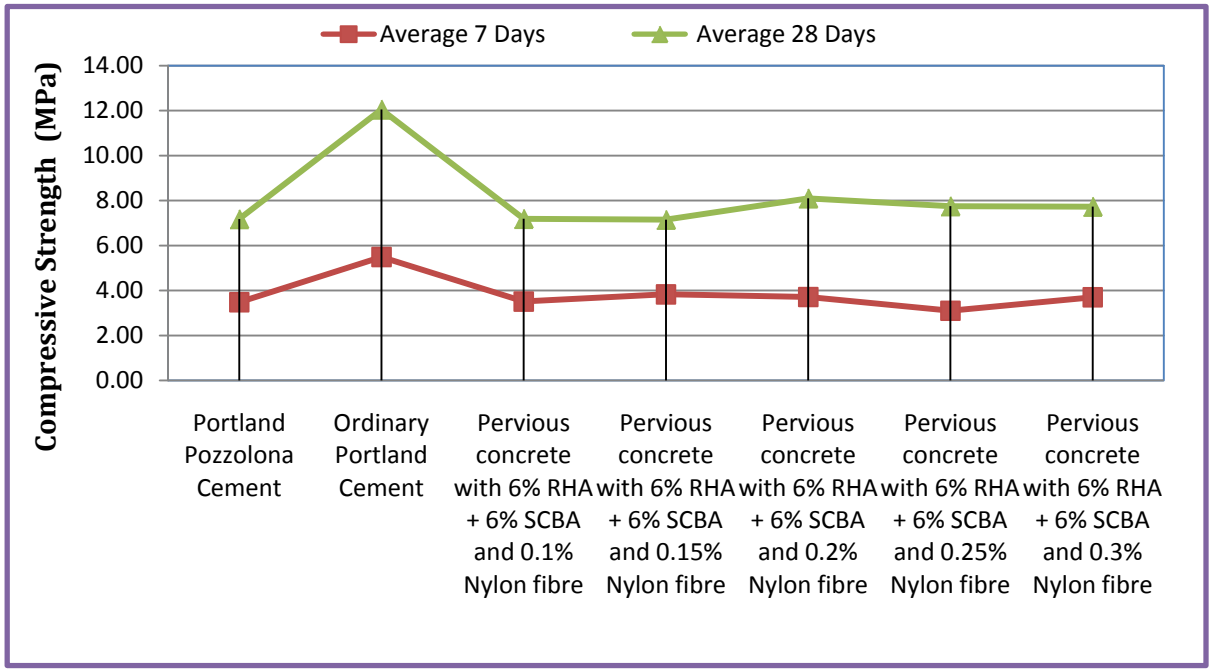

Figure 9: Graphical Presentation of Presentation of 6% RHA + 6% SCBA and %age of Nylon Fibre used in Pervious Concrete.

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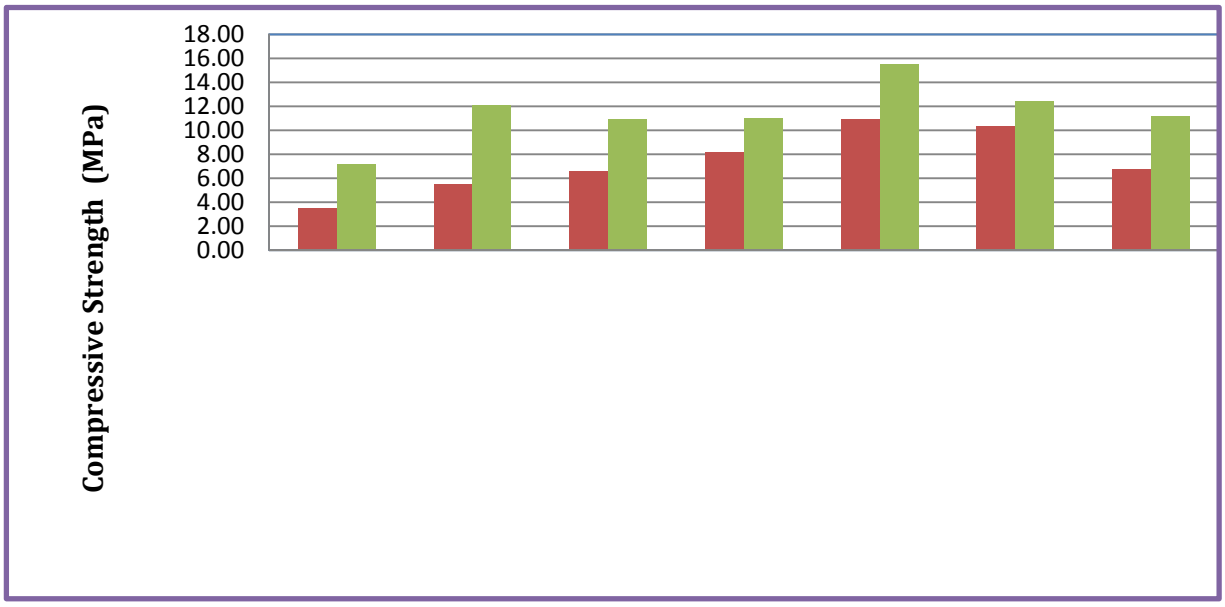

Figure 10: Bar Chart Presentation of 6% RHA + 6% SCBA and %age of Polypropylene Fibre used in Pervious Concrete.

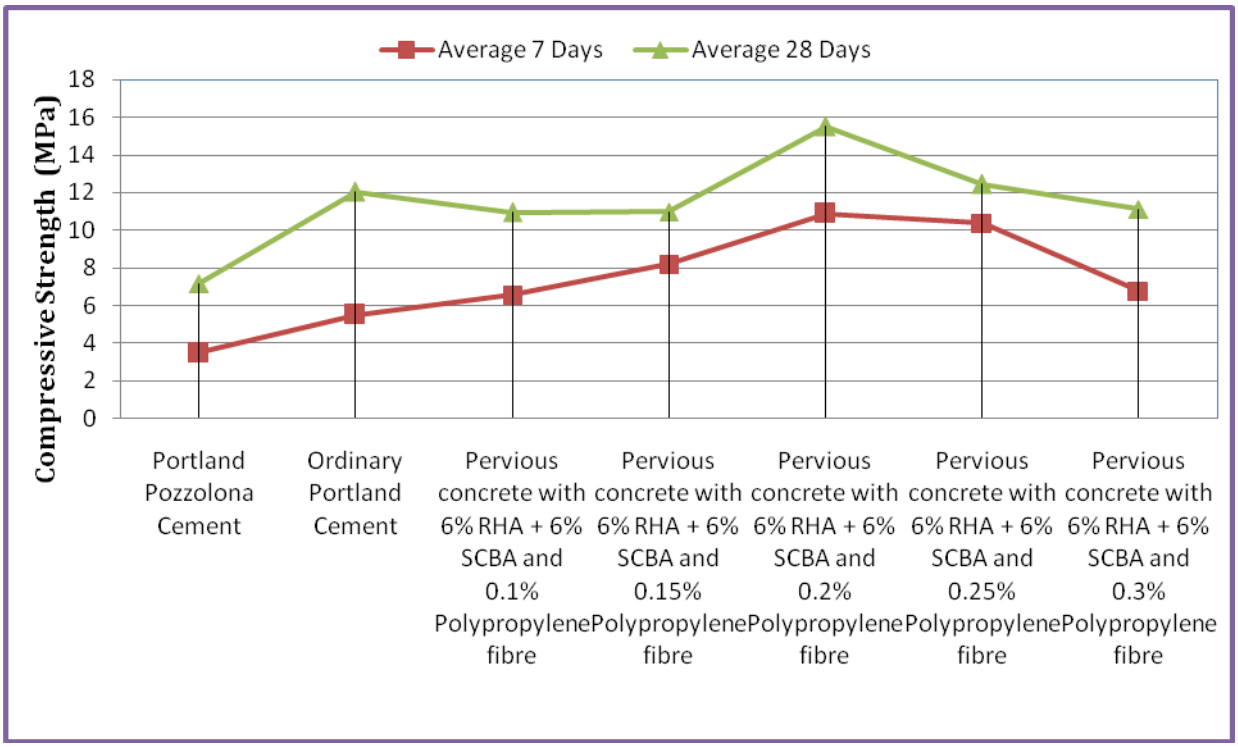

Figure 11: Graphical Presentation of 6% RHA + 6% SCBA and %age of Polypropylene Fibre used in Pervious Concrete.

8. Conclusion

- The compressive strength of pervious concrete mix with RHA, SCBA and nylon fibre and pervious concrete mix with RHA, SCBA and polypropylene fibre is increased as comparison to the plain pervious concrete.
- When we used the 6 % RHA and 6 % SCBA with nylon fibre and polypropylene fibre in pervious concrete in various proportion of 0.1%, 0.15%, 0.2%, 0.25% and 0.3% of the weight of concrete, the result obtained by the compressive strength of nylon fibre with 6 % RHA and 6 % SCBA and polypropylene fibre 6 % RHA and 6 % SCBA is up-to 0.2 % of used result get increased.
- Comparative research in nylon fibre with 6 % RHA and 6 % SCBA and polypropylene fibre with 6 % RHA and 6 % SCBA used in pervious concrete, the result of polypropylene fibre with 6 % RHA and 6 % SCBA is more
- 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 860 ml.
- The permeability of nylon fibre with 6 % RHA and 6 % SCBA mixed pervious concrete is increased as comparison to the plain pervious concrete.
- The compressive strength of 0.25% and 0.3% polypropylene fibre with 6 % RHA and 6 % SCBA mixed pervious concrete is less but permeability is more than 0.2% nylon fibre with 6 % RHA and 6 % SCBA mixed pervious concrete.
- The strength of pervious concrete is increased when fibre used in 0.2% with 6 % RHA and 6 % SCBA more than of its used the strength decreased. So we conclude that the ratio of fibre used is less than 0.2% with 6 % RHA and 6 % SCBA.

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