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MULTI FIBER REINFORCED CONCRETE

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ABSTRACT: The aim of the study was to utilize the fiber materials i.e. coconut coir, prosopis juliflora and carbon fibers for mass scale utilization such as in construction of concrete reinforced structures in an environmental safe manner.of percolation. From the results it is observed that the addition of cellulose polymer increases the strength of the pavement as well as the rate of percolation. As a first part of this study, an attempt was made to assess the stabilization of the fiber reinforced concrete(FRC) containing coconut coir, prosopis juliflora(stem) and carbon fibers by performing basic tests such as slump cone test, flow table, compaction factor, vee bee test, flexure test, modulus of elasticity, compressive strength test. Our main aim is to replace the quantity of sand used in concrete with the fibers and to reduce the utility of sand proportion in the concrete. Fibers are mixed in concrete with various proportion so as to determine the stability of the concrete. The binding quality is increased in the concrete due to the utility of fiber materials. Due to the scarcity of sand now a days, our motto is to find the material that plays the similar characteristic of sand in the concrete and the experiment is performed accordingly. The design and performance of fiber Concrete mainly depends upon the quality and percentage of binder in used. Experimental investigations were undertaken to check the fiber concrete worthiness of these mixes.

1. INTRODUCTION

1.1. GENERAL

Multi fiber reinforced concrete is the mixture of cement, sand, aggregate and combination of three fibers namely coconut coir, carbon fiber and prosopis juliflora(stem).The main aim of using fiber is to reduce the quantity of sand used in the concrete and increase the binding property of the concrete. It is design on the basis to go good stability, workability, strength and to increase the life span of the concrete. The fiber that are used in the concrete are considered as a waste materials on earth. Therefore using such waste fibers also increases the strength of concrete as well as clean the environment. By this method of manufacturing of concrete we can also degrab the waste substance on earth as well as save the natural resource for our future generation.

1.2. OBJECTIVES

- To make use of waste fibers such as prosopis juliflora (stem).
- To increase the binding property and reduce the occurance of voids in the concrete.
- To reduce the usage of sand in concrete.
- To reduce the damage and crack in the structures.
- To increase the strength of the concrete.

1.3. METHODOLOGY

- Literature Review
- Collection of Raw Materials
- Tests on Raw Materials
- Mixing and Curing
- Experimental Investigations
- Report submission

1.4. MULTI FIBERS

Fibers are the binding materials that increases the binding property and stability of the concrete. Three types of fibers are being used namely carbon fiber, coconut coir and prosopis juliflora(stem).The fiber such as prosopis juliflora(stem) are considered as a harmful plant to environment as it consumes large amount of underground water. Therefore to resolve both the problem such as water scarcity as well as the sand scarcity, these fibers are being utilized. Fibers are used right from ancient day and they give the higher performance and good result.

1.4.1. PROPERTIES OF MULTI FIBERS

- Fiber are extensible and are elastic.
- They are cohesive and uniform.
- They have the property of high abrasion resistance and are less flammable.
- They have physical shape, elastic recovery and elongation resiliency.
- Fiber have high length and width ratio.

Prosopis juliflora (stem)

Carbon Fiber

Coconut coir

Fig. 1. Multi Fibers

1.4.2. APPLICATIONS OF MULTI FIBERS

- Fibers when mixed with the concrete reduces the occurance of voids as well as crack.
- They are used in various sectors to enhance the performance rate and also user friendly to environment.
- Fibers and more available material with less cost that is economical.
- Different forms of fibers has their own advantage in specific property.
- Increases strength and workability.

2. PREPARATION OF CONCRETE

2.1. MIX DESIGN

The following mix proportioning helps to attain the required amount of void content of freshly mixed pervious concrete. The mix design of pervious concrete according to ACI method as follows,

1. Void content of aggregates,

% of voids $= \frac{(G \times W) - M}{G \times W} \times 100$

Specific gravity of aggregates

(G) = 2.75

Bulk Density of aggregates

(M) = 1520 kg/m^3

Unit weight of water

(W) = 1000 kg/m^3

% of voids

$= \frac{(2.75 \times 1000) - 1520}{2.75 \times 1000} \times 100$

= 44.72 %

2. Percentage of paste volume,

V_p (%)= (Aggregate void content + Compaction index – Design void content)

The value of Compaction Index (CI) can be varied based on the anticipated consolidation to be used in the field.

For greater consolidation Compaction index = 1 to 2%

For lighter consolidation Compaction index = 7 to 8%

The average value of 5% to get similar values between measured fresh pervious concrete void content and design void content.

Compaction index = 5 %

Design void content = 30 %

Percentage of paste volume

= 44.72 + 5 – 30 V_p (%)

= 19.72 %

3. Paste Volume,

V_p = 27 x (19.72 / 100)

= 5.324 ft^3

= 0.15 m^3

4. Water to cement ratio,

W/C = 0.3

5. Absolute volume of cement, V_c

$= \frac{V_P}{1 + [W/C \times RD_C]}$

Specific gravity of cement,

RD_c = 3.15

Absolute volume of cement,

$V_c = \frac{5.324}{1 + [0.3 \times 3.15]}$

= 2.73 ft^3

Absolute volume of cement,

V_c = 0.079 m^3

6. Volume of water,

$V_w = V_p - V_c$

= 5.32 – 2.73

= 2.59 ft^3

Volume of water,

V_w = 0.073 m^3

7. Volume of aggregates, V_{agg}

= 27 x ($V_p + V_{void}$)

= 27 x (49.72) /100

= 13.42 ft^3

Volume of aggregates,

V_{agg} = 0.38 m^3

8. Conversion of Volume to weight

Weight of cement

= $V_c \times RD_c \times 62.4 \times 0.593$

= 2.73 x 3.15 x 62.4 x 0.593

= 316.21 kg/m^3

Weight of water

= V_w x 62.4 x 0.593
= 2.58 x 62.4 x 0.593
= 95.47 kg/m^3

Weight of aggregates
= V_{agg} x RD_{agg} x 62.4 x 0.59
= 13.42 x 2.75 x 62.4 x 0.59
= 1365.6 kg/m^3

2.2. MIXING OF RAW MATERIALS

The cement and aggregates are mixed with a mix ratio of 1 : 4.32 (One parts cement and 4.32 parts of aggregates) with a water to cement ratio of 0.3. The cellulose is added to the cement with the percentage of 2%, 2.5% and 3% respectively.

Fig. 2. Mixing of Raw Materials

2.3. MOULDING

Moulding is the process of shaping the liquid or flexible raw material using a rigid frame called a mould. The standard mould of size of 150mm x 150mm x 150mm is used for the moulding.

Fig. 3. Moulding of Concrete

2.4. DEMOULDING

Demoulding is the process of removing the shaped material from the mould. Usually the demoulding is done after the initial setting time of the concrete. The initial setting time of concrete is about 24 hours.

Fig. 4. Demoulding of Concrete

3. TESTS ON PERVIOUS CONCRETE

3.1. COMPRESSIVE STRENGTH TEST

The compression strength of concrete is the ability of the concrete to resist the compression loads which acts upon it. It is measured by crushing cubical concrete specimens in compression testing machine. The following procedure is used to find out the compressive strength of the hardened concrete,

Calculate the mix proportion of concrete and mix the raw materials as per the mix design.

Apply the oil on the sides of the mould and pour the fresh concrete into the mould.

Fill the mould with the concrete in three layers and compact each layer by 25 times using tamping rod. Remove the concrete from the mould after the initial setting time of 24 hours.

The concrete is cured in the water for 7 days, 14 days and 28 days respectively. Place the

concrete in the compression testing machine. The load is gradually increased until the specimen fails.

Note down the value of failure load. Repeat the procedure for various proportion of concrete and compare their results with conventional concrete.

3.2. PERMEABILITY TEST

To find out the amount of water percolated per unit time the permeability

3.3. TEST RESULTS

S.No	Properties	Curing Period	Conventional Concrete	Sand + 2% of fibere	Sand + 2.5% of fiber	Sand+ 3 % of fiber
1.	Load at Failure (kN)	7 Days	218 Kn	226 Kn	238 kN	253 kN
		14 Days	327 Kn	336 Kn	350 kN	362 kN
		28 Days	369 Kn	385 Kn	392 kN	405 kN
2.	Compressive Strength (MPa)	7 Days	9.7 MPa	10.04 MPa	10.57 MPa	11.26 MPa
		14 Days	14.53 MPa	14.93 MPa	15.54 MPa	16.09 MPa
		28 Days	16.4 MPa	17.1 MPa	17.42 MPa	18.02 MPa

3.3.1. COMPRESSIVE STRENGTH

Test is carried out in pervious concrete. The test procedure for the determination of rate of percolation are as follows,

The cube size of 150mm x 150mm x 150mm is taken for the permeability test, the sides of the cube is sealed to prevent the side drains of the water.

The water is allowed on the top surface of the concrete cube only by placing the concrete cube in the constant flow of tap water.

The water is allowed through the concrete for a certain time and the percolated water is collected in the bucket which is placed below the concrete.

The time taken is also noted and the rate of percolation is calculated by, Rate of percolation

$$= \frac{\text{Amount of water collected}}{\text{Percolation time}}$$

Repeat the procedure for various concrete samples and compare the values with conventional concrete.

3.3.2. RATE OF PERCOLATION

S.NO	PROPERTIES	Conventional Concrete	Sand + 2 % of fiber	Sand + 2.5 % of fiber	sand + 3 % of fiber
1.	Percolation Time	19 sec	18 sec	19 sec	19 sec
2.	Amount of water collected (ml)	2300 ml	2600 ml	2800 ml	2970 ml
3.	Rate of percolation (l/sec)	0.12	0.14	0.147	0.156

3.4. COMPARISON OF RESULTS

3.4.1. COMPRESSIVE STRENGTH

The addition of cellulose will also increase the compressive strength. It is a long chain polymer which are closely holding together so it has high tensile strength which increases the strength of the pavement.

The graph is plotted between the concentration of cellulose (%) and the compressive strength of the concrete (MPa). The graph is plotted for curing period of 7 days, 14 days and 28 days separately for the comparison of compressive strength of concrete of various proportions.

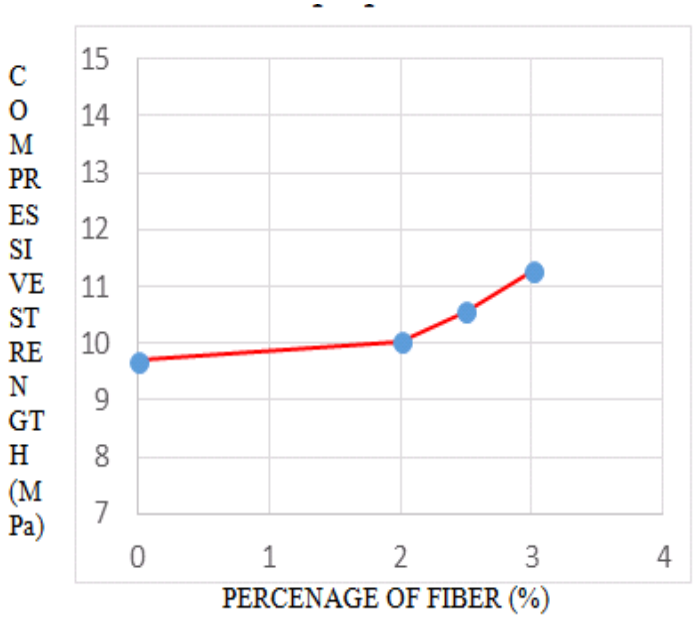
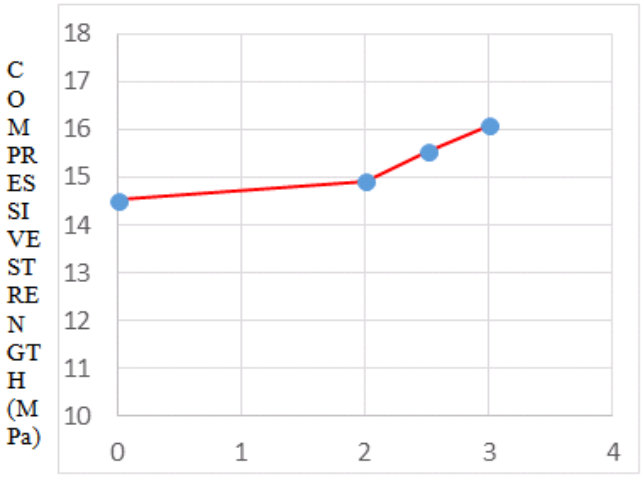


Fig. 6(a). Comparison of Compressive strength for 7 days curing.



6(b). Comparison of Compressive strength for 14 days curing.

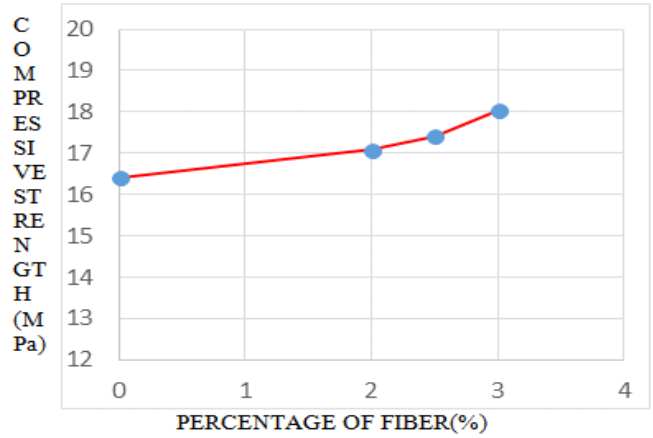


Fig. 6(c). Comparison of Compressive strength for 28 days curing.

3.4.2. RATE OF PERCOLATION

From the results obtained from permeability test of allowing water through the concrete specimen the increase in cellulose content will also increases the rate of percolation of concrete. The cellulose is hydrophilic in nature hence it absorbs certain amount of water which increases the permeability of the pavement.

The graph is plotted between the concentration of fiber (%) and the Rate of percolation (l/sec) for the comparison of various proportions with conventional concrete. The graph clearly shows that the rate of percolation is increased with increase in cellulose content.

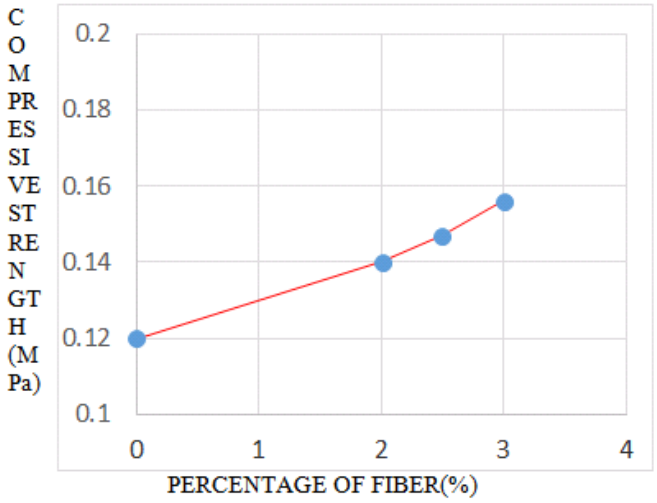


Fig. 5. Comparison of Rate of Percolation

CONCLUSION

The multi fiber reinforced concrete is an effective method to overcome the property of sand. It also helps in increase in the ground water level. The strength of the permeable pavement is less compared with the other types of pavements. In order to increase its strength, we are using cellulose polymer which has high tensile strength and hydrophilic in nature. The mix design of pervious concrete was done by using ACI method. The cement and aggregates are mixed with the mix proportion of 1 : 4.15 as per the mix design at the water to cement ratio of 0.3. The permeability test and compressive strength test was carried out on the concrete to find out its rate of percolation and compressive strength. The compressive strength test was

carried out for the curing period of 7 days, 14 days and 28 days respectively. From the results it is observed that the addition of cellulose polymer increases the strength of the concrete as well as the permeability of the concrete.

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