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IMPROVEMENT OF LIGHTWEIGHT CONCRETE BY USING NATURAL FIBRES

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Abstract - *This project deals with the improvement in strength of lightweight concrete by using natural fibres. Lightweight concrete made a huge impact in concrete field. In this research we are working on lightweight concrete to make it good in strength with respect to non-structural member. Addition of natural fibres with varying percentage (0.1%,0.2%,0.3%,0.4%) have been carried out.*

Key Words: Lightweight, Natural Fibres, Pumice Stone, Strength, Banana Fibre

1. INTRODUCTION

Lightweight concrete is generally selected to reduce the weight of construction. The main specialty of lightweight concrete is low density and thermal conductivity. Lightweight concrete has been successfully used for marine application and in ship building. Lightweight concrete ships where produce in the USA during the 1940 to 1980 war, and their success led to the production of (USS Selma) a war ship. Replacing aggregate with pumice stone reduce density and increases thermal insulation which makes the concrete lightweight. Pumice is a lightweight aggregate of low specific gravity. It is highly porous material with high water absorption percentage. In this we do not use the conventional aggregate and replace it by the pumice stone. Density of pumice stone is 0.25gm/cm^3. Pumice is created when superheated, highly pressurize rock is violently ejected from volcano. The unusual foamy configuration of pumice happens because of simultaneously rapid cooling and rapid depressurization. The depressurization create bubble by lowering the solubility of gases that are dissolved in lava, causes the gases to rapidly ex solve. The simultaneously cooling and depressurization freezes the bubble in the matrix. Addition of fiber lowers the permeability of concrete matrix and thus reduce the bleeding of water, it also enhance the toughness property of concrete. Addition of natural fibers leads to enhance engineering properties like compressive strength, split tensile strength, and flexural strength.

2. MATERIALS

As we are familiar with the current situation of availability of material in India, it is quite difficult to access the required amount of raw material which is used for construction work. The ban on any raw material may affect the construction of any site, and to avoid such condition replacement of such aggregates over sand and soil helps to continue the work.

2.1 CEMENT :-

The cement which was used is ordinary Portland cement of 53 grade. The concrete was designed for M25 grade. The OPC 53 grade has a ability to achieve higher strength.

property	IS: 8112 -1989
Specimen	OPC 53 grade
Normal consistency	35%
Initial setting time	31 min.
Final setting time	580 min
Specific gravity	3.15

Table 1 – properties of cement

2.2 AGGREGATE :-

Aggregates are one of the important material in the concrete which reduce the shrinkage and effect economy

a) Coarse aggregate:

Locally available coarse aggregate having the maximum size of 20mm and fineness modulus of 8.75 is used. The specific gravity of coarse aggregate that was taken is 2.6

Physical properties	Values
Specific gravity	2.6
Fineness modulus	8.75
Water absorption	0.5%
Bulk density	1590 kg/m^3
Free moisture content	0.2%
Aggregate impact value	11.2%
Aggregate crushing value	24.12%

Table 2- properties of coarse aggregate

b) Fine aggregate:

The sand sieved through 4.75mm sieve and retain in 600 micron sieve is used having specific gravity of 2.6 and fineness modulus 2.5 is used

Physical properties	Values
Specific gravity	2.6
Fineness modulus	2.83
Water absorption	0.75%
Bulk density	1654 kg/m^3
Free moisture content	0.1%

Table 3- properties of fine aggregate

2.3 PUMICE STONE:-

Pumice is lightweight aggregate with low specific gravity of 2350 kg/m^3. It is highly porous material with high water absorption of 41.66%.

Fig 1- pumice stone

2.4 FIBERS

Banana fibre is one of the most widely used natural fibre and is easily implemented. It has high strength, lightweight, smaller elongation, fire resistance, and strong moisture absorption. It is bio-degradable and has no negative effect on environment and thus can be categorized as ecofriendly fibre.

Fig 2- banana fibres

2.5 WATER

Water is used in the mixing is to be fresh and free from any organic and harmful solution which will leads to deterioration in the properties of mortar, salt water is not to ne used. Potatble water is feet for use mixing water as well as for curing.

3. EXPERIMENTAL WORK

Replacement of 40% aggregate with pumice stone and 40% sand with pumice powder leads to reduction of weight of concrete and density. The casting was done by varying percentage (0.2%,0.3%,0.3%) of banana fibre as a natural fibre referring the mix design 1:1.17:2.3 with water cement ratio 0.47.

The compressive tests results were taken after 7 days and 28 days of proper curing.

a) Compressive strength

Compressive strength tests were performed on compressive testing machine using cube samples for varying proportion were tested and average strength values reported in this paper. The loading rate on the cube is 9.83 N/mm^2 per min.

Fig 3- compressive strength test

Fig 4- compressive strength test

b) Flexural Strength

Flexural strength is considered as an index of a tensile strength of concrete. The flexural strength performed on the beam. In this test theoretical maximum tensile stress reaching at the bottom of the fiber of the test beam is known as the' modulus of rupture'. For the specified mix, allowable modulus of rupture is calculated by following formula,

Modulus of Rupture= $0.7\sqrt{fck}$

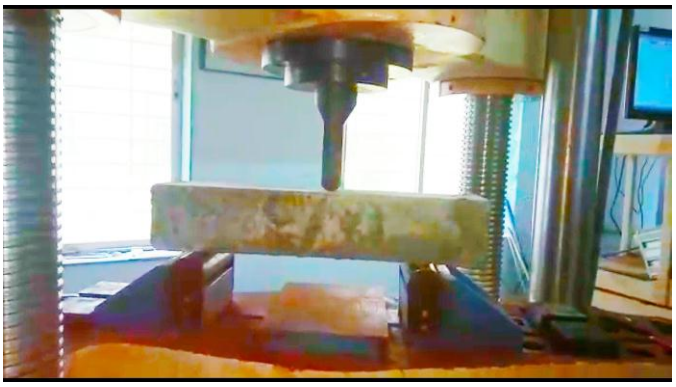


Fig -5 flexural strength test

A beam of 550*100*100 mm will be casting with suitable proportion and applying center point load method. The value of the modulus of rupture is depends upon the dimension of the beam and the arrangement of the loading.

c) Split Tensile Strength

Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Split tensile test can be calculated by below formula

T = 2P/ π DL

P = applied load

D = diameter of the specimen

L = length of the specimen

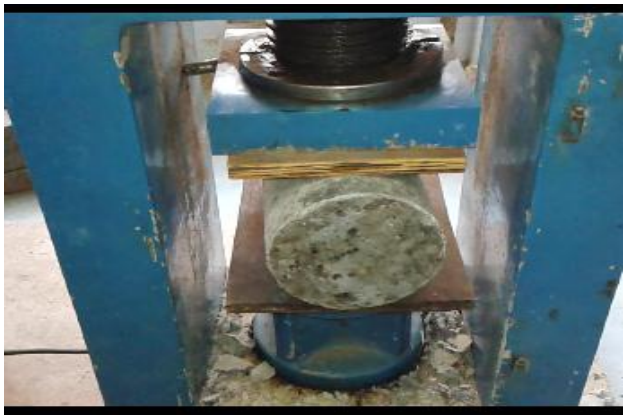


Fig 6- split tensile test

4. RESULTS

The results are taken after 7 and 28 days which are stated below in charted form.

Days	Weight of cube	Load	Compressive strength
7	5.46	180	8
28	5.28	240	10.66

Table 4- result of fibreless concrete

Days	Weight of cube (Kg)	Load (kN)	Compressive strength (Mpa)	Average compressive strength (Mpa)
7 days	5.32	180	8	7.85
	4.98	190	8.44	
	5.44	160	7.11	
28 days	5.08	220	9.77	10.37
	5.6	240	10.66	
	5.42	240	10.66	

Table 5- results for 0.1% fibre

Days	Weight of cube (Kg)	Load (kN)	Compressive strength (mpa)	Average compressive strength (Mpa)
7 days	5.58	220	9.77	8.74
	5.44	180	8	
	5.46	190	8.44	
28 days	5.32	260	11.55	10.81
	5.19	250	11.11	
	5.24	210	10.66	

Table 6- results for 0.2% fibre

Days	Weight of cube (Kg)	Load (kN)	Compressive strength (Mpa)	Average compressive strength (Mpa)
7 days	5.60	240	10.66	11.77
	5.48	270	12	
	5.68	280	12.44	
28 days	5.58	310	13.77	12.88
	5.62	290	12.88	
	5.28	270	12	

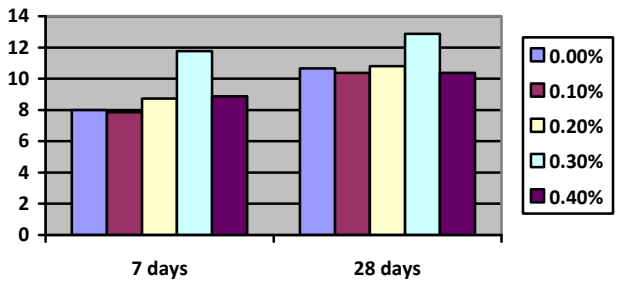
Table 7- results for 0.3% fibre

Days	Weight of cube (Kg)	Load (kN)	Compressive strength (Mpa)	Average compressive strength (Mpa)
7 days	5.48	210	9.33	8.88
	5.62	180	8	
	5.59	210	9.33	
28 days	5.34	240	10.66	10.37
	5.69	220	9.7	
	5.28	240	10.66	

Table 8- results for 0.4% fibre

Sr no	Fibre content	Compressive strength(Mpa)	
		7 days	28 days
1	0.0%		
2	0.1%	7.85	10.37
3	0.2%	8.74	10.81
4	0.3%	11.77	12.88
5	0.4%	8.88	10.37

Table 9- Tabular representation of results



Graph 1- Graphical presentation of results

From the above figure, it is clear that compressive strength of banana fiber increases from 0.1% to 0.3% and after 0.3% compressive strength is decreases. Hence 0.3% is optimum percentage of fiber mixing in concrete.

The result of split tensile strength for optimum percentage are

Days	Weight of cylinder (Kg)	Load (kN)	Tensile strength(Mpa)
7	9.08	120	1.13
28	9.21	160	1.50

Table 10- results for split tensile strength

The result of flexural strength for optimum percentage are

Days	Weight of beam (Kg)	Load (kN)	Flexural strength(Mpa)
7	9.35	12.94	2.354
28	9.40	14.16	2.576

5. CONCLUSIONS

[1] Studying above results, it is clear that 0.3% is the optimum percentage at which we get optimum results

[2] From the above investigation, it is clear that simultaneous replacement of aggregate and also sand is feasible in concrete as it gives satisfactory results for non structural member.

[3] As sand is also replaced with the pumice powder, flexural and split tensile strength is affected much which cannot be improved even after addition of banana fibres.

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