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Study on Glass Fibre Concrete Roof Tiles

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Abstract: The main objective of the fibre glass in concrete roof tile is to obtain good strength, heat resistant, & water seepage resistant roof tile. To ensure that the roof tile produced plays a role development with minimum cost, and high flexure strength. To draw an analogy between the normal concrete roof tile with glass fibre concrete roof tile. The sizes of short fibres used were 25mm and the glass fibres were alkali resistant. The effect of these short fibres on wet transverse strength, compressive strength and water absorption was carried out.
Keywords: Roof tile, fibre glass, heat resistance, seepage resistance

I. INTRODUCTION

One of the most important building material is concrete and its use has been ever increasing in the entire world. The reasons being that it is relatively cheap and its constituents are easily available, and has usability in wide range of civil infrastructure works. However concrete has certain disadvantages like brittleness and poor resistance to crack opening and spread. Concrete is brittle by nature and possess very low tensile strength and therefore fibres are used in one form or another to increase its tensile strength and decrease the brittle behaviour. With time a lot of experiments have been done to enhance the properties of concrete both in fresh state as well as hardened state. The basic materials remain the same but superplasticizers, admixtures, micro fillers are also being used to get the desired properties like workability, Increase or decrease in setting time and higher compressive strength.

Fibres which are applied for structural concretes are classified according to their material.

As Steel fibres, Alkali resistant Glass fibres (AR), Synthetic fibres, Carbon, pitch and polyacrylonitrile (PAN) fibres.

II. GLASS FIBRE REINFORCED CONCRETE

Glass fibre reinforced concrete (GFRC) is a cementitous composite product reinforced with discrete glass fibres of varying length and size. The glass fibre used is alkaline resistant as glass fibre are susceptible to alkali which decreases the durability of GFRC. Glass strands are utilized for the most part for outside claddings, veneer plates and different components where their reinforcing impacts are required during construction.

The main area of FRC applications are as follows

A. Runway, Aircraft Parking and Pavements
B. Tunnel lining and slope stabilization
C. Blast Resistant structures
D. Thin Shell, Walls, Pipes, and Manholes
E. Dams and Hydraulic Structure
F. Different Applications include machine tool and instrument frames, lighting poles, water and oil tanks and concrete repairs.

III. MATERIALS

1) *Cement* is an extremely ground material having adhesive and cohesive properties which provide a binding medium for the discrete ingredients. The processes used for manufacture of cement can be classified as dry and wet. The cement commonly used is Portland cement, it is also defined as hydraulic cement, i.e. a cement which hardens when it comes with water due to chemical reaction but there by forming a water resistant product. Portland cement is obtained when argillaceous and calcareous materials are grounded to fine powder and mixed in definite proportion and fused at high temperature. When blast furnace slag is also used as one of the ingredients than the cement obtained is called Ordinary Portland cement (OPC) -53 grade.
2) *Fine Aggregates* are generally obtained from natural deposits of sand and gravel, or from quarries by cutting rocks. The least expensive among them are the regular sand and rock which have been lessened to present size by characteristic specialists, for example, water, wind and snow and so on. The fine aggregate used for the experimental programme was M sand. The fine aggregate passed through 4.75 mm sieve and had a specific gravity of 2.66. The sand belonged to zone III as per IS standards.

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3) *Water* is the one most essential element of cement. Water assumes the vital part of hydration of concrete which frames the coupling lattice in which the dormant totals are held in suspension medium until the grid has solidified, furthermore it serves as the lubricant between the fine and coarse aggregates and makes concrete workable.
4) *Fibre* is a natural or synthetic string or used as a component of composite materials, or, when matted into sheets, used to make products such as paper, papyrus, or felt. Concrete is brittle by nature and is weak in flexure as well as direct tension therefore in order to improve this properties fibres are added to concrete. Various types of fibres have been added to concrete some have high modulus of elasticity some have low modulus of elasticity each category can improve certain properties of concrete. In our case short discrete glass fibres were used and as glass fibre is susceptible to alkali we used alkali resistant glass fibres.

Fig.1 Glass fibre

5) *Bentonite* in civil engineering applications is used traditionally as a thixotropic, support and lubricant agent in diaphragm walls and foundations, in tunnelling, in horizontal directional drilling and pipe jacking. It was found that significant compressive strength was achieved at 15.0 % replacement of Bentonite for OPC & 12.5% for PPC. The mechanical strength benefits can be obtained with the addition to the bodies of treated bentonites, with high smectite content, in such small amounts (1.5-2.5%)

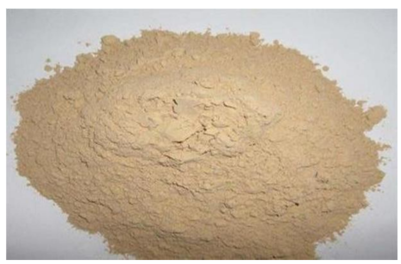

Fig.2 Bentonite powder

Test of raw materials was done before the casting of tiles to ensure safety, quality and the efficacy of the concrete roof tile produced.

<table>
<tr><td colspan="6">TEST ON CEMENT</td></tr>
<tr><td>Specific Gravity</td><td colspan="2">Fineness Modulus (%)</td><td colspan="2">Standard Consistency (%)</td><td>Initial and Final Setting Time (Minutes)</td></tr>
<tr><td>3.13</td><td colspan="2">9%</td><td colspan="2">30%</td><td>Initial time = 35 Minutes Final time = 175 Minutes</td></tr>
<tr><td colspan="6">TEST ON FINE AGGREGATE</td></tr>
<tr><td colspan="2">Specific Gravity</td><td colspan="2">Fineness Modulus (%)</td><td colspan="2">Water Absorption (%)</td></tr>
<tr><td colspan="2">2.66</td><td colspan="2">3.65%</td><td colspan="2">2.54%</td></tr>
<tr><td colspan="6">WATER CONTENT</td></tr>
<tr><td colspan="2">Consistency of Concrete</td><td colspan="2">Quantity of Water (Litres per C kg. Cement)</td><td colspan="2">Observation</td></tr>
<tr><td colspan="2">Dry</td><td colspan="2">C x 0.5</td><td colspan="2" rowspan="3">Aggregates should be slightly moist (1 to 2 percent humidity)</td></tr>
<tr><td colspan="2">Plastic</td><td colspan="2">C x 0.6 to 0.7</td></tr>
<tr><td colspan="2">Fluid</td><td colspan="2">C x 0.75 to 0.8</td></tr>
</table>

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Indian standard codes for test of raw materials

A. Specific gravity of cement IS 2720 PART 3
B. Fineness modulus of cement IS 4031 PART 1
C. Consistency of cement IS 4031 PART 4
D. Specific gravity of fine aggregate IS 2386 PART 3
E. Fineness modulus of fine aggregate IS 2386 PART 1
F. Water absorption of fine aggregate IS 2386 PART 3

The basic materials remain the same but superplasticizers, admixtures, micro fillers are also being used to get the desired properties like workability, Increase or decrease in setting time and higher compressive strength.
The ideal ratio of the mortar mix required for this technology is given by the weight of Dry materials, i.e. a cement : sand ratio of 1:3.

IV. CASTING AND CURING OF TILES

The tiles were prepared as per the guidelines of IS 1237:2012. The size chosen was one of the standard sizes mentioned in the code. The size was 300mm*300mm*20mm.The tiles were prepared from a mixture of Ordinary Portland cement, fine aggregates and glass fibre after casting this tiles were vibrated. The tiles were single layered and outmost care was taken to prepare them so that thickest and thinnest tile in the sample when compared did not exceed 10% of the minimum thickness. The mix was prepared by machine and then the mix prepared was poured in the moulds one at a time and then first they were hand compacted after that vibrated on the vibrator table. The surface finishing was done by using a finishing trowel. After pouring in the moulds and compacting on the vibrator table the moulds were put down on the surface and allowed to set for 24hrs.


Fig.3 Mixing with Glass Fibre Fig.4 Addition of water


Fig.5 Addition of Super plasticizer (1%) Fig.6 Greasing the mould


Fig.7 Finishing with Trowel


Fig.8 After Vibration

In order to obtain a uniform mix thorough mixing of concrete is necessary. Concrete can be produced in two ways either by hand mixing or machine mixing. Hand mixing can be done on a plane levelled surface such as a wooden platform or a paved surface having tight joints so as to prevent paste loss To do mixing first the surface is cleaned and then moistened after that sand is first poured on the surface and then cement is spread on the sand after that thorough mixing is done.
After that water is added and mixed again until a uniform coloured mix is obtained. After all this process the concrete is dropped on a flat and clean plate from where we take it and fill our moulds. All specimens were first filled in their respective moulds and then hand compacted using a rod of 30mm diameter in three layers by tamping 20 times on each layer .
To attain full compaction the specimen were vibrated on vibrator table. The tiles were prepared by putting the concrete in the mould and then hand tamping using a plane surfaced wooden block and then the mould was held tight by hands and vibrated on the vibrator table. A significant part of the physical properties of cement rely on upon the degree of hydration of bond and the resultant microstructure of the hydrated concrete.
Hydration of cement takes place only when the capillary pores remain saturated. Curing is necessary to make the concrete more durable, strong, impermeable and resistant to abrasion and frost. Curing starts as soon as the concrete reaches its final set. It is generally recommended to do curing for at least 14 days to attain at least 90% of the expected strength. In our case pond curing method was used for all specimens including tiles.

V. RESULTS

The effect of glass fibres on cement and concrete tiles which are produced by vibration method are also studied. The properties studied are compressive strength, wet transverse strength and water absorption. The concrete mix gets harsher and less workable with increase of fibre content therefore use of admixture become necessary. Therefore it was not possible to go beyond 0.7% fibre content.

S. no	Test	Test results for varying % of Glass fibre							Without Glass fibre
		0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.7%	
1.	Compressive strength (N/mm^2)	37	37	36	38	33	32	31	45
2.	Wet transverse (N/mm^2)	1.64	1.72	1.87	1.94	2.24	2.39	2.54	1.41
3.	Water absorption (in %)	2.30	1.95	1.57	1.22	1.19	1.17	1.02	2.69

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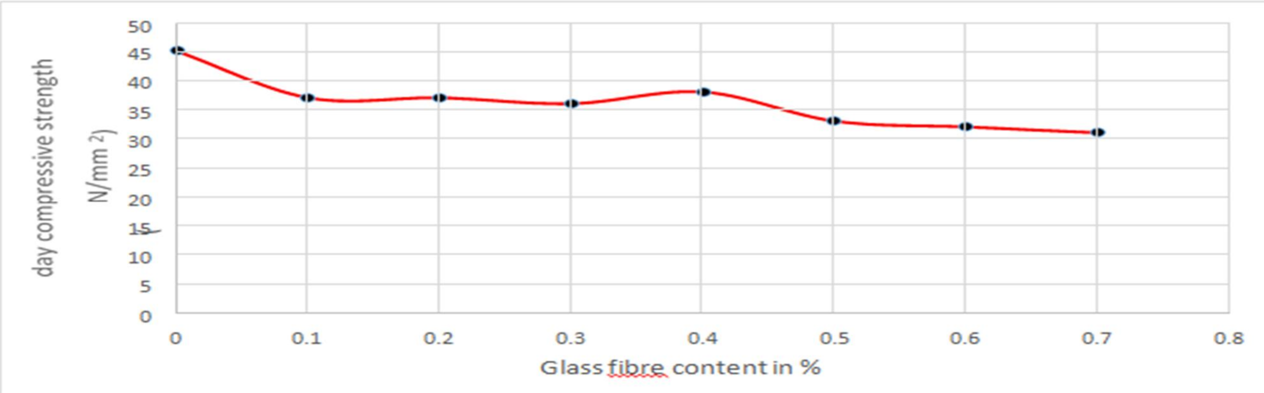

Figure 9 Effect of Glass fibres on 28 days Compressive Strength

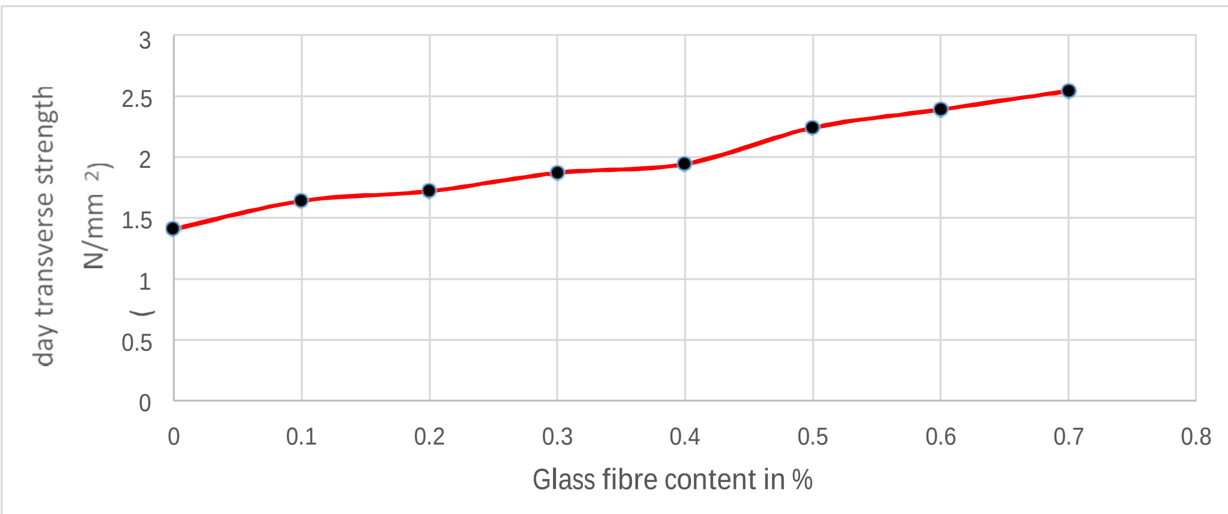

Figure 10 Effect of Glass fibres on 28 days Wet Transverse Strength

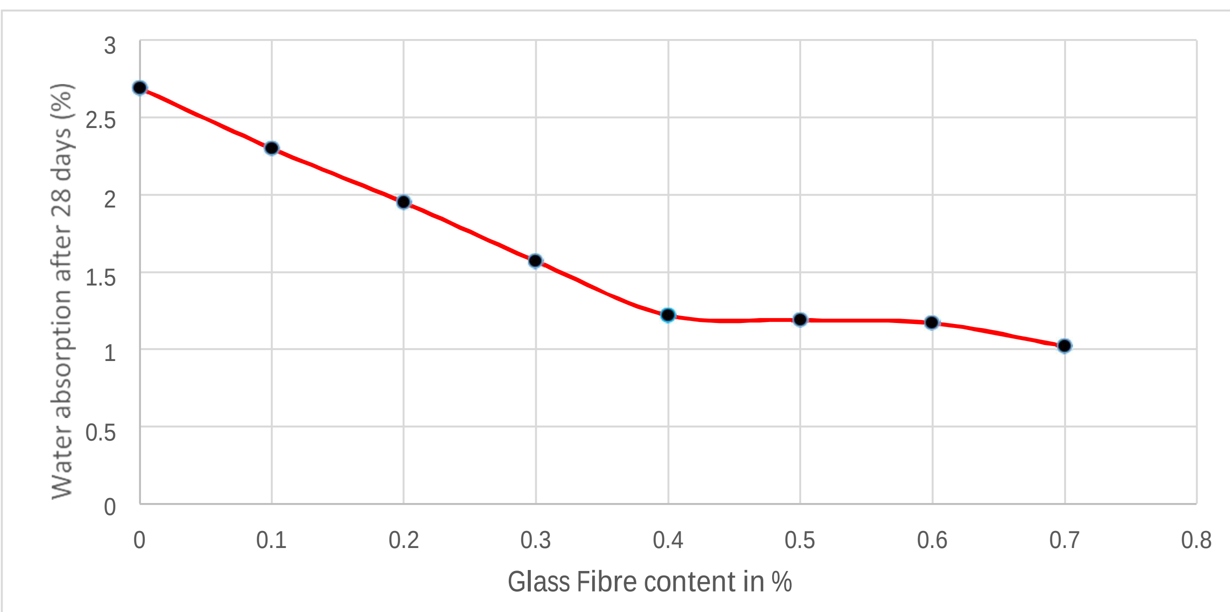

Figure 11 Effect of Glass fibres on 28 days Water absorption of concrete

Visual Test IS 1237:2012

Flatness of Tile Surface: The concavity and convexity in the tiles did not exceed 1 mm.

Perpendicularity: The maximum gap between the arm of the square and the edge of the tile did not exceed 2 percent of the length of the edge of the tile.

Fig.12 Straightness Fig.13 Perpendicularity

VI. CONCLUSIONS

A. The compressive strength of concrete without admixture is not affected by the presence of short discrete glass fibres with fibre content in the range 0.1 to 0.3 % of fibre content by weight of concrete.

B. The split tensile strength of concrete increases with the addition of glass fibres.

C. The flexural strength of concrete increases with increase in fibre content and as such the tension carrying capacity of concrete may increase in flexure.

D. The wet transverse strength of tiles increases and the increase has been found with addition of fibres

E. The water absorption of the concrete also decreases with increase in fibre content.

F. The compressive strength of concrete with admixture was not affected 0.4 % fibre content but decreased with the presence of higher amount of fibres.

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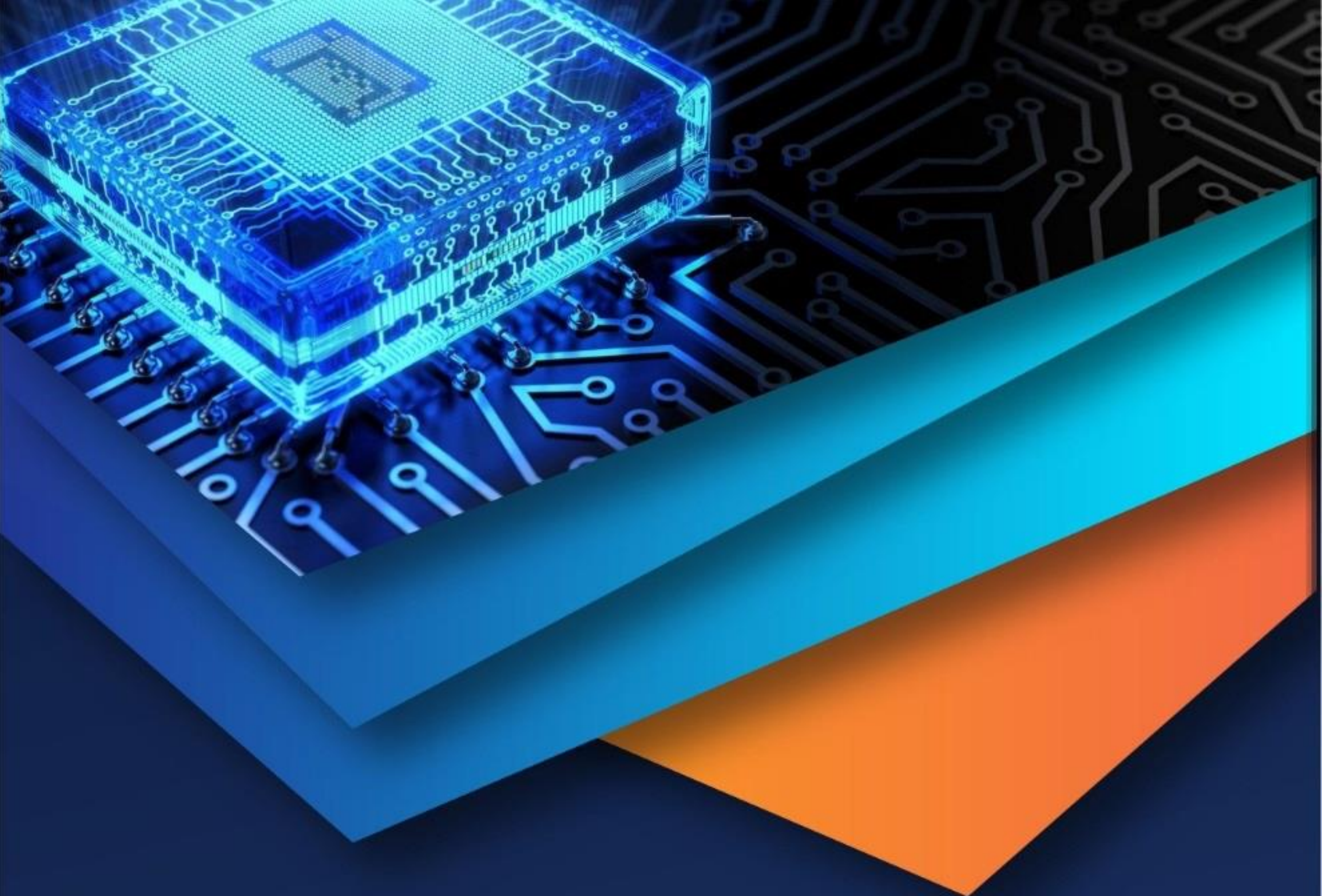

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