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AN EXPERIMENTAL INVESTIGATION ON FIBRE REINFORCED TRANSPARENT CONCRETE

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Abstract - *The transparent concrete is the one of the materials used to introduce the natural light inside the building or to reduce the power consumption and also to increase the indoor brightness in civil structures. It is the concrete based building material which is having light transmitting properties.*

The main objective of this work is to study the characteristics properties of GI fibre reinforced transparent concrete for different percentages of GI fibres. The percentage of GI fibre used in this work is 0%. 0.5%, 1.0%, 1.5% and 2%. In this work the plastic optical fibre is introduced in the concrete. Different strength parameters of the conventional concrete and transparent concretes with different percentage of GI fibres are studied after 28days of curing like compressive strength and flexural strength. Along with these above tests, light transmittance test, water absorption test and soroptivity tests are studied.

By the results it may be concluded that the strength parameter of transparent concrete reaches a peak value at 1.5% addition of GI fibres.

Key Words: Plastic optical fibre, GI fibre, LDR, Compressive strength, Flexural strength, Light transmittance.

1. INTRODUCTION

Concrete is important constructional material extensively used all over the world. Concrete has a key role in development of building, infrastructure and housing.

The transparent concrete is the one of the materials used to introduce the natural light inside the building or to reduce the power consumption and also to increase the indoor brightness in civil structures. It is the concrete based building material which is having light transmitting properties.

The first transparent concrete is introduced in 2001 by the Hungarian architect Aron Losonczi. This concrete block isfirst produced successfully in 2003. Large amount of the glass fibres are used in this concrete. This concrete is named as "LiTraCon" (Light transmitting concrete).This concrete is manufactured by using optical fibre and concrete or mortar.

In this study, compressive and flexural strength of conventional and GI fibre reinforced transparent concrete is studied. And also water absorption, soroptivity and light transmittance of the transparent concrete is studied.

2. MATERIALS AND ITS PROPERTIES

2.1 Cement: OPC 43 Grade cement of specific gravity of 3.15 is used in this work.

2.2 Fine aggregate: Fine aggregate used in this project is having a specific gravity 2.60. Zone-II sand is used. Water absorption of fine aggregate 1.0%.

2.3 Coarse aggregate: The natural crushed aggregate is used for this work. The aggregate which is passing 6.13 mm and retained on 2.00 mm is used for preparing the concrete mix. Specific gravity of coarse aggregate is 2.65. Water absorption of coarse aggregate is 0.5%.

2.4 Optical fibre: In this study plastic optical fibre of diameter 1mm is used.

2.5 GI fibre: The galvanized iron fibre of 1mm diameter is used in concrete mix. The length of the fibre is kept as 15mm. The aspect ratio of the fibre is 15. The fibre is added in concrete in different volume fraction like 0%, 0.5%, 1.0%, 1.5% and 2.0%. Density of the GI fibre is 7850 kg/m^3.

3. METHODOLOGY

3.1 Preparation of mould

The moulds are prepared in required pattern as shown in Figure 1 and Figure 2. In cube mould the spacing of the fibres are kept 10mm c/c in required pattern as shown Figure 1. For the beam specimen mould the holes are made on all the four side of the plates. The spacing of the holes is kept 20mm c/c spacing. This beam mould is made by GI sheet.

Figure: 1 Cube mould

Figure: 2 Beam mould

3.2 Placing of optical fibre

It is the very difficult job to pass the fibre from one side to another side of the mould. Initially the optical fibres are passed as per required pattern. For the cube mould the fibres as kept 10mm c/c spacing both ways. Similarly for the beam mould the fibres are kept 20mm c/c spacing. In beam mould the fibres are provided in both the direction.

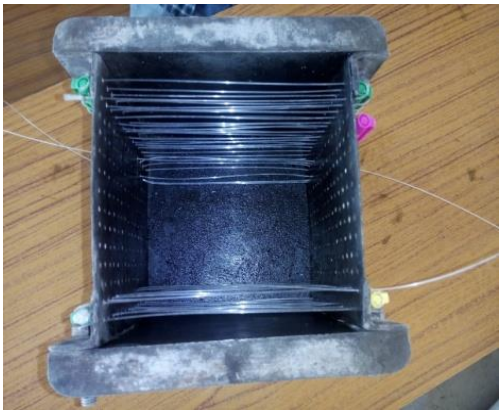

Figure: 3 Placing of optical fibre

3.3 Mix Proportion

The mix design of M30 concrete grade was carried out as per IS 10262-2009. It yielded a proportion of 1:2.15:1.61 with a w/c ratio of 0.45.

4. TEST RESULTS AND DISCUSSIONS

4.1 Results

4.1.1 Test results on slump

Table 1 shows the slump cone test results for concrete with different percentages of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%.

Table 1 Slump cone test result

Percentage of GI fibre	Initial reading of the graduated rod in mm	Final reading of the graduated rod in mm	Slump value in mm
0.0%	300	240	60
0.5%	300	260	40
1.0%	300	268	32
1.5%	300	275	25
2.0%	300	380	20

4.1.2 Test results on compaction factor

Table 2 shows the compaction factor test results for concrete with different percentages of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%.

Table 2 Compaction factor test results

Percentage of GI fibre	Compaction factor
0.0%	0.792
0.5%	0.778
1.0%	0.775
1.5%	0.761
2.0%	0.752

4.1.3 Test results on flow table

Table 3 shows the flow table test results for concrete with different percentages of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%.

Table 3 Flow table test result

Percentage of GI fibre	Percentage flow
0.0%	43.68
0.5%	38.60
1.0%	35.68
1.5%	35.00
2.0%	33.32

4.1.4 Test results on Vee-Bee Consistometer

Table 4 shows the Vee-Bee consistometer test results for concrete with different percentages of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%.

Table 4 Vee-Bee consistometer test results

Percentage of GI fibre (Volume fraction)	Vee-Bee degree in sec
0.0%	26
0.5%	30
1.0%	33
1.5%	39
2.0%	43

4.1.5 Water absorption

Table 5 shows the water absorption test results for the conventional concrete and transparent concrete with different percentage of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%.

Table 5 Water absorption test results

Percentage of GI fibre	Percentage of water absorption
Conventional concrete (Without POF and GI fibre)	0.55
0.0% GI	0.50
0.5% GI	0.46
1.0% GI	0.42
1.5% GI	0.40
2.0% GI	0.37

4.1.6 Soroptivity

Table 6 shows the soroptivity test results for the conventional concrete and transparent concrete with different percentage of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%.

Table 6 Soroptivity test results

Percentage of GI fibre	Soroptivity in $mm/min^{1/2}$
Conventional concrete (Without POF and GI fibre)	5.69
0.0%	5.66
0.5%	4.17
1.0%	3.63
1.5%	3.48
2.0%	2.99

4.1.7 Light transmittance

Table 7 shows the light transmittance test results for the conventional concrete and transparent concrete with different percentage of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%.

Table 7 Light tranmmitance test results

Percentage of GI fibre	Without sample ammeter reading (A1) in mA	With sample ammeter reading (A2) in mA	Light transmittance in percentage $= 100 - \frac{A1-A2}{A1} \times 100$
Conventional concrete (Without POF and GI fibre)	7.20	0.00	0.00
0.0%	7.20	0.30	4.16
0.5%	7.20	0.25	3.47
1.0%	7.20	0.30	4.16
1.5%	7.20	0.30	4.16
2.0%	7.20	0.25	3.47

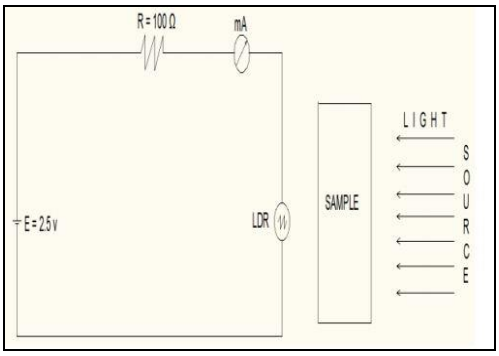

Figure 4 Circuit diagram for light transmittance test

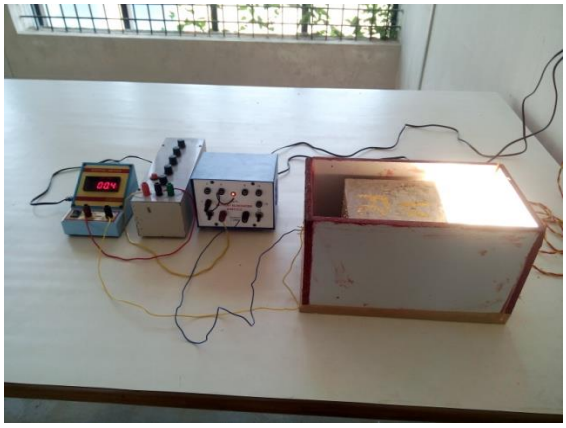

Figure 5 Experimental setup for light transmittance test

4.1.8 Compressive strength

Table 8 shows the compressive strength test results for the conventional concrete and transparent concrete with different percentage of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%. Figure 6 shows the variation of compressive strength results.

Table 8 Compressive strength results

Percentage of GI fibre	Average compressive strength (N/mm^2)	Percentage increase of compressive strength w.r.t conventional concrete
Conventional Concrete (Without POF and GI fibre)	32.59	--
0.00%	34.07	4.55
0.50%	35.41	8.64
1.00%	36.89	13.18
1.50%	37.93	16.36
2.00%	37.19	14.09

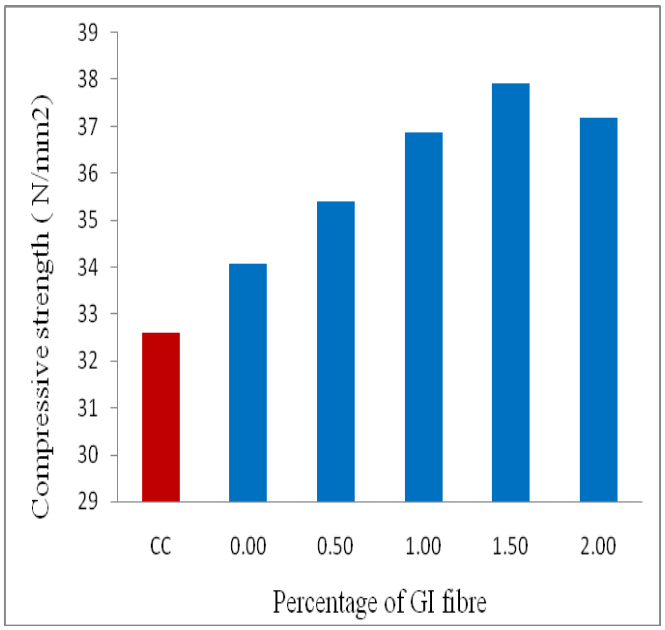

Figure 6 Variation of compressive strength

4.1.9 Flexural strength

Table 9 shows the flexural strength test results for the conventional concrete and transparent concrete with different percentage of GI fibres like 0.0%, 0.5%, 1.0%, 1.5% and 2.0%. Figure 7 shows variation of flexural strength results.

Table 9 Flexural strength result

Percentage of GI fibre	Average flexural strength (N/mm²)	Percentage increase of flexural strength w.r.t conventional concrete
Conventional Concrete (Without POF and GI fibre	3.00	--
0.00%	3.27	8.89
0.50%	3.47	15.56
1.00%	3.93	31.11
1.50%	4.67	55.56
2.00%	4.13	37.78

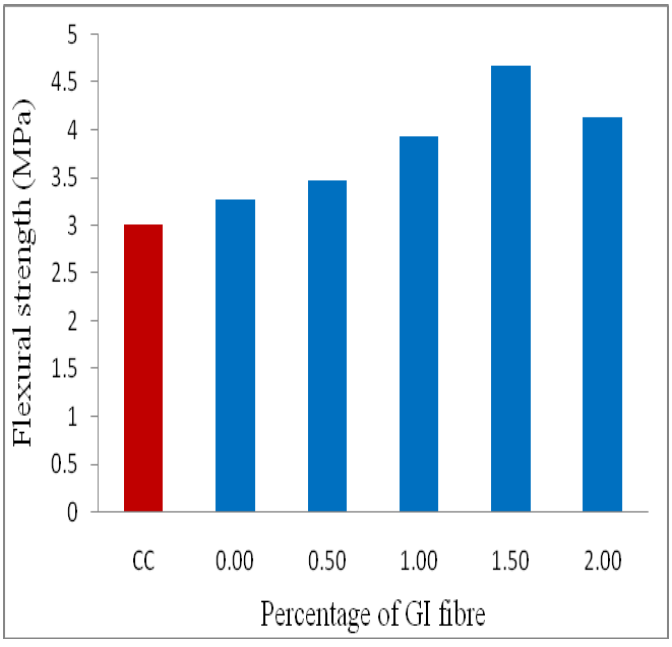

Figure 7 Variation of flexural strength

4.2 Discussions

The workability values as measured from slump, compaction factor, percentage flow and Vee-Bee degree go on decreasing as the percentage of GI fibres in the concrete increase.

The water absorption of GI fibre reinforced transparent concrete goes on decreasing as the percentage of GI fibre increases. This may be due to the fact that more percentage of GI fibres offers more obstruction to the flow of moisture through the concrete mass.

The soroptivity of GI fibre reinforced transparent concrete goes on decreasing as the percentage of GI fibres increases.

The compressive strength of GI fibre reinforced transparent concrete goes on increasing up to 1.5% addition of GI fibres in it. After 1.5 % addition, the compressive strength decreases. The percentage increase in the compressive strength is found to be 16.36% when 1.5% GI fibres are added with reference to the conventional concrete without optical fibres. Thus the higher compressive strength for GI fibre reinforced transparent concrete may be obtained by adding 1.5% GI fibres.

The flexural strength of GI fibre reinforced transparent concrete goes on increasing up to 1.5% addition of GI fibres in it. After 1.5 % addition, the flexural strength decreases. The percentage increase in the flexural strength is found to be 55.56% when 1.5% GI fibres are added with reference to the conventional concrete without optical fibres. Thus the higher flexural strength for GI fibre reinforced transparent concrete may be obtained by adding 1.5% GI fibres.

The percentage light transmission has remained almost same for all the percentage additions of GI fibres in GI fibre reinforced transparent concrete. This is obviously due to the fact that the optical fibres kept in all the specimen is same.

5. CONCLUSIONS

Following conclusions may be drown based on the observations made.

1. The workability of GI fibre reinforced concrete decreases as the percentage of GI fibre in it increases.
2. The water absorption of GI fibre reinforced transparent concrete goes on decreasing as the percentage of GI fibres increases.
3. The soroptivity of GI fibre reinforced transparent concrete goes on decreasing as the percentage of GI fibres increases.

4. The higher compressive strength for GI fibre reinforced transparent concrete may be obtained by the addition of 1.5% GI fibres.
5. The higher flexural strength for GI fibre reinforced transparent concrete may be obtained by the addition of 1.5% GI fibres.
6. The light transmission percentage will remain almost constant for all the percentage addition of GI fibres in GI fibre reinforced transparent concrete.

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