An Experimental Study on Translucent Concrete

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***Abstract*- In the present research work, the compressive strength of cubes for 7days, 14days, and 28days were made with two different percentages of fibre that is 0.3% and 0.6%. In the existing study, both concrete and mortar blocks were prepared of size 100mm X 100mm X 100mm in order to study the behavior of light transmission index in both the samples. To proceed with the further study different configurations of fibres are used to substantiate the effective usage of optical fibres. The existing study is also an attempt to know the strength and durability parameters of Translucent concrete. The following tests conducted in order to study strength and durability parameters are Compressive strength test, Acid resistant test, Sulphate resistant test and Light transmissibility test to understand the transmissibility index.**

Keywords— Optical fibre, Acid resistant test, Sulphate resistant test, Light transmissibility test, Transmissibility index

I. INTRODUCTION

At present, green structures are greatly focusing on saving energy with indoor thermal systems. However, in area of illumination field, there is little research offering relevant solution. Translucent concrete is new technique different from normal concrete. Translucent concrete allow more light and less weight compared to normal concrete. The use of sunlight instead of using electrical energy is main purpose of translucent concrete, so as to reduce the load on non- renewable sources and result it into the energy saving. Research shows that addition of 0.25% of optical fibres increases compressive strength approximately around 23% and tensile strength approximately around 80% [1]. Similar research also shows that for obtaining translucent concrete mixture of polycarbonate and epoxy matrices can be used. The content of the component is: epoxy matrix from 0% to 90%, and the polycarbonate matrix from 0% to 10%, colloidal silica sol from 0.5% to 5%, fibreglass from 0% to 10%, silica from 0.5% to 10%, diethylenetriamine (DETA). The ratio of the polymer matrices and the mortar is at least 1.5:1. The different percentage of components used, yielded a very good light transmissibility properties and as well as the concrete does not lose the strength parameter when compared to regular concrete and also it has very vital property for the aesthetical point of view [2]. Research's published also shows that the compressive strength of light transmitting concrete with 10% replacement of cement by silica fume has been increased by 17.13% than that of conventional concrete. It is observed that the split tensile strength of concrete with 10% replacement of cement by silica fume increased by 13.61% compared to CC and 8.26% for 15% replacement [3].

II. EXPERIMENTAL INVESTIGATION

Materials

The strength of Translucent concrete incorporated with optical fibres is to study in determining the mechanism of strength and durability of concrete. The making of translucent concrete incorporated with optical fibres consisting of five types of raw material, namely OPC (ordinary Portland cement), fine aggregates, coarse aggregates, water, and optical fibres. Ordinary Portland cement (OPC) of grade 53 was used throughout the study. The fine aggregates have been used as a filler material for the present study with specific gravity of 2.53 and coarse aggregate of 2.35 specific gravity. The maximum size of coarse aggregates used were 6mm. Potable water has been used for casting concrete specimens. The commonly available diameters of optical fibres are 0.25 mm, 0.5 mm, 0.75 mm, 1 mm, and 2 mm. In this project the optical fibre of diameter 1mm are used.

III. METHODOLOGY

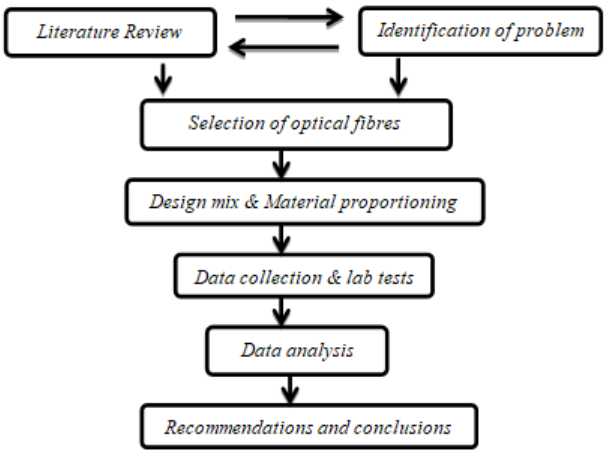

Fig 1: Methodology

We use M25 grade concrete as per IS10262:2009 and mortar ratio of 1:4. Different configurations of optical fibres used in cubes are as shown in the figure below.

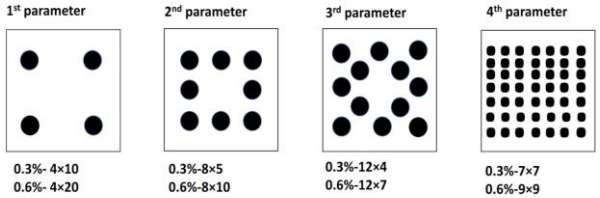

Fig 2: Different Configurations

Table 1: Test properties of different materials

Sl. No	Materials	Test	Result / Values
1	Cement	Fineness Of Cement	5%
		Normal Consistency	32%
		Specific Gravity	3.16
		Initial Setting Time	95 mins
		Final Setting Time	630 mins
2	Fine Aggregates	Specific Gravity	2.53
		Sieve Analysis	Zone I Table 4 of IS 383 (1970)
3	Coarse Aggregates	Specific Gravity	2.35
		Water Absorption	0.50%
		Sieve Analysis	Zone I Table 4 of IS 383 (1970)

IV. MIX DESIGN CALCULATIONS:

The mix proportioning was done using IS 10262:2009, as per this method proportions of materials required for $1m^3$ of concrete is 1:1.87:2.57 and W/C ratio- 0.5. The proportion used for preparation of mortar cube is 1:4.

V. MECHANICAL AND DURABILITY TESTS

A. Compressive Strength Test of Concrete:

For cube test the size of the cubes used was 10cm×10cm×10cm. These specimens are tested by compression testing machine after 7, 14 & 28 days of curing. Load should be applied gradually at the rate of 140 kg/cm^2 per minute till the specimens fails Load at the failure divided by area of specimen gives the compressive strength of concrete.

B. Acid Resistance Test:

The acid resistance test was conducted on 100 mm size cubes specimen after curing for a period of 28 days. Then the specimen cubes were weighed and immersed in water diluted with 2N, 10% by weight of HCl acid for 8 weeks. In this process the specimen cubes were subjected to alternate drying and wetting for every 2 days.

C. Sulphate Resistance Test:

The effect of sulphate attack results in chemical break down in components of cement paste. In this study the sulphate resistance test was conducted on 100 mm size cube specimens after curing for a period of 28 days. Then the specimen cubes were weighed and immersed in water diluted with 5% by weight of $MgSO_4$ for 8 weeks.

D. Light Transmissibility Test:

Transmissibility of the bulb of 9 Watts kept at a certain distance was found to be 3800 Lux. Then, the transmissibility values were obtained by placing translucent concrete samples.

$$\% \text{ Transmissibility} = \frac{\text{Transmissibility through concrete}}{\text{Transmissibility through air}} * 100$$

Therefore Light intensity is noted in terms of lumecs.

Fig 3: Testing of Concrete block

Fig 4: Testing Concrete block Parameters along with HCL

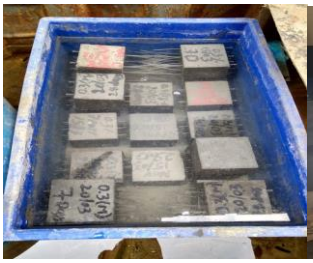

Fig 5: Testing Concrete block Of all parameters along with MgSo4

Fig 6: Light Intensity Test

Table 2: Compressive Strength of Conventional Concrete

Compressive Strength Of Conventional Concrete				
Categories	**Sl no**	**Particulars**	**No of days of curing**	**Compressive Strength ($N\backslash mm^2$)**
Concrete	1	Normal	7	18.40
	2		14	21.80
	3		28	26.70
Mortar	4	Normal	7	43.10
	5		14	53.25
	6		28	63.40

Table 3: Compressive Strength of Translucent Concrete for 0.3 % POF

Compressive Strength of Translucent Concrete For 0.3 % POF				
Categories	**Sl no**	**Particulars (Strads * Location)**	**No of days of Curing**	**Compressive Strength ($N\backslash mm^2$)**
Concrete	1	1st parameter (10*4)	7	17.60
	2		14	22.30
	3		28	26.70
	4	2nd parameter (5*8)	7	18.70
	5		14	23.45
	6		28	27.20
	7	3rd parameter (4*12)	7	16.70
	8		14	21.80
	9		28	27.40
	10	4th parameter (1*49)	7	17.30
	11		14	23.80
	12		28	25.60
Mortar	13	1st parameter (10*4)	7	28.45
	14		14	35.50
	15		28	49.50
	16	2nd parameter (5*8)	7	21.20
	17		14	37.40
	18		28	53.50
	19	3rd parameter (4*12)	7	26.80
	20		14	34.60
	21		28	54.15
	22	4th parameter (1*49)	7	28.30
	23		14	37.45
	24		28	55.60

Table 4: Compressive Strength of Translucent Concrete for 0.6% POF

Compressive Strength of Translucent Concrete For 0.6 % POF				
Categories	**Sl no**	**Particulars (Strads * Location)**	**No of days of curing**	**Compressive strength (N\mm^2)**
Concrete	1	1st parameter (20*4)	7	16.70
	2		14	22.30
	3		28	26.75
	4	2nd parameter (10*8)	7	17.85
	5		14	23.70
	6		28	27.15
	7	3rd parameter (7*12)	7	15.40
	8		14	21.50
	9		28	26.65
	10	4th parameter (1*81)	7	15.85
	11		14	22.35
	12		28	26.45
Mortar	13	1st parameter (20*4)	7	27.70
	14		14	38.50
	15		28	54.10
	16	2nd parameter (10*8)	7	39.50
	17		14	46.32
	18		28	55.40
	19	3rd parameter (7*12)	7	35.40
	20		14	40.20
	21		28	56.15
	22	4th parameter (1*81)	7	39.20
	23		14	41.45
	24		28	53.10

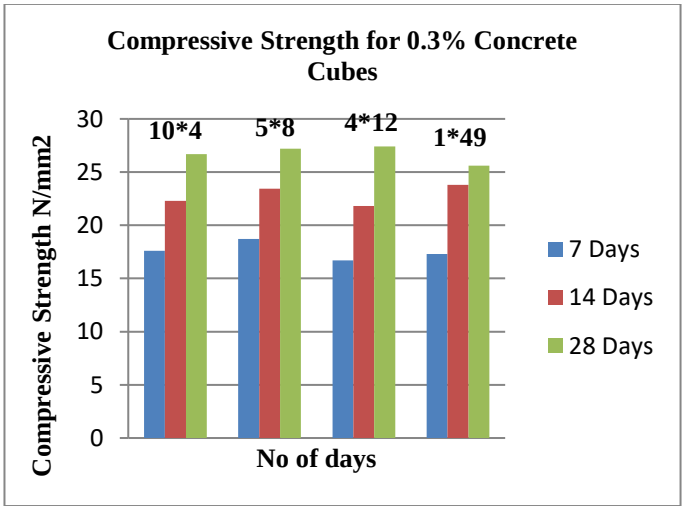

Fig 7: Compressive Strength for 0.3% Concrete Cubes

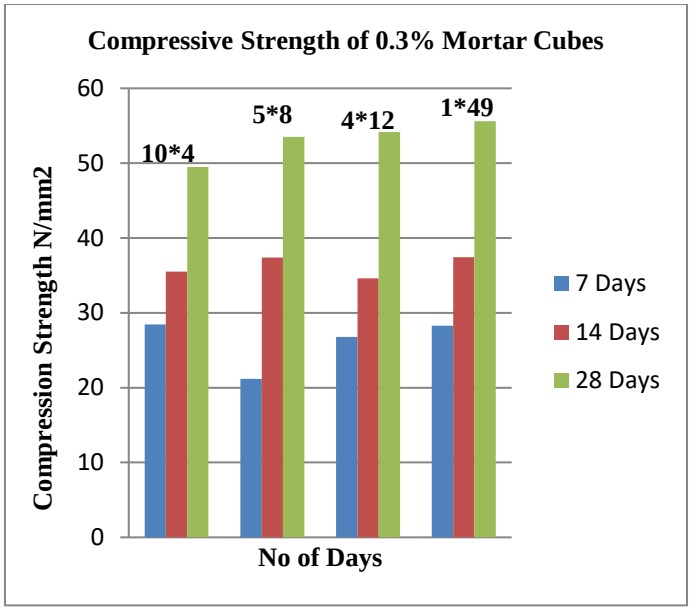

Fig 8: Compressive Strength for 0.3% Mortar Cubes

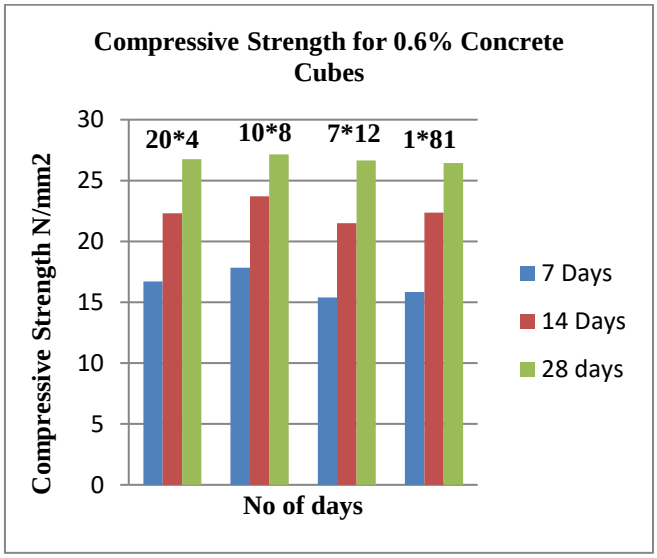

Fig 9: Compressive Strength for 0.6% Concrete Cubes

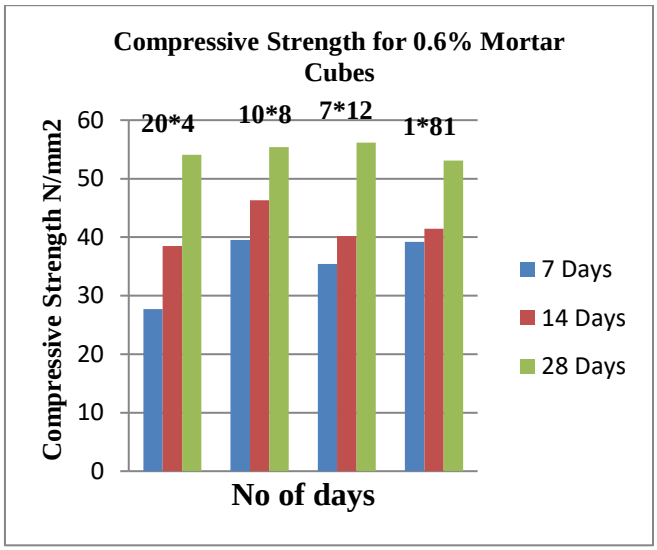

Fig 10: Compressive Strength of 0.6% Mortar Cubes

Table 5: Acid Attack (Hydrochloric Acid-HCl) for Conventional and Translucent concrete and mortar

Categories	% of POF	Sl no	Particulars (Strands *Location)	Compressive strength (N\mm^2)		Weight loss (Kg)
				7 Days	28 Days	
Concrete	0.30%	1	(10*4)	24.1	23.4	0.11
		2	(5*8)	23.3	22.65	0.16
		3	(4*12)	27	26.25	0.15
		4	(1*49)	28.55	27.35	0.1
	Normal	5	normal	32.6	30.45	0.15
	0.60%	6	(20*4)	31.9	29.68	0.01
		7	(10*8)	27.6	26.35	0.1
		8	(7*12)	33.8	31.25	0.05
		9	(1*81)	31.62	29.8	0.1
Mortar	0.30%	10	(10*4)	52.2	51.45	0.1
		11	(5*8)	53.4	52.3	0.15
		12	(4*12)	53.15	52.16	0.08
		13	(1*49)	54.6	53.1	0.11
	Normal	14	Normal	53.8	52.4	0.15
	0.60%	15	(20*4)	46.78	45.32	0.05
		16	(10*8)	49.6	48.75	0.08
		17	(7*12)	48.4	48.1	0.16
		18	(1*81)	49.35	48.55	0.02

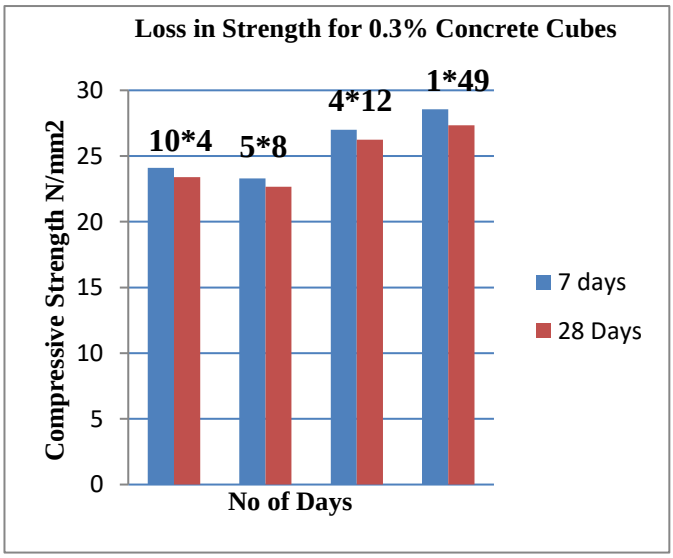

Fig11: Loss in Strength for 0.3% Concrete Cubes

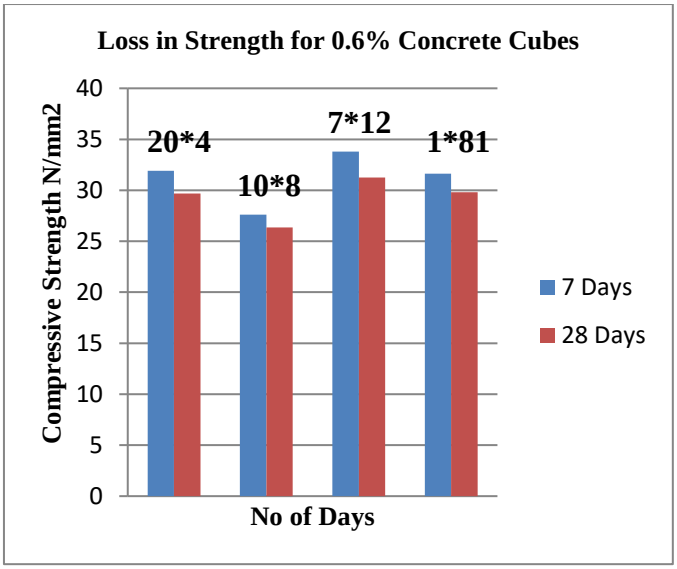

Fig12: Loss in Strength for 0.6% Concrete Cubes

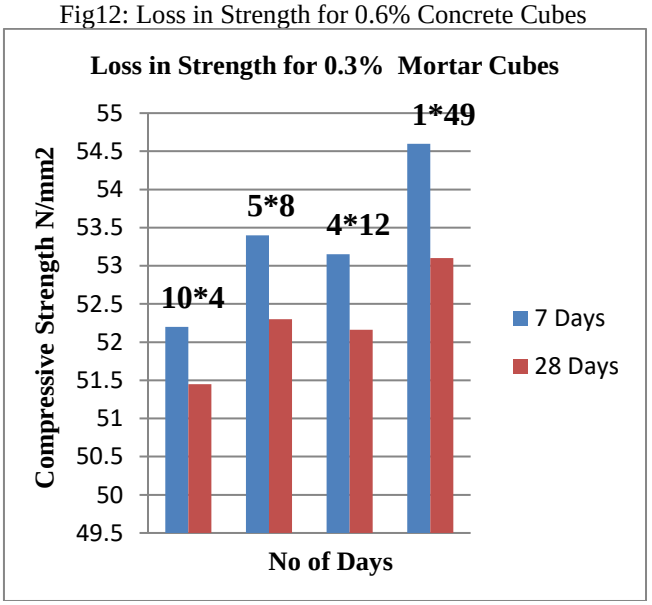

Fig13: Loss in Strength for 0.3% Mortar Cubes

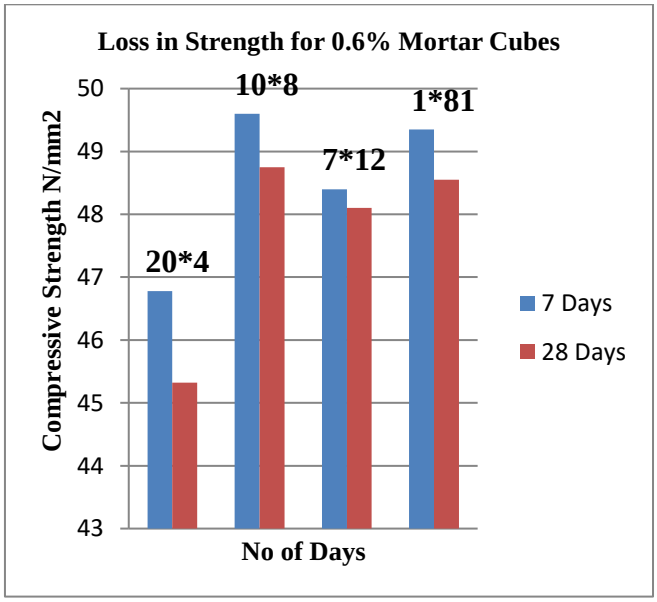

Fig14: Loss in Strength for 0.6% Mortar Cubes

Table 6: Sulphate Attack (Magnesium Sulphate-$MgSo_4$) Conventional and Translucent for concrete and mortar

Categories	% of POF	Sl No	Particulars (Strads * Location)	Compressive strength (N\mm^2)		Weigh t loss (Kg)
				7 Days	28 Days	
Concrete	0.30%	1	(10*4)	26.5	24.25	0.11
		2	(5*8)	26.1	24.5	0.15
		3	(4*12)	25.5	24.1	0.18
		4	(1*49)	26.7	24.8	0.17
	Normal	5	Normal	26.15	25.1	0.14
	0.60%	6	(20*4)	27.2	26.85	0.11
		7	(10*8)	32.2	29.19	0.17
		8	(7*12)	31.15	29.6	0.18
		9	(1*81)	30	28.85	0.19
Mortar	0.30%	10	(10*4)	52.7	51.35	0.1
		11	(5*8)	47.1	46.1	0.15
		12	(4*12)	49.35	49.1	0.12
		13	(1*49)	53.46	52.58	0.1
	Normal	14	Normal	54.15	53.12	0.19
	0.60%	15	(20*4)	54.1	53.3	0.18
		16	(10*8)	52.65	52.15	0.17
		17	(7*12)	54.78	53.2	0.19
		18	(1*81)	54.2	53.66	0.2

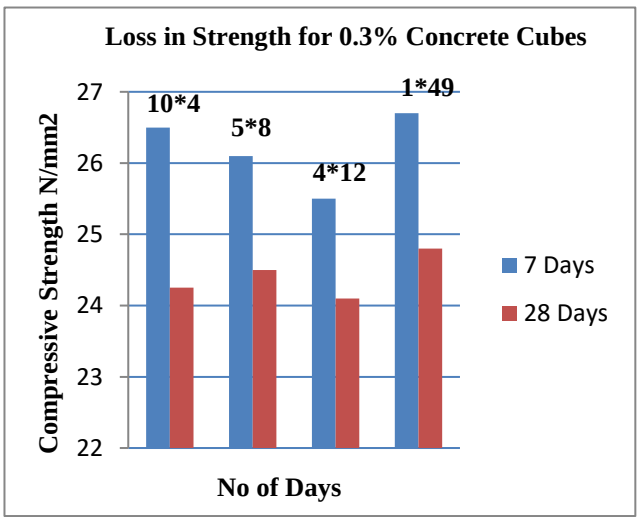

Fig 15: Loss in Strength for 0.3% Concrete Cubes

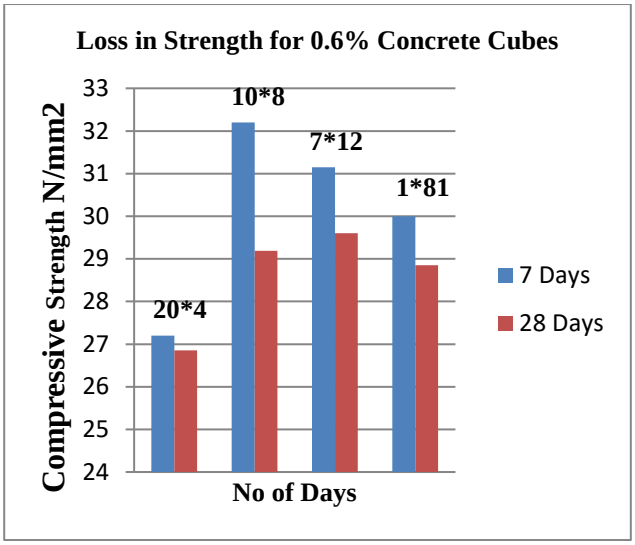

Fig 16: Loss in Strength for 0.6% Concrete Cubes

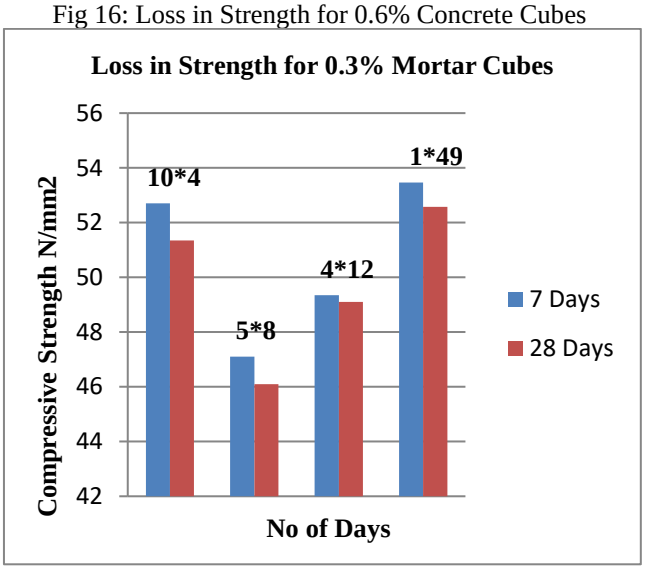

Fig 17: Loss in Strength for 0.3% Mortar Cubes

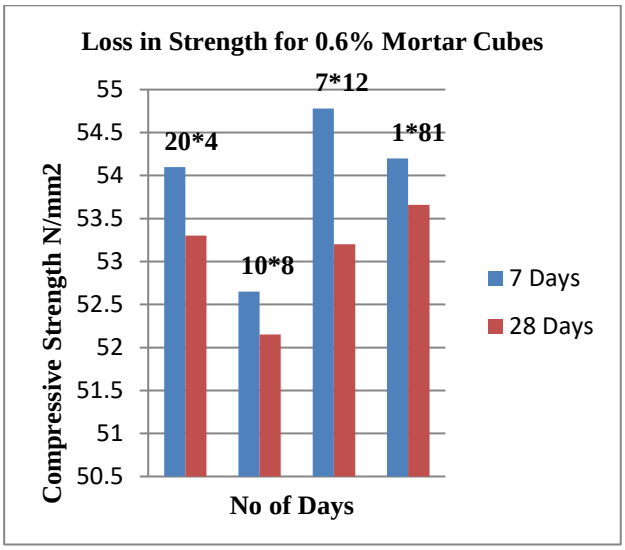

Fig 18: Loss in Strength for 0.6% Mortar Cubes

Table 7: Light Transmissibility Test (Using LUX Meter) for Translucent Concrete

Categories	% of POF	Sl no	Parameters	Transmissibility through Concrete in lux	% of Transmissibility passed in lux
Concrete	0.30 %	1	(10*4)	425	11.18
		2	(5*8)	386	10.15
		3	(4*12)	382	10.05
		4	(1*49)	530	13.94
	0.60 %	5	(20*4)	950	25
		6	(10*8)	969	25.5
		7	(7*12)	923	24.28
		8	(1*81)	1000	26.31
Mortar	0.30 %	1	(10*4)	436	11.47
		2	(5*8)	391	10.28
		3	(4*12)	396	10.42
		4	(1*49)	478	12.57
	0.60 %	5	(20*4)	940	24.73
		6	(10*8)	990	26.05
		7	(7*12)	903	23.76
		8	(1*81)	995	26.1

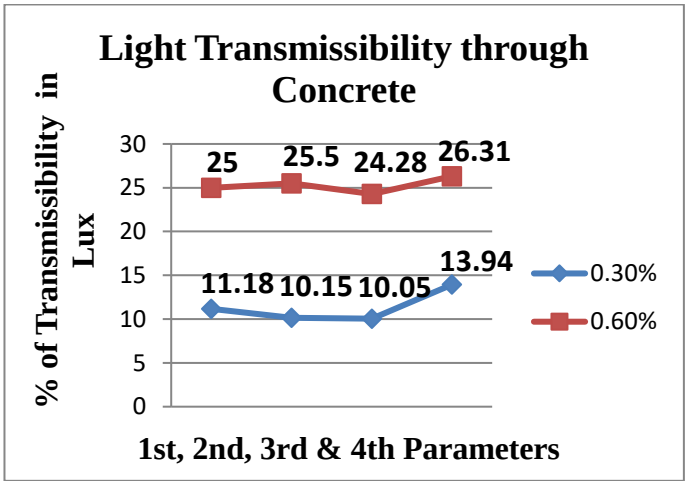

Fig 19: Light Transmissibility through Concrete

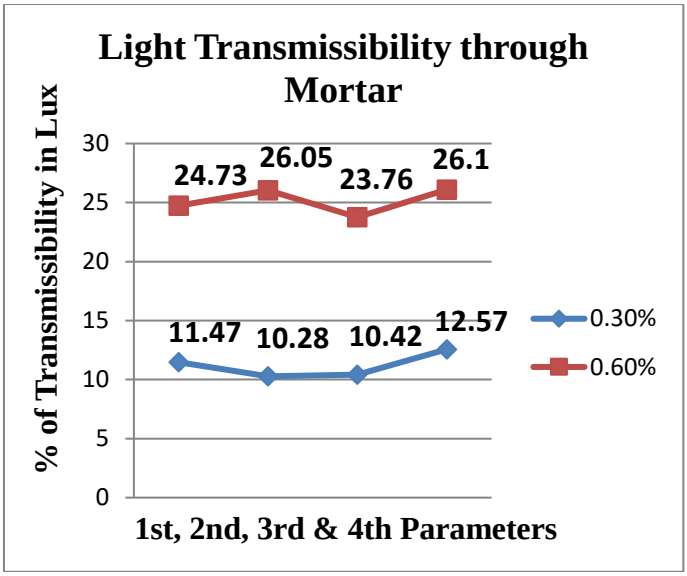

Fig 20: Light Transmissibility through Mortar

VI. CONCLUSION

1. From the test results it is observed that difference configuration of fibres in terms of its pattern definitely have significant influence on light transmission ability.
2. Experimental investigation reflects that with increase in percentages of optical fibres, light transmission ability through both concrete and mortar cubes are also increasing.
3. Results depict that, when compared with different parameters of optical fibres in terms of its location, the ability of 4th parameter to transmit light proves to be 20% more efficient than rest of the parameters.
4. When compared with concrete and mortar cubes, it is observed that light transmitting ability of mortar cubes are 10% more efficient than the concrete cubes.
5. From the test results it is noted that, there is no compromise in terms of strength of concrete and mortar cubes even if the percentage of optical fibres is increased when compared to conventional concrete.
6. Durability results shows that, optical fibres used in concrete and mortar cubes offer better resistance against various chemical actions such as acid resistance test and sulphate resistance test without affecting light transmissibility index.

VII. REFERENCES

[1] Atish Kumar V and Suresh T (2015): Translucent Concrete, International Journal of Scientific and Research Publications, Volume 3, Issue 10, October 2013 1 ISSN 2250-3153

[2] Soumyajit Paul and Avik Dutta (2013): An Experimental Study on Light Transmitting Concrete, International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308

[3] Salmabanu uhar and Urvashi Khandelwal (2015): Research and Development of Plastic Optical Fibre Based Smart Translucent Concrete, Proc. of SPIE Vol. 7293 72930F-2

[4] P. M. Shanmugavadivu et al (2014): Spectral light transmission measure and radiance model validation of an innovative translucent concrete panel for façades, Elsevier Sci Verse Science Direct, Energy Procedia 30 (2012) 1184 – 1194

[5] Jadhav G S et al (2016): Basics of Light Transmitting Concrete, Global Advanced Research Journal of Engineering, Technology and Innovation (ISSN: 2315-5124) Vol. 2(3) pp. 076-083, March, 2013

[6] T. Bhagyasri et al (2016): To evaluate properties of translucent concrete / Mortar & their panels, IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET) ISSN(E): 2321-8843; ISSN(P): 2347-4599 Vol.1, Issue 7, Dec 2013, 2.