Vol. 5, Issue. 6, 2018, ISSN 2349-0780

Litracon

Shreyas.K [1]

[1]***Asst professor***

Dept of Civil engineering

Don Bosco Institute of Technology, Bangalore, India

Shreyasconnect27@gmail.com

ABSTRACT

Transparent concrete is the new type of concrete introduced in modern era which carries special property of light transmitting due to presence of glass rods or optical fibres & is also known as translucent concrete or light transmitting concrete. It is lighter than conventional concrete having special features such as low density and thermal conductivity with main advantage of reduction in dead weight, faster building rate in construction, lower haulage & handling cost. Light is transmitted from one surface of the brick wall to the other due to glass rods along the overall width of the wall which allows light to pass through. An optical glass fibre (or optical fibre) is a flexible, transparent fibre made of glass (silica) or plastic, slightly thicker than a human hair & can function as waveguide, or "light pipe" to transmit light between the two ends. Main aim of the study is to design translucent concrete blocks with the use of glass rods & optical fibres with sand & cement then analyse their various physical & engineering properties with respect to conventional concrete blocks by adding glass rods & optical fibres of 1%, 2 %, 3 % 4 % 5% of concrete mix weight at 1.5 cms spacing respectively.

From the study, it can be concluded that there is 5% to 10% increase in initial compressive strength for 7 days & also 10% to 15% increase in initial compressive strength for 28 days to a glass rod & optical fibres mix of 3% Whereas the initial & final characteristic compressive strength gradually decreases with an increase in glass rods in the concrete mix.

KEY WORDS: **Transparent concrete, Workability, Compressive strength, Tensile strength, Flexural strength.**

I.INTRODUCTION

Translucent lightweight Concrete is a new material with various applications in the construction field, architecture, decoration and even in furniture industry. In today's time where whole of the research is concentrated towards non utilization of natural resources as much as possible and to reduce its consumption which are decreasing with time, Lightweight LiTraCon ("Lightweight light transmitting concrete") is a lightweight translucent concrete building material made of fine concrete embedded with up to 5% by weight of concrete mix which are impregnated inside the concrete cubes so that light can be transmitted from the outside in or inside out of the building. Due to great economic growth, urbanization, population growth, space utilization worldwide, there is drastic change in concrete technology. Most of the big buildings are built close to each other all in the same areas like sky scrapers There arises one of biggest problem in deriving natural light in building due obstruction of nearby structures. When buildings are stacks closed to each other, there is not much natural sunlight passing through it.

A wall made of "Light LitraCon" has the strength of traditional concrete and an embedded array of glass rods that can display a view of the outside world. Thousands of optical glass rods or optical fibres form a matrix and run parallel to each other between the two main surfaces of every blocks where in which Shadows on the lighter side will appear with sharp outlines on the darker one. An optical glass fibre is a flexible transparent fibre made of glass (silica) or plastic, slightly thicker than a human hair & is a three layered cable made up of Buffer coating, cladding and core with transmits light through the core of optical fibres. Where as the glass rods are having the diameter of 0.5mm

which are layered inside the fine aggregate concrete for allowing the light to pass through the other side.

Benefits of optical glass rods & fibres.

Glass is a non-crystalline amorphous solid that is often transparent and has widespread practical technological and decorative usage in many things. Glass has many useful properties. Optical fibres generally work as a hollow cylindrical waveguide which transmits light along its axis, by the principle of total internal reflection as shown in the optical fibre strands.

1. It is transparent & One can see through it to the other side.
2. Strong & hard which can bear lot of load on it.
3. It is impermeable. It does not allow water or other liquid to pass through and it doesn't get soggy or stained itself.
4. User friendly- The glass rod is durable, UV protected & there is nothing to break or burn out, virtually maintenance free.
5. It is transparent, strong & hard with impermeable characteristics which does not allow water or other liquid to pass through it.

II.REVIEW OF LITERATURE

The concrete specimen are produced by reinforcing optical fibres with various percentages and is compared with normal conventional concrete, the material used for this concrete are cement(53 grade), sand(2.36 mm sieve passing), optical fibre cables 200 micron diameter with fine cement concrete mix ratio for this concrete is 1:2 and water cement ratio is 0.45. The result of this experimental investigation shows that the compressive strength of light transmitting concrete was ranging between 20 - 23N/mm^2 with optical fibre specimens which indicates that it satisfies the compressive strength requirements for M20 grade concrete and also we can conclude that the transparency of light is possible in concrete without affecting its compressive strength [1].

Investigations have been done to develop the building with increase in aesthetic value by modern construction techniques and also consumption of energy by eco-friendly way. The main purpose is to use sunlight as a light source to reduce the alternate power consumption by using optical fibres to sense the stresses of structures and also as an architectural purpose for good aesthetical view of the building. They conclude that the fibres will not loose the strength parameter when compared to regular conventional concrete which can integrate the concept of green energy saving with the usage self-sensing properties of functional material [2].

The light guiding performance of concrete materials is completely determined by the internal POFs area ratio and the surface roughness in certain sections. POF based transparent concrete could be regarded as an art which could be used in museums and specific exhibitions rather than just a construction material [3].

When a solid wall is imbued with the ability to transmit light, it means that a home can use fewer lights in their house during daylight hours & also it has very good architectural properties for giving good aesthetical view to the building. Energy saving can be done by utilization of transparent concrete in building which is totally environment friendly because of its light transmitting characteristics & therefore energy consumption can be reduced. The major disadvantage is translucent concrete is very costly because of the optical fibres used for construction & casting of transparent concrete block is difficult & special skilled person is required [4].

The physio-chemical properties of coir pith in relation to particle size suitable for potting medium. Coir pith, light to dark brown in colour, consists primarily of particles in the size range 0.2–4 mm. The physio-chemical properties of coir pith was investigated after grading it based on particle size (100µm to 2000µm) for the use as potting medium. The porosity, density and absorptivity decreased as the particle size increased. Ph of raw coir pith was found to be acidic in nature but as the particle size increased, the pH also became alkaline. The electrical conductivity was observed to be high in lower grades of coir pith (4.41 mS / cm) which gradually decreased as the size increased (3.32 mS /

cm). The salt analysis made on coir pith did not show any significant change according to particle size [5].

III.MATERIALS & METHODOLOGY

1. Materials

a. Ordinary Portland Cement of 53 Grade.
b. Manufactured Sand of pertaining Sieve size (<4.75mm) as per IS standards.
c. Glass Rods 0.5 mm in Diameter are used for casting transparent concrete.
d. 200 μ Diameter Optical fibre Strands are used for casting translucent concrete.

2. Methodology

Preliminary tests were conducted on the normal conventional concrete materials as per IS standards & specifications for its physical & engineering properties, cubes were casted in the standard metallic moulds & vibrated to obtain the required sample size of specimen. The moulds were cleaned initially and oiled on all the sides before concrete sample is poured in to it. Thoroughly mixed concrete is poured into the moulds in three equal layers and compacted using vibrating table for a small period of 5 minutes. The excess concrete is removed out of the mould using trowel and the top surface is finished with smooth surface.

The manufacturing process of transparent concrete is same as of the regular conventional concrete blocks with the Only change is glass rods & optical fibres are spread throughout the fine aggregate and cement mix & Small layers of the concrete are poured on top of each other and infused with the rods in the wooden casted box. Light transmitting concrete is produced by adding 1%, 2%, 3%, 4% & 5% of glass rods & optical fibres by weight into the concrete mixture, the translucent concrete mixture is made from fine aggregate materials only & does not contain coarse aggregates whereas optical fibres are woven together instead of single filaments.

Glass rods and oven optical fibres with concrete are alternately inserted into moulds at an intervals of approximately 1.5cm spacing & the casted materials are cut into small panels or blocks of the specified thickness finally the surface is typically polished resulting in semi-gloss to high-gloss surface finish.

After 24 hours the samples of both normal conventional concrete & translucent concrete were demoulded and put in curing tank for the respective periods of 7, 14 and 28 days strength with a set of 5 samples were prepared for each stage of curing. The temperature of curing tank was maintained about 25 degree during the analysis of characteristic strength & the results were tabulated.

The main aim of the methodology is to-

- To calculate the compressive strength of M25 grade plain concrete & translucent concrete by laboratory experiments as per IS specifications.
- To calculate the Split tensile strength of M25 grade plain concrete & translucent concrete by laboratory experiments as per IS specifications.
- To calculate the Flexural strength of M25 grade plain concrete & translucent concrete by laboratory experiments as per IS specifications.

Tests (physical properties) conducted on Concrete materials

➢ **Test on cement**

- Fineness of cement.
- Normal Consistency of cement.
- Soundness test.
- Specific gravity.
- Initial setting time of cement.
- Final setting time of cement.

TABLE-1 Test on Cement

Si no	Test	Method of test	Average Result	Permissible value

1	Fineness of cement	IS 269-1976	8%	Max 10%
2	Normal consistency	IS:4031-Pt-4	27%	26 to 33%
3	Soundness	IS:4031-Pt-3	7 mm	< 10mm
4	Specific gravity	IS:2720-Pt-3	3.12	3.12 to 3.19
5	Initial setting time	IS 4031-1968	46 mins	Min 30 mins
6	Final setting time	IS 4031-1968	360 mins	Max 600 mins

➢ **Test on fine aggregates – Manufactured sand (Size <4.75mm)**

- Specific gravity and Water absorption test.

TABLE-2 Test on fine aggregates (Manufactured sand)

Si no	Test	Method of test	Average Result	Permissible value
1	Specific gravity	IS:2720-Pt-3	Bulk specific gravity = 2.6 Apparent specific gravity = 2.5	2.53 to 2.67
2	Water absorption	IS:2386-Pt-3	1.2	<2%

3. Tests (Engineering properties) conducted on Plain Concrete

➢ **Test on Plain concrete**

- Slump test.
- Compaction factor.
- Vee Bee consistometer.
- Compressive strength of concrete.
- Split tensile strength of concrete.
- Flexural strength of concrete.

TABLE-3 Test on Plain cement concrete

Si no	Test	Method of test	Average Result	Permissible value
1	Slump test	IS-7320-1974	True slump for 0.55 water cement ratio	--
2	Compaction factor	IS-1199-1959	0.9	--
3	Vee Bee consistometer	IS-10510-1983	22 seconds	--
4	Compressive strength of plain concrete (7 days)	IS 1489-1991	18.4 N/mm^2	Min 17 N/mm^2
5	Compressive strength of plain concrete (14 days)	IS 1489-1991	22.0 N/mm^2	Min 22 N/mm^2
6	Compressive strength of plain concrete (28 days)	IS 1489-1991	25.5 N/mm^2	Min 25 N/mm^2
7	Split tensile strength of plain concrete (7 days)	IS 5816-1976	4.9 N/mm^2	--

8	Split tensile strength of plain concrete (28 days)	IS 5816-1976	5.4 N/mm^2	--
9	Flexural strength of plain concrete (7 days)	IS: 516-1959	5.2 N/mm^2	--
10	Flexural strength of plain concrete (28 days)	IS: 516-1959	5.3 N/mm^2	--

4. Tests (Engineering properties) conducted on Transparent Concrete

➢ **Test on Transparent concrete**

- Slump test.
- Compaction factor.
- Vee Bee consistometer.
- Compressive strength of concrete.
- Split tensile strength of concrete.
- Flexural strength of concrete.

TABLE-4 Test on Transparent concrete (Glass rods)

Si no	Test	Method of test	Average Result	Permissible value
1	Slump test	IS-7320-1974	True slump for 0.55 water cement ratio	--
2	Compaction factor	IS-1199-1959	0.8	--
3	Vee Bee consistometer	IS-10510-1983	18 seconds	--
4	Compressive strength of Translucent concrete (7 days)	IS 1489-1991	17.0 N/mm^2	Min 17 N/mm^2
5	Compressive strength of Translucent concrete (14 days)	IS 1489-1991	21.5 N/mm^2	Min 22 N/mm^2
6	Compressive strength of Translucent concrete (28 days)	IS 1489-1991	25.0 N/mm^2	Min 25 N/mm^2
7	Split tensile strength of Translucent concrete (7 days)	IS 5816-1976	4.89 N/mm^2	--
8	Split tensile strength of Translucent concrete (28 days)	IS 5816-1976	5.32 N/mm^2	--
9	Flexural strength of Translucent concrete (7 days)	IS: 516-1959	5.21 N/mm^2	--
10	Flexural strength of Translucent concrete (28 days)	IS: 516-1959	5.36 N/mm^2	--

TABLE-5 Test on Transparent concrete (Optical fibres)

Si no	Test	Method of test	Average Result	Permissible value
1	Compressive strength of Translucent concrete (7 days)	IS 1489-1991	17.0 N/mm^2	Min 17 N/mm^2
2	Compressive strength of	IS 1489-1991	21.7 N/mm^2	Min 22 N/mm^2

	Translucent concrete (14 days)			
3	Compressive strength of Translucent concrete (28 days)	IS 1489-1991	24.6 N/mm^2	Min 25 N/mm^2
4	Split tensile strength of Translucent concrete (7 days)	IS 5816-1976	4.95 N/mm^2	--
5	Split tensile strength of Translucent concrete (28 days)	IS 5816-1976	5.32 N/mm^2	--
6	Flexural strength of Translucent concrete (7 days)	IS: 516-1959	5.21 N/mm^2	--
7	Flexural strength of Translucent concrete (28 days)	IS: 516-1959	5.36 N/mm^2	--

5. EXPERIMENTAL DESIGN

MIX DESIGN

Volumetric batching is done for the material mix to analyse the amount of quantity required for casting each cube specimen considering the design mix as M25 grade (cement: fine aggregate) is 1: 1 as per IS 383-1970 & IS 456-2000 specifications. The aggregates with cement mix are varied up to 35% of porosity by varying the materials having minimal or zero number of fine aggregates & is mixed with cement for a water cement ratio of 0.55 to cast the moulds for analysing the compressive strength of 7, 14 & 28 days strength for an average of 5 specimens.

Light transmitting concrete is produced by adding 1%, 2%, 3%, 4% & 5% of glass rods & optical fibres by its weight into the concrete mixture. The translucent concrete mixture is made from fine aggregate materials only & does not contain coarse aggregates.

Glass rods and oven optical fibres with concrete are alternately inserted into moulds at an intervals of approximately 1.5cm & the casted materials are cut into small panels or blocks of the specified thickness finally the surface is typically polished resulting in semi-gloss to high-gloss surface finish.

After 24 hours the samples of both normal conventional concrete & translucent concrete were demoulded and put in curing tank for the respective periods of 7, 14 and 28 days & a set of 5 samples were prepared for each stage of curing.

IV.RESULTS & DISCUSSION

Relation between characteristic strength for the plain concrete mix for 7, 14 & 28 days

With the volumetric batching for the plain concrete material mix is done to analyse the amount of quantity required for casting each cube specimen considering the design mix as M25 grade (cement: fine aggregate) is 1: 1 as per IS 383-1970 & IS 456-2000 specifications & tested for its strength for 7, 14 & 28 days strength in which the compressive strength is analysed by testing under compressive testing machine has given an average values of 22.0 N/mm^2 & 25.5 N/mm^2 for 14 & 28 days which are more than permissible limits as per specifications respectively.

TABLE-6: Comparison of compressive strength in concrete specimens for 7, 14 & 28 days in N/mm^2

Si no	Average strength at 7 days (N/mm^2)	Average strength at 14 days (N/mm^2)	Average strength at 28 days (N/mm^2)
1	18.5	21.1	24.78
2	18.55	21.9	26.98

3	18.54	22.0	25.50
4	18.20	21.6	24.40
5	18.60	23.4	25.89

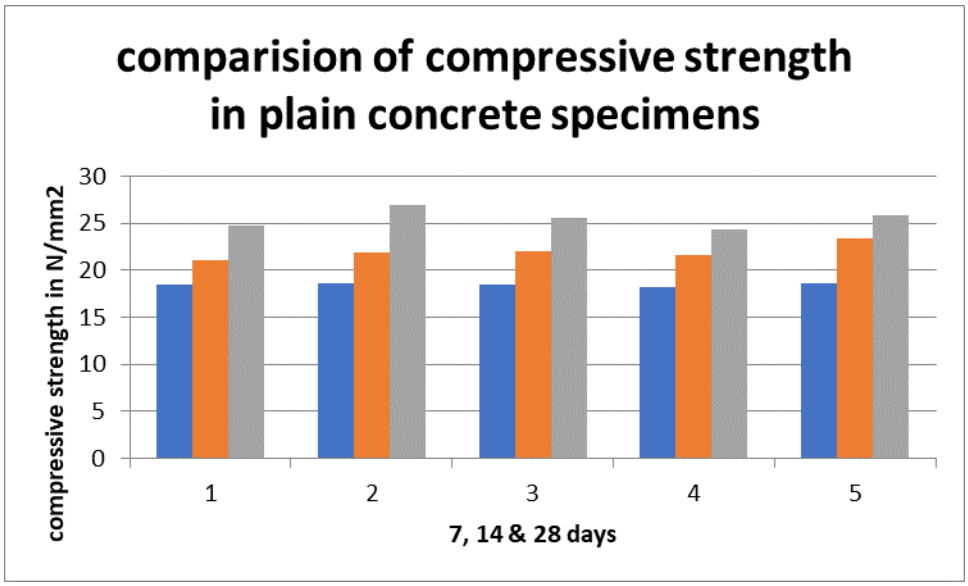

Fig-1: Comparison between compressive strength of plain cement concrete for 7, 14 & 28 days

TABLE-7: Comparison of Split tensile strength in plain concrete specimens for 7 & 28 days in N/mm^2

Si no	**Average strength at 7 days (N/mm^2)**	**Average strength at 28 days (N/mm^2)**
1	4.95	5.36
2	5.23	5.43
3	4.98	5.2
4	4.6	5.67
5	5.2	5.8

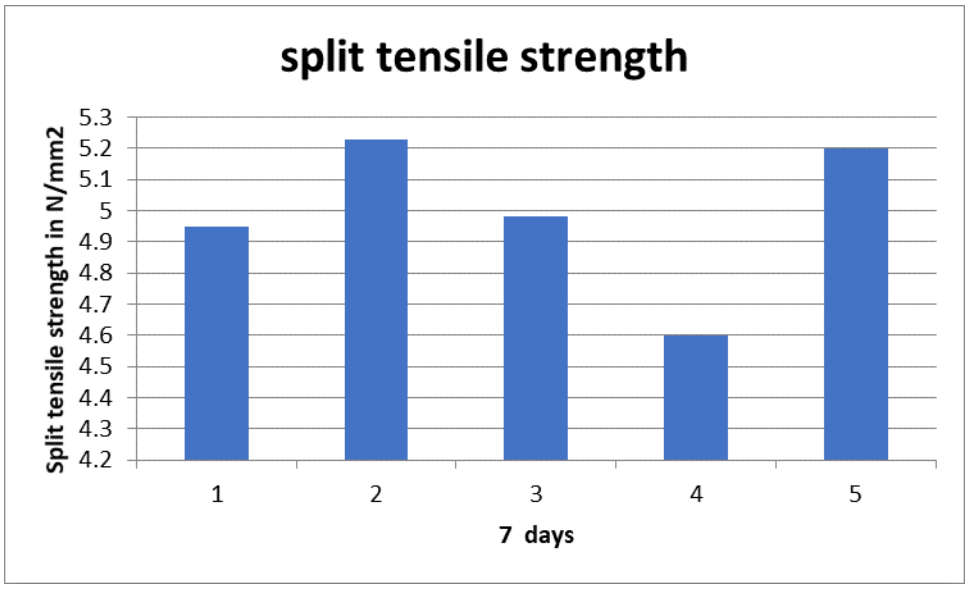

Fig-2: Comparison between Split tensile strength of plain cement concrete for 7 days

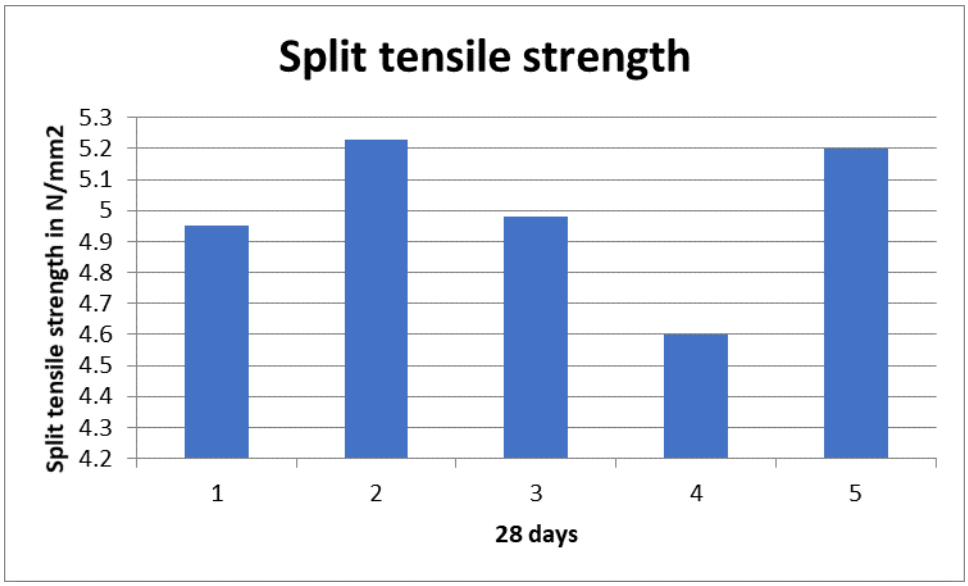

Fig-3: Comparison between Split tensile strength of plain cement concrete for 28 days

TABLE-8: Comparison of Flexural strength in plain concrete specimens for 7 & 28 days in N/mm^2

Si no	Average strength at 7 days (N/mm^2)	Average strength at 28 days (N/mm^2)
1	5.15	5.32
2	5.23	5.29
3	5.19	5.3
4	5.25	5.4
5	5.62	5.5

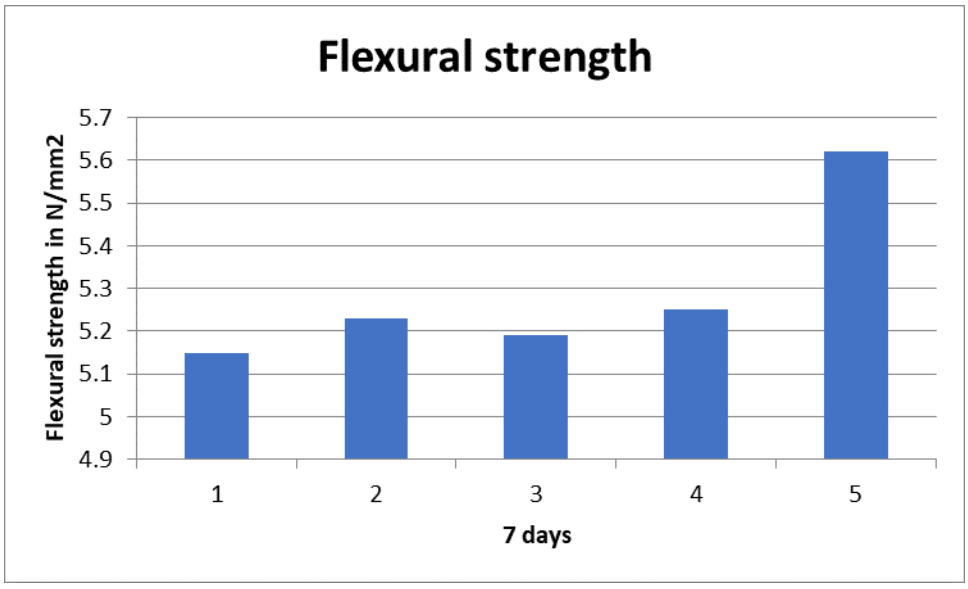

Fig-4: Comparison between Flexural strength of plain cement concrete for 7 days

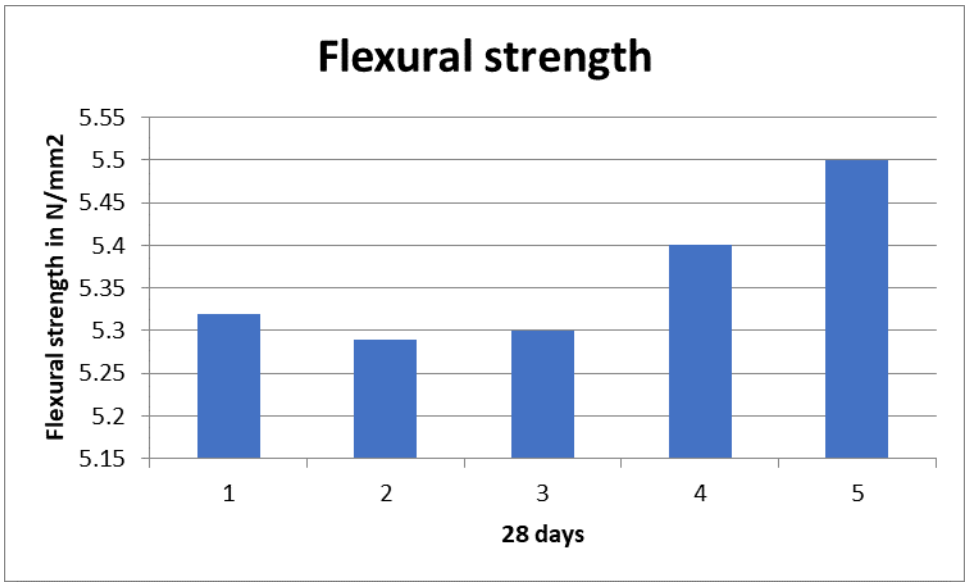

Fig-5: Comparison between Flexural strength of plain cement concrete for 28 days

Relation between characteristic strength of transparent concrete for 7, 14 & 28 days

With the inclusion of Glass rod fibres in varied proportions of 1%,2%,3%,4% & 5% the strength of concrete gradually increases up to a certain limit but the gradually decreases. By the experimental analysis with the inclusion of Glass rods by its weight will lead to increase in the initial compressive strength of the concrete up to a certain percentages in the transparent concrete blocks. There is 5% to 10% increase in initial compressive strength for 7 days & also 10% to 15% increase in initial compressive strength for 28 days for Glass rod mix of 3% whereas initial & final characteristic compressive strength gradually decreases with an increase in percentage of Glass rods in the concrete mix.

TABLE-9: Comparison of compressive strength for various specimens with varying % in Glass rods of 1.5 cms spacing for 7, 14 & 28 days in N/mm^2

Si no	% of Glass rods in 1.5 cm spacing	Average strength at 7 days (N/mm^2)	Average strength at 14 days (N/mm^2)	Average strength at 28 days (N/mm^2)
1	**1**	16.3	20.9	25.0
2	**2**	16.9	21.1	25.7
3	**3**	17.9	22.9	26.4
4	**4**	16.3	21.2	24.3
5	**5**	16.6	21.4	22.6

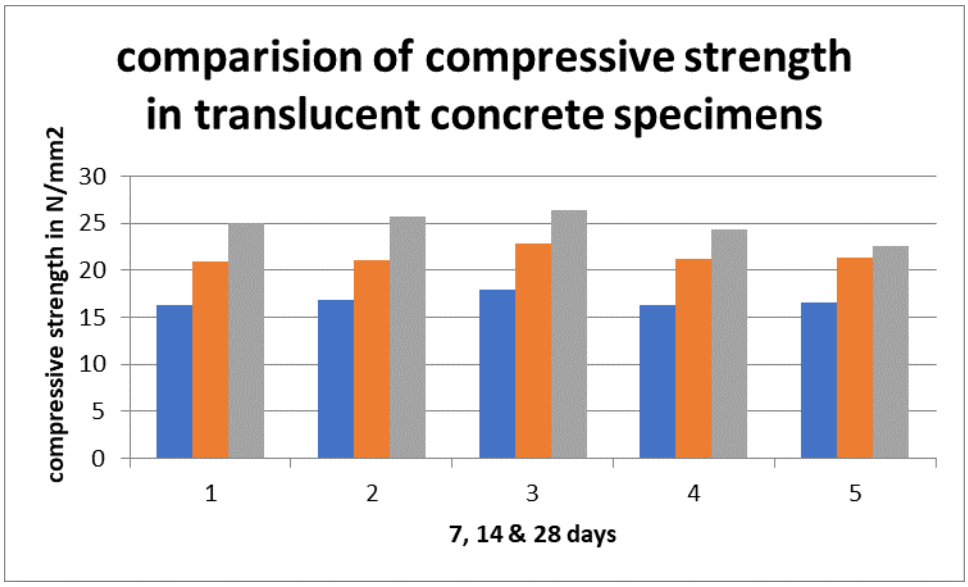

Fig-6: Comparison of compressive strength for various specimens with varying % in Glass rods of 1.5 cms spacing for 7, 14 & 28 days

TABLE-10: Comparison of Split tensile strength in translucent concrete specimens of 1.5 cms spacing for 7 & 28 days in N/mm^2

Si no	Average strength at 7 days (N/mm^2)	Average strength at 28 days (N/mm^2)
1	4.95	5.3
2	5.2	5.5
3	4.5	5.5
4	4.6	5.2
5	5.2	5.1

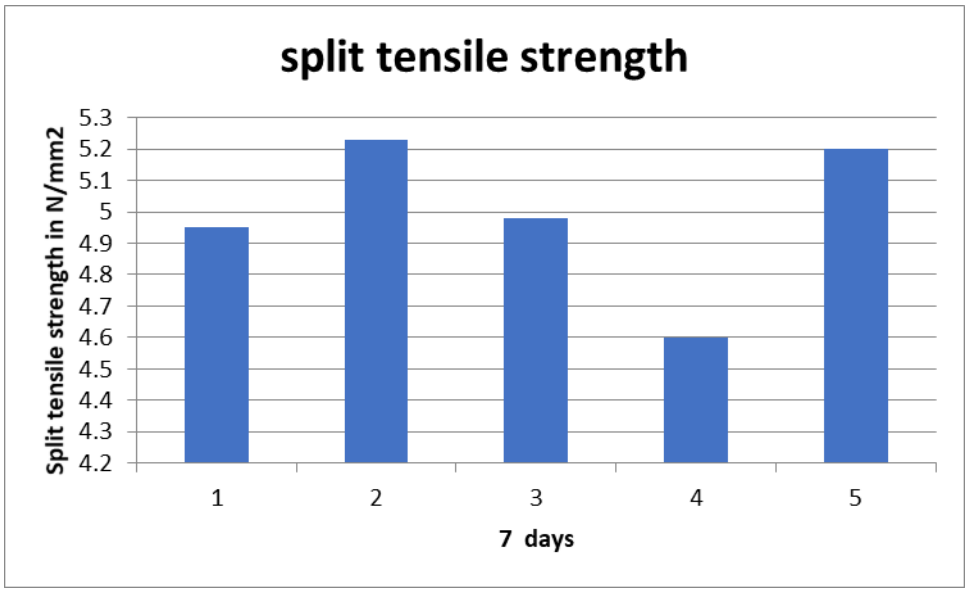

Fig-7: Comparison of Split tensile strength in translucent concrete specimens of 1.5 cms spacing for 7 days

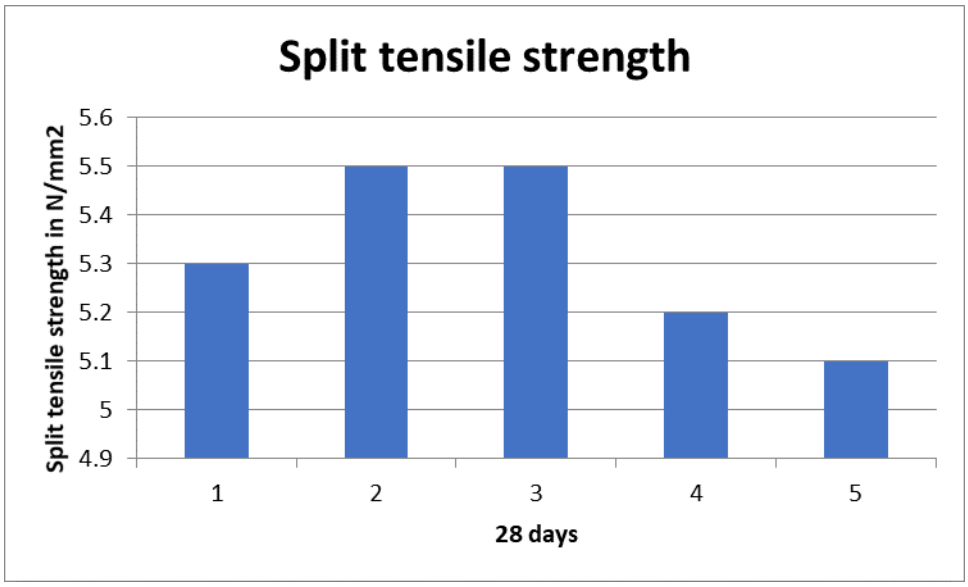

Fig-8: Comparison of Split tensile strength in translucent concrete specimens of 1.5 cms spacing for 28 days

TABLE-11: Comparison of Flexural strength in translucent concrete specimens of 1.5 cms spacing for 7 & 28 days in N/mm^2

Si no	Average strength at 7 days (N/mm^2)	Average strength at 28 days (N/mm^2)
1	5.15	5.3
2	5.3	5.9
3	5.19	5.3
4	5.25	5.2
5	5.16	5.1

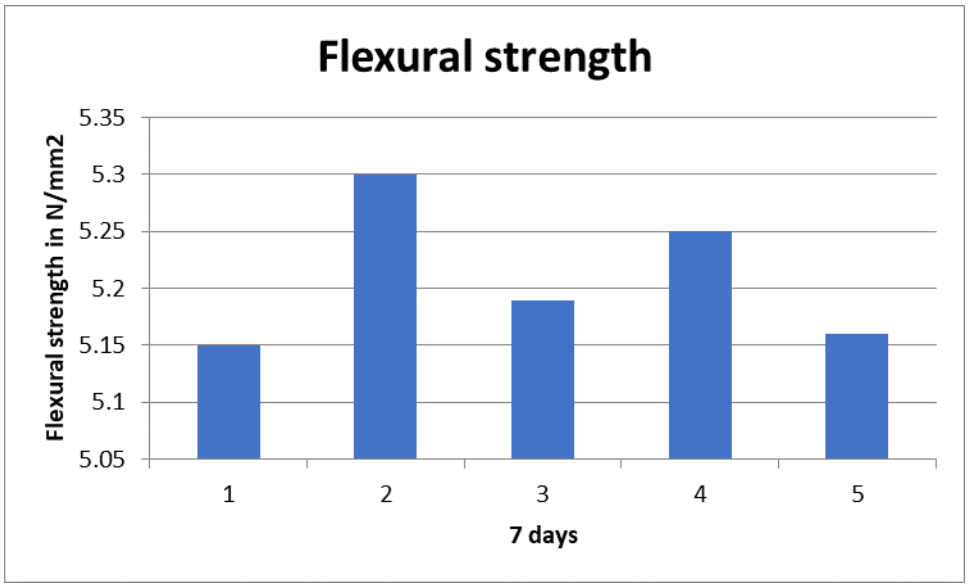

Fig-9: Comparison of Flexural strength in translucent concrete specimens of 1.5 cms spacing for 7 days

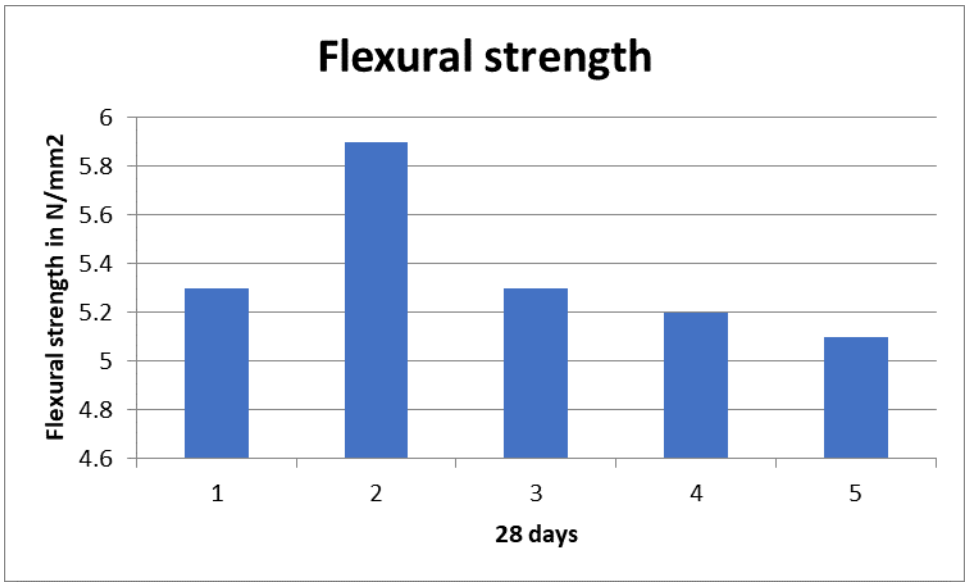

Fig-10: Comparison of Flexural strength in translucent concrete specimens of 1.5 cms spacing for 28 days

Relation between characteristic strength of translucent concrete for 7, 14 & 28 days

With the inclusion of Optical fibres in varied proportions of 1%,2%,3%,4% & 5% the strength of concrete gradually increases up to a certain limit but the gradually decreases. By the experimental analysis with the inclusion of Optical fibres by its weight will lead to increase in the initial compressive strength of the concrete up to a certain percentages in the translucent concrete blocks. There is 5% to 10% increase in initial compressive strength for 7 days & also 10% to 15% increase in initial compressive strength for 28 days for optical fibres mix of 3% whereas initial & final characteristic compressive strength gradually decreases with an increase in Optical fibres in the concrete mix.

TABLE- 12: Comparison of compressive strength for various specimens with varying % in Optical fibres of 1.5 cms spacing for 7, 14 & 28 days in N/mm^2

Si no	% of Optical fibers in 1.5 cm spacing	Average strength at 7 days (N/mm^2)	Average strength at 14 days (N/mm^2)	Average strength at 28 days (N/mm^2)
1	**1**	16.3	20.0	24.0
2	**2**	16.1	21.1	25.7
3	**3**	17.9	23.8	26.4
4	**4**	16.3	22.2	24.3
5	**5**	16.6	21.4	22.6

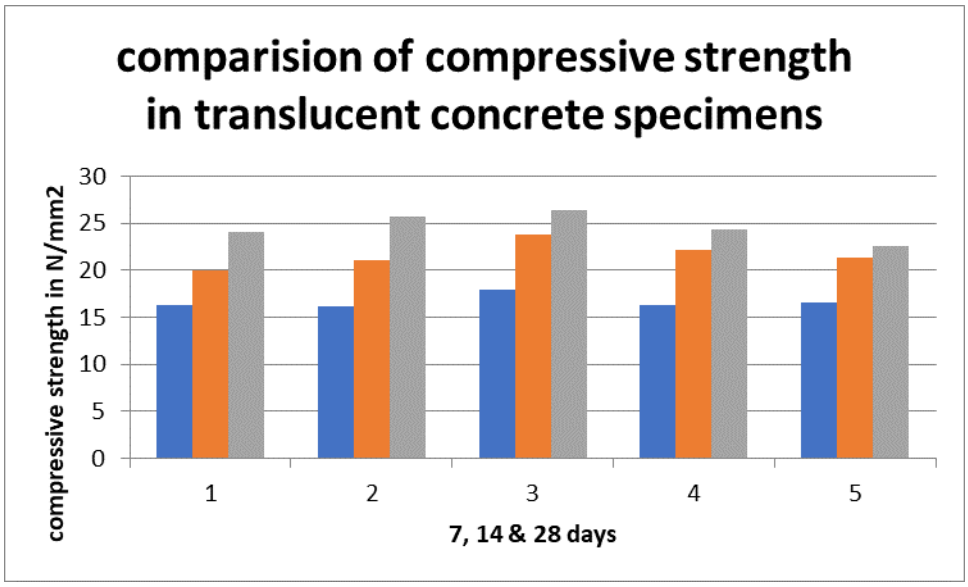

Fig- 11: Comparison of compressive strength for various specimens with varying % in Optical fibres of 1.5 cms spacing for 7, 14 & 28 days

TABLE- 13: Comparison of Split tensile strength in translucent concrete specimens of 1.5 cms spacing for 7 & 28 days in N/mm^2

Si no	Average strength at 7 days (N/mm^2)	Average strength at 28 days (N/mm^2)
1	4.95	5.3
2	5.2	5.5
3	4.5	5.5
4	4.6	5.2
5	5.2	5.1

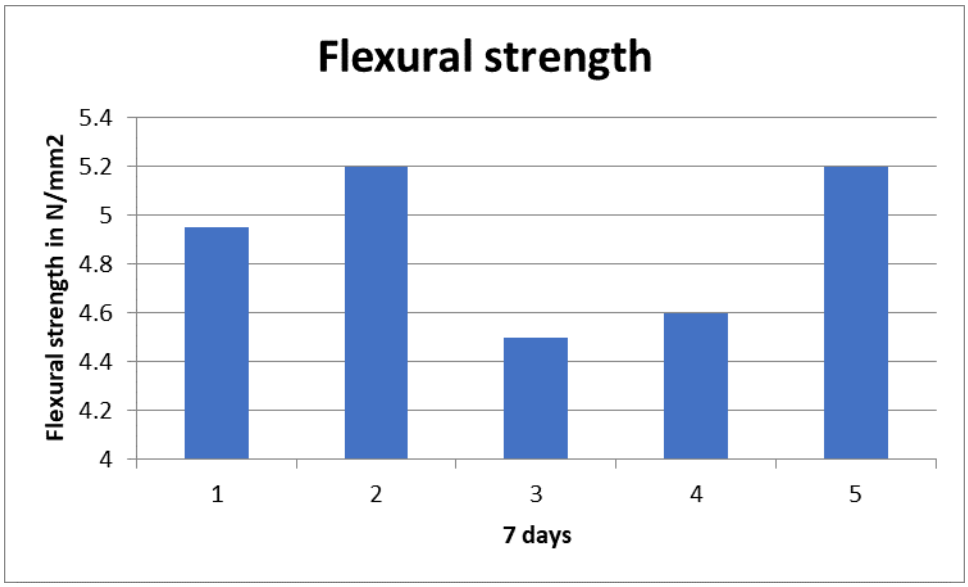

Fig-12: Comparison of Split tensile strength in translucent concrete specimens of 1.5 cms spacing for 7 days

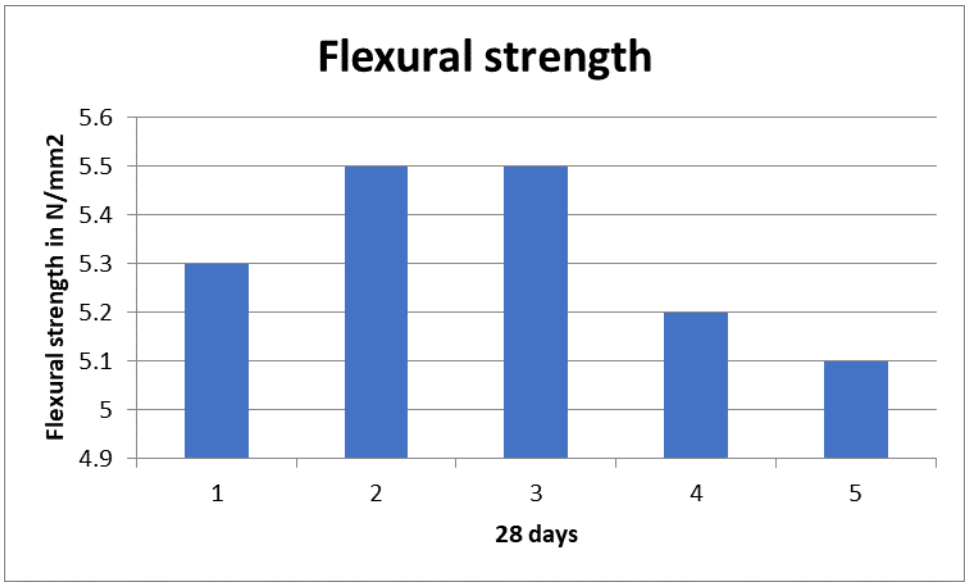

Fig- 13: Comparison of Split tensile strength in translucent concrete specimens of 1.5 cms spacing for 28 days

TABLE- 14: Comparison of Flexural strength in translucent concrete specimens of 1.5 cms spacing for 7 & 28 days in N/mm^2

Si no	Average strength at 7 days (N/mm^2)	Average strength at 28 days (N/mm^2)
1	5.15	5.3
2	5.3	5.9
3	5.19	5.3
4	5.25	5.2
5	5.16	5.1

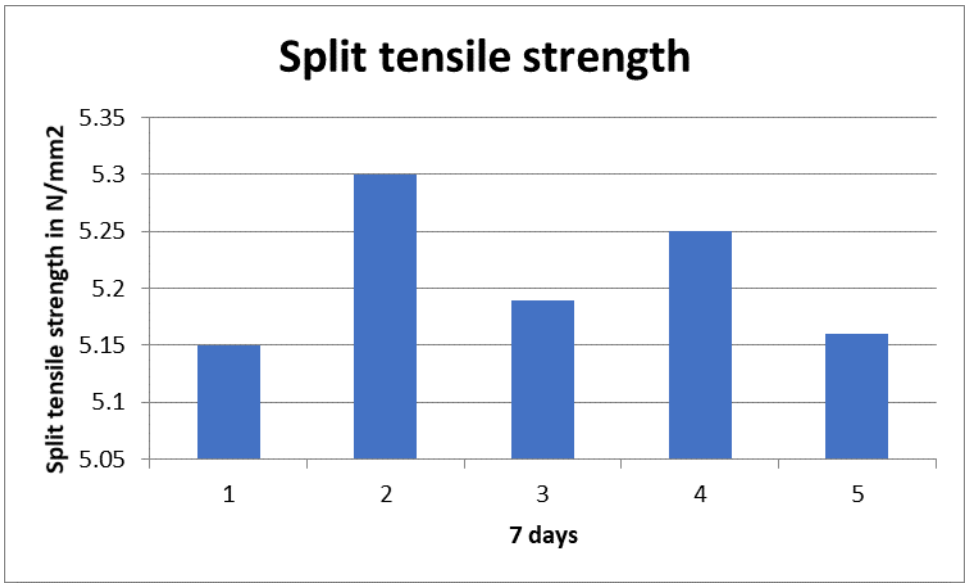

Fig- 14: Comparison of Flexural strength in translucent concrete specimens of 1.5 cms spacing for 7 days

Vol. 5, Issue. 6, 2018, ISSN 2349-0780

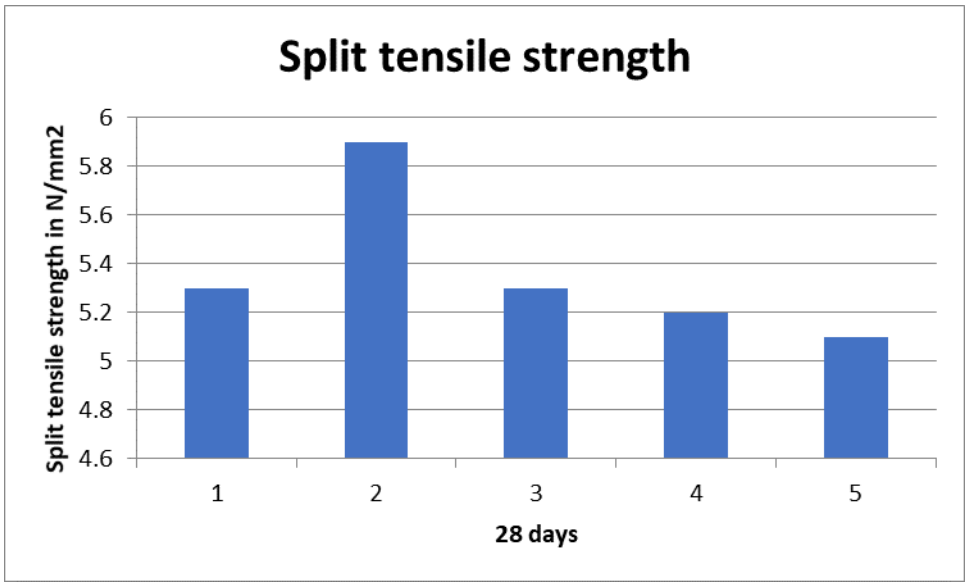

Fig- 15: Comparison of Flexural strength in translucent concrete specimens of 1.5 cms spacing for 28 days

V.CONCLUSION

1. Mechanical behavior of plain concrete cubes were studied for Compressive, Split tensile & Flexural strength test with curing time of 7 days, 14 days, 21 days and 28 days which shows characteristic increase in its strength behavior.
2. There is 5% to 10% increase in initial compressive strength for 7 days & also 10% to 15% increase in initial compressive strength for 28 days for both glass rods & optical fibres mix of 3%.
3. Whereas the initial & final characteristic compressive strength gradually decreases with an increase in Optical fibres & glass rods in the concrete mix.
4. It will also reduce the carbon emission which is hazardous for environment & can be treated as one of the high performance concrete.
5. The main advantage of translucent concrete is its lightweight which reduces the self-weight of any concrete structure & also can be used as decorative concrete in interior design of buildings as panels in slabs, walls etc.
6. From the above study, it can be concluded that the Optical fibers can be used in concrete mix up to 5% replacement will give an excellent results both in strength & quality aspects.

Vol. 5, Issue. 6, 2018, ISSN 2349-0780

REFERENCES

[1]. Momin, A., Kadiranaikar, R., Jagirdar, V. & Inamdar, A., "Study of Light Transmittance of Concrete Using Optical Fibers and Glass Rods," Proceedings: International Conference on Advances in Engineering & Technology – 2014.
[2]. Shanmugavadivu, P., Scinduja, V., Sarathivelan, T. & Shudhesamithronn, C., "An Experimenal Study of Light Transmitting Concrete," *IJRET*, vol. 3, no. 11, 2014.
[3]. Zhou, Z., Ou, G., Hang, Y., Chen, G. & Ou, J., "Research and Development of Plastic Optical Fiber Based Smart Transparent Concrete," *SPIE*, vol. 7293, no. F, 2009.
[4]. Prasad. Bishetti. Etal, " EXPERIMENTAL STUDY OF TRANSLUCENT CONCRETE ON COMPRESSIVE STRENGTH", International Journal of Technical Research and Applications e-ISSN: 2320 - 8163, www.ijtra.com Volume 4, Issue 4 (July-Aug, 2016), PP. 120-122.
[5]. BasmaF.Bashbash, "Basics of light Transmitting Concrete", International Journal of Research ISSN 2249 - 9695 in Environmental Science and Technology- Determination of Physico-Chemical Properties of Coir Pith In Relation To Particle Size Suitable For Potting Medium, pp 079-083, (2013).
[6]. IS: 7320-1974 Code of practice for "WORKABILITY OF CONCRETE BY SLUMP TEST**".**
[7]. IS:1199-1959 Code of practice for "WORKABILITY OF CONCRETE BY COMPACTION FACTOR TEST".
[8]. IS:10510-1983 Code of practice for "WORKABILITY TEST BY VEE-BEE CONSISTOMETER".
[9]. IS: 516-1959 Code of practice for "FLEXURAL STRENGTH TEST".
[10]. IS 5816-1976 Code of practice for "SPLIT TENSILE STRENGTH TEST".
[11]. IS: 516-1959 Code of practice for "COMPRESSIVE STRENGTH TEST"**.**

Bibilography

AUTHOR-1

Shreyas.K is Currently working in the Dept of Civil engineering Don Bosco Institute of Technology Bangalore. The author has completed UG degree in civil engineering from MS Ramaiah institute of technology Bangalore, Post-graduation in highway engineering from RV college of engineering. The author is also pursuing Doctoral degree from Bangalore university, Bangalore.

Current and previous research interests of the author is in the design & evaluation of pavement & pavement materials.

1. Life Member of I.S.T.E.
2. Life member of I.C.I.
3. Life member of I.R.C.
4. Life member of I.S.C.A.
5. Associate member of I.R.E.D.

*E- mail:*Shreyasconnect27@gmail.com