



A Sustainable Approach To Light-Transmitting Concrete: Mechanical Performance And Eco-Analysis(LTC)

¹Dr.G.Vikas Paul, ²Mohammed Shoaib Akthar

¹Assistant Professor , ²M.E Student

¹Civil Engineering,

¹Lords Institute of Engineering & Technology, Hyderabad, Telangana

Abstract: Transparent concrete, also known as translucent concrete or light-transmitting concrete (LiTraCon), is an innovative concrete-based material that possesses light-transmitting properties. Light passes through the concrete either naturally or via artificial sources, from one end to the other, due to the presence of optical fibers embedded within the mix. For this study, three types of molds—cubes, cylinders and beams—were prepared using M30 grade concrete. The concrete mix incorporates 4% optical fibers, and glass powder is used as a partial replacement for cement at varying proportions (5%, 10%, and 15%).

This modified concrete is tested to evaluate its mechanical properties and performance. The prepared specimens are assessed for compressive strength and split tensile strength at curing intervals of 7, 14, and 28 days. The experimental analysis involves comparing the strength characteristics of the transparent concrete with those of conventional concrete. Transparent concrete is particularly suitable for prefabricated buildings and wall paneling, offering both functional and aesthetic advantages. One of its major benefits is the potential reduction in daytime power consumption by utilizing natural sunlight. Moreover, it contributes to green building practices, promoting sustainable and eco-friendly construction.

1. INTRODUCTION

GENERAL

Translucent light-weight Concrete could be a new material with numerous applications within the construction field, design, decoration and even in article of furniture business. In today's time wherever whole of the analysis is targeted towards non utilization of natural resources the maximum amount as attainable and to cut back its consumption that area unit decreasing with time, light-weight LiTraCon ("Lightweight light-weight transmission Concrete") could be a light-weight semi transparent concrete artefact fabricated from concrete with embedded with up to completely different percentages by weight of concrete combine that area unit fertilized concrete cubes and cylinders in order that light-weight are often transmitted from the surface in and within out of the building. associate plastic optical fibers slightly thicker than a person's hair & could be a 3 bedded cable created of Buffer coating, facing and core with transmits light-weight through the core of fibers. Our project of casting transparent

concrete aims at analysing the compressive and tensile strength of samples by varied the share by volume of 4% optical fibres and partly replacement of glass powders for cement numerous percentages (5%, 10%, 15%).

II.OBJECTIVE AND SCOPE OF STUDY

2.1 OBJECTIVE

1. To determine the mechanical properties of concrete. Such as compressive strength, split tensile strength
2. To compare strength characteristics of translucent concrete and conventional concrete
3. To determine the optimum percentage of addition of fibers based on compressive strength
4. To check the transmittance of the translucent concrete
5. To ascertain the formative scrutiny of the cementitious compound beam utilizing SEM (Scanning Electron Microscopy) examination.

2.2 SCOPE OF STUDY

1. 1.Light weight – increasing the strength and life span of the concrete
2. Cracking control
3. Light transmitting concrete

III.MATERIALS USED

The materials used in the study included ordinary portland cement, fine aggregate, coarse aggregate, water, optical fiber and glass powder.

3.1 CEMENT

Ordinary portland cement is factory-made by combination of pozzolanic materials. this sort of cement is factory-made to powder by compounding rock and alternative raw materials that consists of argillaceous, carbonate and mineral. OPC fifty three grade cement is needed to substantiate to BIS specifications IS:12269-1987 with a designed strength for twenty eight days being a minimum of fifty three MPa. fifty three grade OPC provides high strength and sturdiness to structures owing to its optimum particle size distribution and superior preserved structure.



Fig:3.1 : Cement

3.2 FINE AGGREGATE

Manufactured sand (M-Sand) is artificial sand made from crushing hard stones into tiny sand sizes angular formed particles, washed and finely hierarchic to be used as construction aggregates. it's superior different to watercourse Sand for construction purpose. M-sand has higher compressive and flexural strength. M-sand is hierarchic with exactitude and consistency therefore it's higher Fineness Modulus compared to natural sand and crushed dirt. this provides sensible workability for concrete. the form of crushed sand is cubicle and angular and encompasses a rough texture and thence it's higher for concrete. it's well hierarchic within the needed proportion for construction. It doesn't contain Associate in Nursing organic and soluble compound that have an effect on cement setting time. it's a cost-effective and eco-friendly material.



Fig:3.2: Fine Aggregate

3.3 COARSE AGGREGATE

Coarse aggregates are any particles bigger than 0.19inch, however usually vary between 3/8 and 1.5 inch. in diameter. Gravel represent the majority of coarse mixture utilized in concrete with crushed stone making up most of the remainder. throughout this 20mm size aggregates has been used throughout this experiment. Crushed stones were used as coarse mixture and conjointly the physical properties were determined.



Fig:3.3: Coarse Aggregate

3.4 GLASS POWDER

A glass is a solid, non-crystalline, typically transparent, amorphous material. The most common type of glass is soda-lime glass, which comprises mostly of silicon dioxide, SiO_2 , along with sodium oxides, calcium oxide and alumina. Another class of compounds used as concrete additives are pozzolans – a group of siliceous or aluminous which can react in water with calcium hydroxide (present in the cement) to produce a material with concrete- like properties Waste glass is one materials when ground to a very fine powder shows pozzolanic properties which can be used as a partial replacement for cement in concrete.



Fig:3.4 : Glass Powder

3.5 OPTICAL FIBERS

An fiber might be a flexible, clear fiber created by drawing glass or plastic to a diameter slightly thicker than that of a human's hair. AN fibre is additionally a versatile, clear fiber created by drawing glass or plastic to a diameter slightly thicker than that of AN human's hair. It functions on the principle total internal refraction, it permits light-weight wave to travel through it whereas not overwhelming energy from it. Its kind is identical as cylindrical, the within a section of this may be factory-made from glass or plastic that is really refractive i.e. the core of the fibre is of high magnitude relation, that cause the passage of sunshine through it whereas not of abundant loss within the P.E. of sunshine. The outer a section of this cylindrical core is assumed to be protection and has low refraction. Either then this fibre has an additional quality that makes it fully fully totally different from others and far helpful than the other material, it permits the sunshine to travel through it even at angle extra then 60° . In our project 4% of plastic optical fibres used in mix.



Fig:3.5 : Optical Fibers

IV.MIX DESIGN

Mix design is the process of selecting suitable ingredients of concrete and determining their relative quantities through conducting preliminary laboratory test for obtaining the economical mix as per IS: 10262-2009.

4.1 Mix Proportioning

The mix was proportioned for M30 grade concrete, as per IS 10262(2009). The mix proportion selected was 1:0.75:1.5 with a water cement ratio of 0.45. Table shows the mix details of the M30 mix. The process of selecting suitable materials of concrete and determining their relative proportion with the object of producing concrete of certain minimum strength and durability as economically as possible and the mix design for this study has been given in the table:

4.2 Quantity of Materials

Cement	-	437 Kg/m ³ Fine Aggregate	-	766 Kg/m ³ Coarse Aggregate
	-	1053 Kg/m ³		
Water	-	197 Kg/m ³		

Table 4.1 : Mix Design

% of Glass Powder replacement in Cement	Cement in Kg/m ³	Glass Powder in Kg/m ³	Fine Aggregate in Kg/m ³	Coarse Aggregate in Kg/m ³	Optical Fiber in Kg/m ³
0	13.98	0	24.52	33.69	0
5%	12.59	1.39	24.52	33.69	1.16
10%	11.89	2.09	24.52	33.69	1.16
15%	11.18	2.8	24.52	33.69	1.16

4.3 SUSTAINABILITY SECTION

Comparison Table: OPC Concrete vs. Glass Powder Concrete

Parameter	OPC Concrete	Glass Powder Concrete (with 4% Optical Fibers)
Cement Content	100% Ordinary Portland Cement (OPC)	partially replaced with glass powder at 5%, 10%, 15%
CO₂ Emissions	~0.9–1 ton CO ₂ per ton of cement)	Reduced proportionally with cement reduction (up to 15% less CO ₂)
Cement Reduction	None	Up to 15% reduction
Material Cost	High (cement is costly)	Reduced cost due to partial replacement with waste glass powder
Waste Utilization	No	Yes — Recycled glass used, promotes sustainability
Light Transmission (4% OF)	None	Enabled via optical fibers
Aesthetic & Functional Use	Structural only	Structural + Architectural (lighttransmitting features)

Durability	Standard	Comparable or better (with fine particle glass powder)
Compressive Strength	Normal (M30–M40 range)	Slight variation; may improve at 10% replacement
Overall Sustainability	Low	High — Due to lower carbon footprint and waste reuse

4.4 EXPERIMENTAL SETUP TO MEASURE LUX LEVELS IN LTC :

OBJECTIVE:

TABLE 4.4 SAMPLE RESULT TABLE:

Trial	Light Source (Lux ₁)	After LTC (Lux ₂)	% Transmission
1	1000 lux	120 lux	12%
2	800 lux	95 lux	11.88%
3	600 lux	70 lux	11.66%

$$\% \text{ Transmission} = (\text{Lux}_2 / \text{Lux}_1) \times 100$$

V. TESTING OF SPECIMENS

Three types of tests were conducted in this study, they are compressive strength test, splitting tensile strength test and flexural strength test. compressive strength test is performed for cube specimens, splitting tensile strength test is performed for cylindrical specimens and flexural strength test is performed for beam specimens and these were prepared using M30 grade concrete. The concrete mix incorporates 4% optical fibers, and glass powder is used as a partial replacement for cement at varying proportions (5%, 10%, and 15%).

This modified concrete is tested to evaluate its mechanical properties and performance. The prepared specimens are assessed for compressive strength and split tensile strength at curing intervals of 7, 14, and 28 days. The experimental analysis involves comparing the strength characteristics of the transparent concrete with those of conventional concrete.

5.1 COMPRESSIVE STRENGTH TEST



Fig.5.1 compression testing on cube specimen

TABLE 5.1 COMPRESSIVE STRENGTH OF THE CUBIC SPECIMEN FOR 7 DAYS, 14 DAYS & 28 DAYS

CUBIC SPECIMEN LABEL	Glass Powder in %	7 days (N/mm ²)	14 days (N/mm ²)	28 days (N/mm ²)
TEST MIX (A) CONVENTIONAL	0	26.28	33.78	38.96
TEST MIX (B) OPTICAL FIBER	5	27.90	32.67	37.28
TEST MIX (C)	10	29.83	34.53	40.62
TEST MIX (D)	15	26.20	33.17	36.70

6.2 Splitting Tensile Strength Test



Fig.5.2 splitting tensile strength test on cylindrical specimen

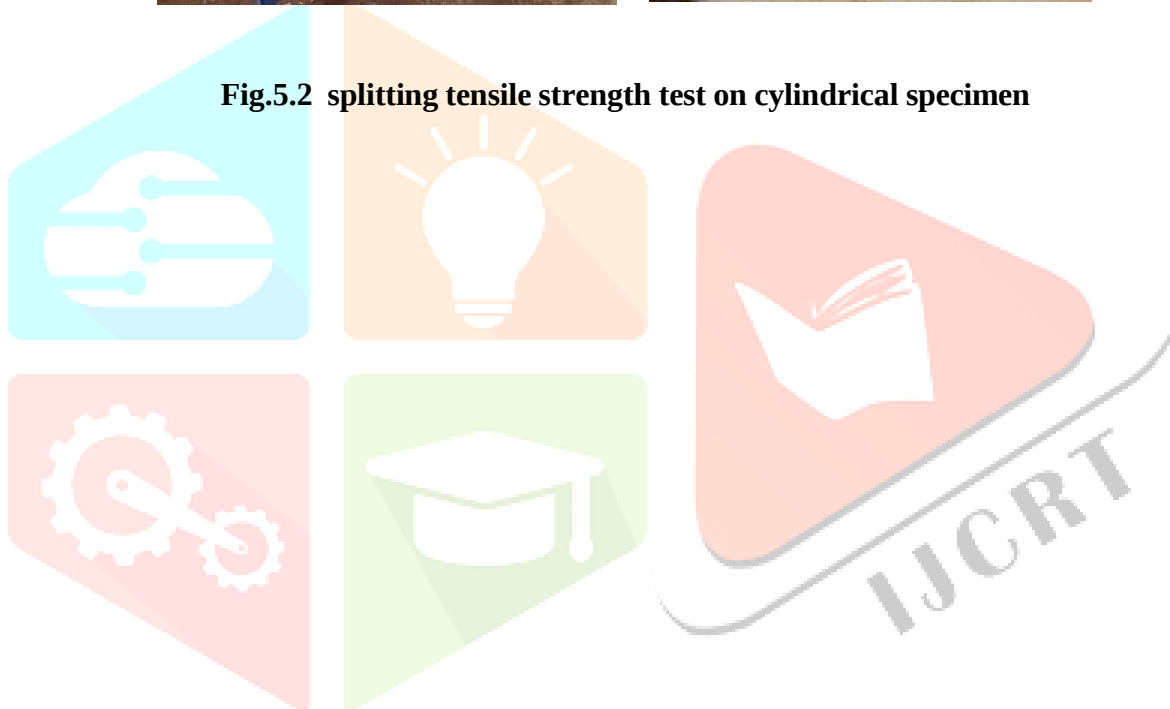


TABLE 5.2 SPLITTING TENSILE STRENGTH OF THE CYLINDRICAL SPECIMEN FOR 28 DAYS

CUBIC SPECIMEN LABEL	Glass Powder in %	AVERAGE SPLIT TENSILE STRENGTH
TEST MIX (A) CONVENTIONAL	0	2.26
TEST MIX (B) OPTICAL FIBER	5	2.41
TEST MIX (C)	10	2.96
TEST MIX (D)	15	2.32

5.3 Flexural strength test

**Fig 5.3 Flexural Testing Machine.****TABLE 5.3 FLEXURAL STRENGTH OF CONCRETE SPECIMEN FOR 28 DAYS**

CUBIC SPECIMEN LABEL	Glass Powder in %	Average Flexural Strength of Concrete (MPa)
TEST MIX (A) CONVENTIONAL	0	4.5
TEST MIX (B) OPTICAL FIBER	5	5.1
TEST MIX (C)	10	4.8
TEST MIX (D)	15	4.4

VI. RESULTS

6.1 Compressive Strength Testing

Table 6.1 : COMPRESSIVE STRENGTH OF THE CUBIC SPECIMEN FOR 7 DAYS, 14 DAYS & 28 DAYS

Glass Powder in %	7 days (N/mm ²)	14 days (N/mm ²)	28 days (N/mm ²)
0	26.28	33.78	38.96
5	27.90	32.67	37.28
10	29.83	34.53	40.62
15	26.20	33.17	36.70

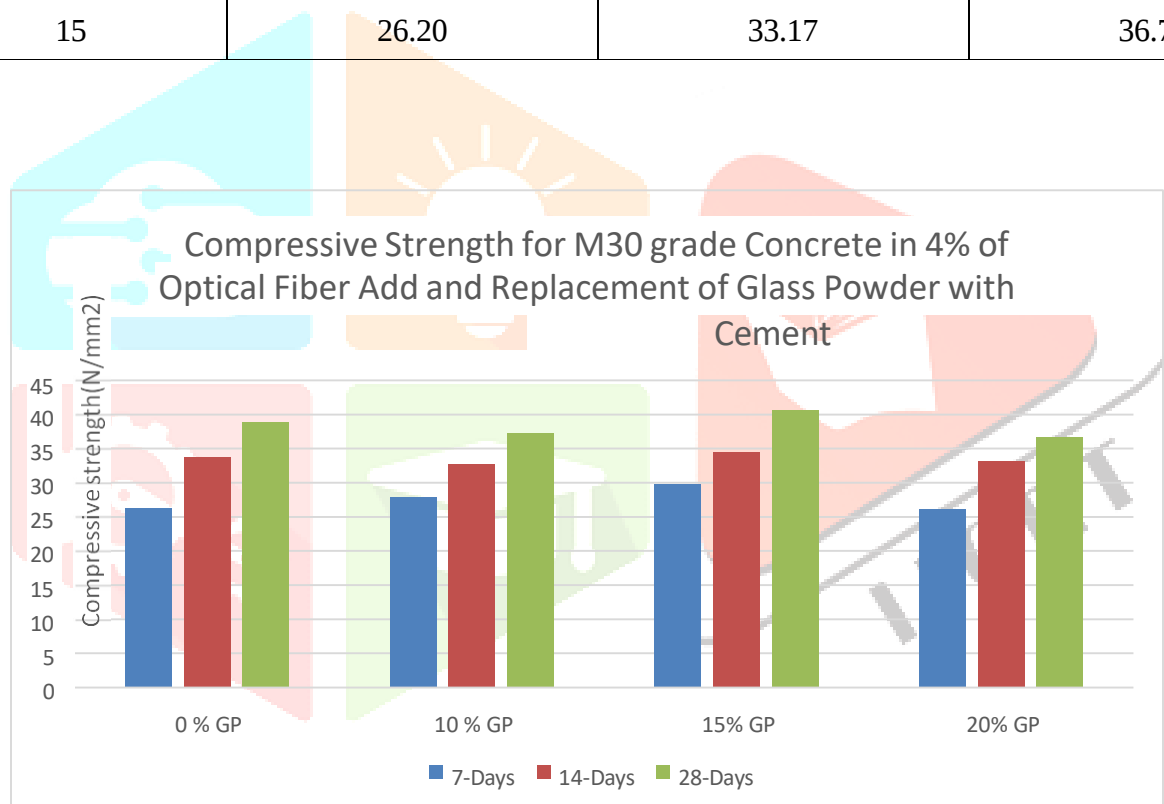


Figure: 6.1 : Comparison of Compressive Strength for 7, 14 and 28 days

6.2 Split Tensile Testing

Table 6.2 : SPLITTING TENSILE STRENGTH OF THE CYLINDRICAL SPECIMEN FOR 28 DAYS

Glass Powder (%)	28 days (N/mm ²)
0	3.72
5	3.83
10	3.98
15	3.79

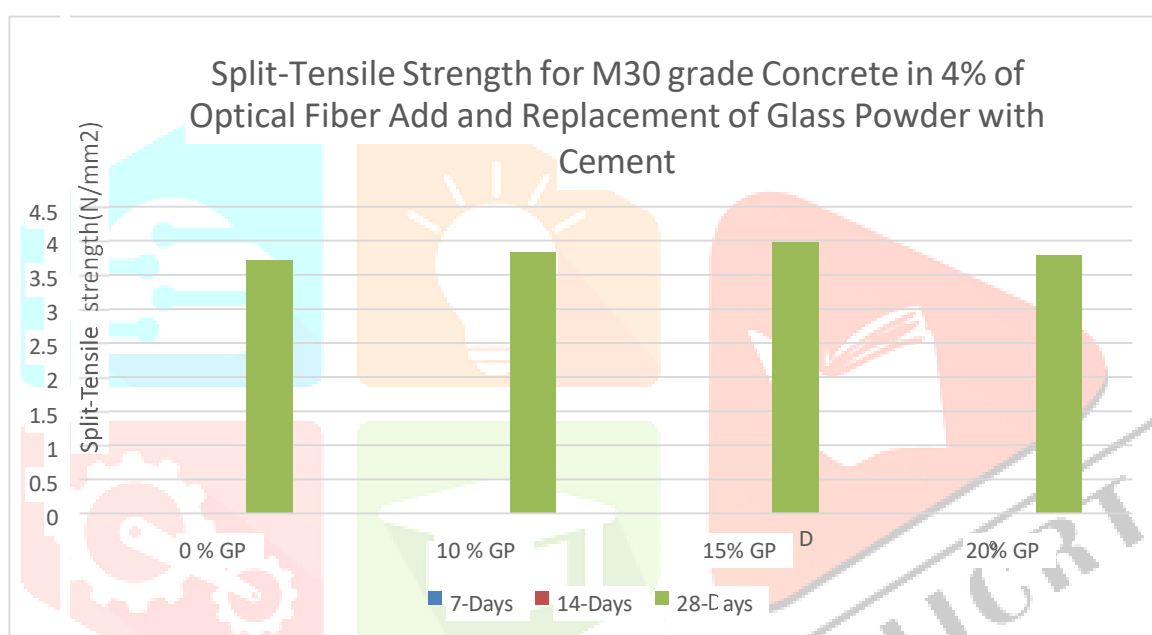


Figure: 6..2 : Comparison of Split-tensile strength for 28 days

6.3 Flexural Strength Testing

TABLE 6.3 FLEXURAL STRENGTH OF CONCRETE SPECIMEN FOR 28 DAYS

CUBIC SPECIMEN LABEL	Glass Powder in %	28 days (N/mm ²)
TEST MIX (A) CONVENTIONAL	0	4.5
TEST MIX (B) OPTICAL FIBER	10	5.1
TEST MIX (C)	15	4.8
TEST MIX (D)	20	4.4

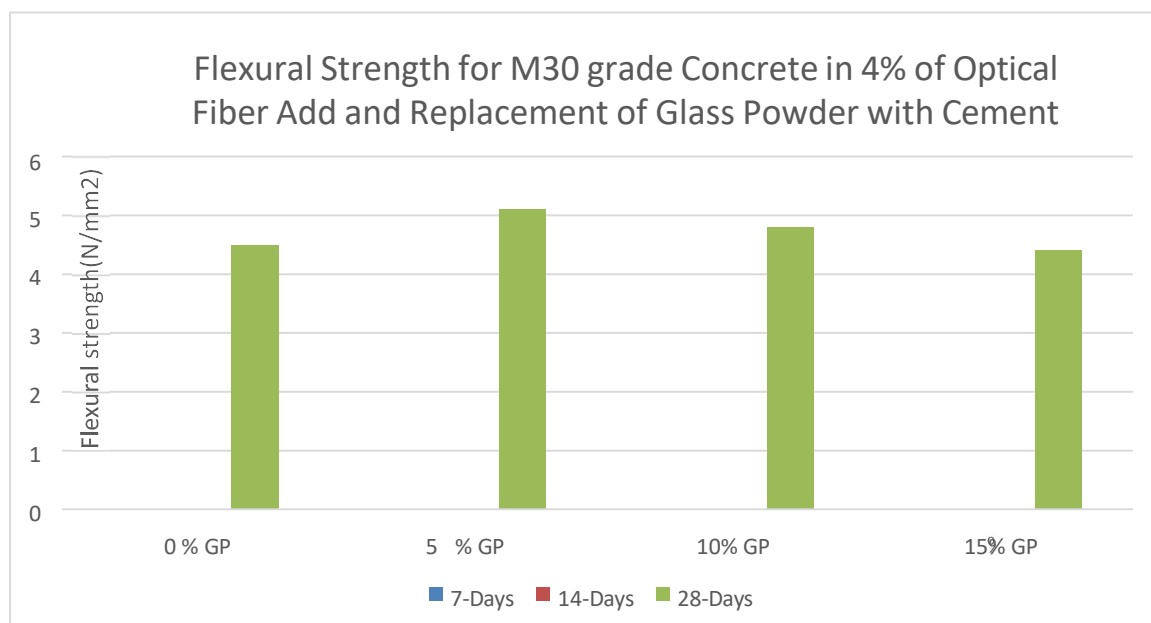


Figure: 6.3 : Comparison of flexural strength for 28 days

VII. Conclusion

The experimental investigation on the development and mechanical properties of Light-Transmitting Concrete (LTC) using glass powder as a partial replacement for cement and 4% optical fibers has led to the following conclusions:

1. MECHANICAL PERFORMANCE SUMMARY:

- The compressive strength and split tensile strength of translucent concrete increased with the increase in glass powder content up to 15%, after which a decline was observed. The maximum compressive and split tensile strength was achieved at 15% glass powder + 4% optical fibers for all curing periods (7, 14, and 28 days).
- For flexural strength, the best performance was observed with 10% glass powder + 4% optical fibers across all curing periods. Beyond 10%, flexural strength gradually decreased, likely due to reduced cementitious content leading to weaker bonding and matrix integrity.

2. OPTIMAL MIX FOR BEST PERFORMANCE:

- Compressive & Split Tensile Strength: Best at 15% glass powder + 4% optical fibers
- Flexural Strength: Best at 10% glass powder + 4% optical fibers

3. PRACTICAL APPLICATIONS:

- This translucent concrete mix can be used in architectural and structural elements where aesthetic appeal and light transmission are required, such as:

- Interior/exterior wall panels
- Partition walls

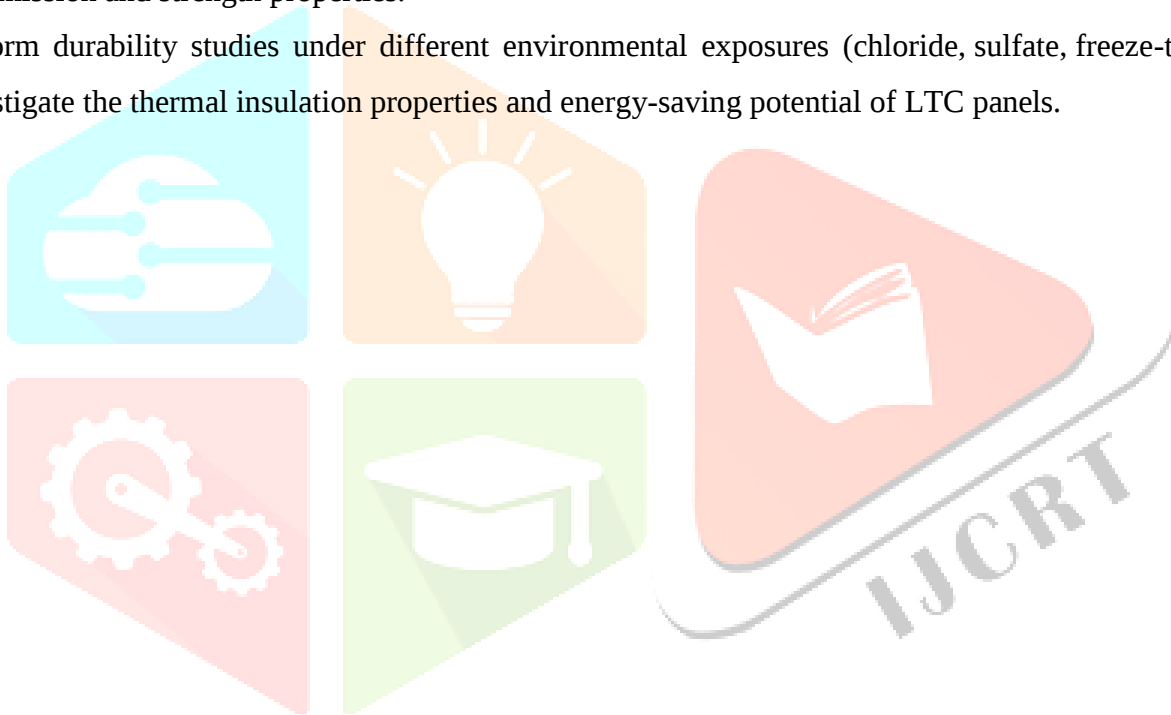
- Façade elements
- Landscape pavements
- It offers both structural functionality and daylight penetration, reducing reliance on artificial lighting in certain applications.

4. WORKABILITY OBSERVATIONS:

- As the replacement percentage of cement with glass powder increases, workability decreases and water demand increases, especially beyond 15–20% replacement. Hence, mix design must be optimized to balance strength and workability.

5. SUGGESTIONS FOR FUTURE RESEARCH:

- Incorporate different types of fibers such as basalt, carbon, or nano-fibers to assess their effect on light transmission and strength properties.
- Perform durability studies under different environmental exposures (chloride, sulfate, freeze-thaw).
- Investigate the thermal insulation properties and energy-saving potential of LTC panels.



REFERENCES

1. Durga Raghavi, Dr.K.Rajasekar, “Experimental Studies on Strength and Durability Properties of Transparent Concrete”, International Journal For Research in Engineering Application & Management, Volume-4, Issue-11, Feb2019, I Dileep Kumar P, Venkatalakshmi, et al, “Evaluation of Strength Characteristics of Transparent Concrete”, International Journal of Engineering Development & Research (IJEDR) Volume-7, Issue-1, ISSN:2321-9939.
2. Dilna R D, et al, “ Partial Replacement of Cement by Glass Powder in Concrete”, International Research Journal of Engineering & Technology (IRJET), Volume- 7, Issue6, June 2020, e-ISSN:2395-0056, p-ISSN:2395-0072.
3. Dinesh w.Gawatre, Suraj D.Giri, et al, “Transparent Concrete as an eco-friendly material for building”, International Journal of Engineering Science Invention”, Volume-5, Issue3, March 2016, ISSN:2319-6734.

4. Nikil K, et al, "Experimental Analysis of Translucent Concrete by Using Optical Fibers", SSRG-International Journal of Civil Engineering(SSRG-IJCE), Volume- 3, Issue-3, March-2016.
5. Poornima D, Shailaja T, et al, "An Experimental Study on Light Transmitting Concrete", International Research Journal of Engineering and Technology (IRJET) Volume-6, Issue-5, May-2019, e-ISSN:2395-0056, p-ISSN:2395-0072.
6. Praveen Kumar R, et al, "An Experimental Study on Smart Transparent Concrete", International Journal of Innovative Research in Science Engineering and Technology, Volume-6, Issue-3, March 2017, ISO:3297-2007.
7. RiyaGite, Shilpakewate, "Critical Study on Transparent Concrete", International Journal of Scientific & Research, Volume-8, Issue-3, March 2017, ISSN:2229- 5518.
8. Samyayit Paul, Avik Dutta, "Translucent Concrete", International Journal of Scientific and Research Publications, Volume 3, Issue-10, October 2013, ISSN:2250-3153.
9. Sandeep Sharma, Dr.O.P.Reddy, "Transparent Concrete", International Journal of Engineering Sciences & Research Technology, March 2017, ISSN:2277-9655.
10. Sangmesh R, et al, "Experimental Study on Light Transmitting Concrete", International Journal of Science Technology & Engineering, Volume-4, Issue-1, July 2017, ISSN:2349-784X.
11. Sasidharan J, Naga Sai Teja A, "Translucent Concrete", International Journal of Engineering Research & Technology, Volume-6, Issue-4, April-2017, ISSN:2278- 0181.
12. Shanmudavadivu P.M, V.Scinduja, et al, "An Experimental Study on Light Transmitting Concrete", International Journal of Research in Engineering and Technology, e-ISSN:2319-1163, p-ISSN:2321-7308.
13. Shreyas.K, "Transparent Concrete", International Journal of Engineering & Technology Science and Research (IJETSR) Volume-5, Issue-3, March 2018, ISSN:2394-3386.
14. Subramani T, et al, "Experimental Study on Concrete Using Cement With Glass Powder", IOSR Journal of Engineering (IOSRJEN), Volume-5, Issue-5, May 2015, e- ISSN:2250-3021, p-ISSN:2278-8719.
15. Vandhiyan R, Ramkumar K, et al, "Experimental Study on Replacement of Cement by Glass Powder", International Journal of Engineering Research & Technology (IJERT), Volume-2, Issue-5, May-2013, ISSN:2278-0181.