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An Experimental Study on Mechanical Properties of Translucent Concrete

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Abstract **— This study deals with the usage of translucent concrete and also the advantages it brings in the field of smart construction, that it can reduce the power consumption of illumination and use the optical fibre can be made to sense the stress of structures and this concrete as an architectural purpose for good aesthetical view of the building. Translucent concrete is a concrete based material with light-trans missive properties, obtained by embedding optical fibres in it. Light is conducted through the fibre from one end to the other. This results into a certain light pattern on the other surface, depending on the fibre structure. Optical fibres transmit light so effectively that there is virtually no loss of light conducted through the fibre. The work presented in this project reports an investigation on the behaviour of concrete and mortar with optical fibre. Concrete and mortar cube are casted with fibres to study the properties and to compare the compressive strength between normal mix concrete with optical fiber and Normal mortar with optical fibre after 7 days, 14 days and 28 days respectivelyand concrete prisms are casted with same fibers to compare the flexural strength between the normal conventional concrete prism and the prism with the optical fiber strands after 7 and 28 days respectively.**

Keywords **— Translucent concrete, Plastic optical fiber, Light transmissive properties, Characteristic compressive strength, Flexural strength.**

1. INTRODUCTION

Concrete is a composite material containing aggregate bonded together with a fluid cement hardens over time. Most use of the time "concrete" refers to Portland cement concrete or to concrete made with other hydraulic cement, such as cement found. However, road surface is also a type of concrete. "Asphaltic concrete", where the cement material is bitumen. In Portland cement concrete and other (hydraulic cement concrete), when the aggregate is mixed together with the dry cement and water, they form a fluid mass that is easily molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix which binds all materials together into a durable stone-like material. Often, additives (such as pozzolana or super plasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material. Famous concrete structures include the Hoover dam, the Panama Canal and Roman Pantheon. The earliest large-scale users of concrete technology were the ancient Romans, and concrete was widely used in the Roman Empire. The Colosseum in Rome was built largely of concrete, and today, large concrete structures (for examples, dams and multi-storey car parks) are usually made with reinforced concrete.

2. MATERIALS AND METHOD

2.1 Cement:

Ordinary Portland Cement (OPC) of grade 53 was used. It is high grade cement. One of the most important benefits is the faster rate of development of strength.

TABLE: 1
PROPERTIES OF CEMENT

S. No	Properties	Result
1	Specific gravity	3.1
2	Fineness	1%
3	Consistency	35%
4	Initial Setting Time	35 minutes

2.2 Fine aggregate:

The reason for using a fine aggregate in the correct proportions, a concrete with very few voids or spaces in it can be made and to produce a strong concrete. River Sand of zone II was determined. Properties of fine aggregate are as follows:

TABLE: 2
PROPERTIES OF FINE AGGREGATE

S. No	Properties	Result
1	Specific gravity	2.67
2	Fineness modulus	3.67
3	Optimum moisture	19%

2.3 Coarse Aggregate:

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Aggregate are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Hard granite broken stones of less than 20mm size were used as coarse aggregate.

TABLE: 3
PROPERTIES OF COARSE AGGREGATE

S. No	Properties	Result
1	impact value	30%
2	Crushing value	18%
3	Fineness modulus	2.21

2.4 Water:

Potable water confirming to the requirements of IS: 456 - 2000 was used for mixing concrete and curing the specimen as well.

2.5 Plastic optical fibre:

Plastic Optical Fiber (POF), typically uses PMMA, (acrylic), a general-purpose resin as the core material, and fluorinated polymers for the cladding material. In large-diameter fiber, 96 percent of the cross-section is the core that facilitates the transmission of the light.

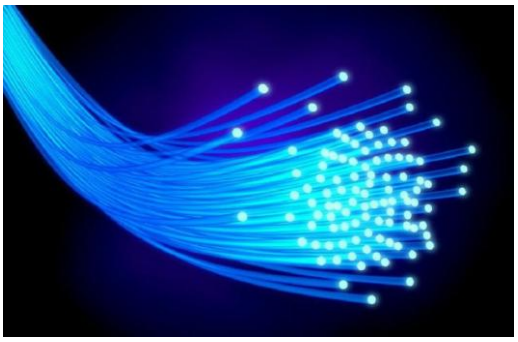

Fig 1: Plastic optical fibre

3. EXPERIMENTAL PROGRAM:

3.1 Concrete mix design:

Concrete of grade M30 was designed as per IS 10262:2009 and the mix ratio was 1:1.47:2.59(cement: fine aggregate: Coarse Aggregate). A water- cement ratio of 0.45 was adopted.

3.2. Preparation of specimens:

The materials required for the preparation of concrete are weighed and taken seperately. The cement and M-Sand were mixed thoroughly and then the coarse aggregate was added and again mixed. The required amount of water is taken and measured with the help of measuring jar and added to the cement-aggregate mixture and the materials are mixed until they are converted into concrete slurry and are poured inside the mould in which the plastic optical fibre strands are inserted. Then the poured concrete is compacted properly.

3.3. Cube compressive strength:

The standard cube moulds of 150*150*150 mm are thoroughly fitted and cleaned and then oil was applied on the inner surface of the mould to reduce the abrasion. Then casting, demoulding and curing process was done as per the procedure. After 28 days of curing process the specimen was tested in a compressive testing machine. The compressive strength of concrete with and without optical fibre strands are tested at the intervals of 7, 14 and 28 days. The results are found compared respectively.

3.4 Flexural strength of prism:

The standard prism moulds of 500*100*100 mm are used. Then the procedure was followed as cube. Finally the prism is tested in universal testing machine. The flexural strength of concrete with and without optical fibre strands are tested at the intervals of 7, 14 and 28 days. The results are found and compared respectively.

4. EXPERIMENTAL INVESTIGATION

4.1Cube compressive strength:

The compressive strength of different fibre ratios are compared with conventional concrete. Eighteen concrete cubes of 150x150x150mm were casted and tested in compression testing machine (ASTM C39) at the end of 7and 28 days. However, the brittle mode of failure associated with plain concrete was transformed into a more ductile one with the increased addition of fibres. Similar fibres may show a variation in strengths when subjected to loading may be due to varied slumps also. Here are the test results for 7 and 28 days.

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Fig 2.Compressive testing machine

The characteristic compressive strength of the conventional concrete of grade M30 at the intervals of 7, 14 and 28 days are

TABLE: 4
Compressive strength results of conventional concrete

Sample	Compressive strength at (N/mm^2)		
	7 days	14 days	28 days
S1	21	29	31
S2	19	24	27
S3	16	28	32
AVERAGE	19	27	30.5

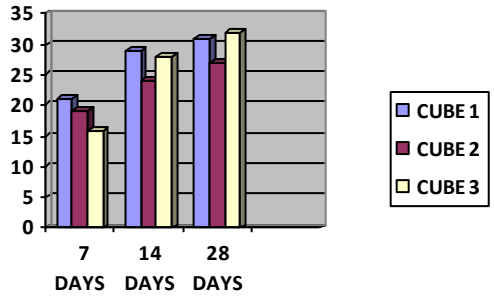

Fig 3: Compressive strength of conventional concrete at 7, 14 and 28 days

The characteristic compressive strength of the translucent concrete of grade M30 at the time intervals of 7, 14 and 28 days are

TABLE: 5
Compressive strength results of translucent concrete

Sample	Compressive strength at (N/mm^2)		
	7 days	14 days	28 days
S1	17.7	27.5	32
S2	17.3	29.8	30.7
S3	20.7	28.4	32.4
AVERAGE	18.5	28.6	32

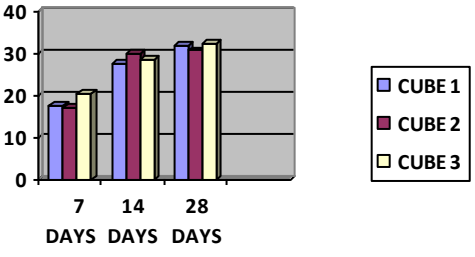

Fig. 4 : Compressive strength of translucent concrete at 7, 14 and 28 days

4.2 Flexural strength of prism:

The flexural strength of different fibre ratios are compared with conventional concrete. Eighteen concrete beams (500x100x100mm) were tested in flexure (ASTM C7875) after 7and 28 days. For plain concrete beams, cracking immediately leads to failure. Use of fibre produces more closely spaced cracks and reduces crack width. Here are the test results for 7 and 28 days.

Fig 5.Universal Testing Machine

TABLE: 6
Flexural Strength of conventional concrete

Sample	Flexural strength at (N/mm^2)		
	7 days	14 days	28 days
S1	4.13	5.63	7.5
S2	3.75	6	7.13
S3	4.13	6	7.5
AVERAGE	4.003	5.75	7.38

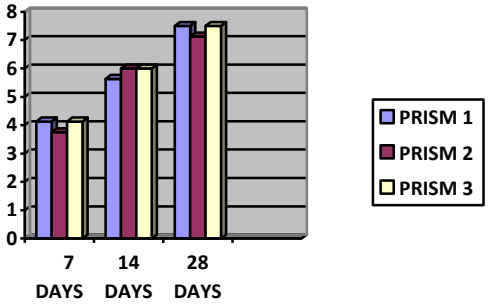

Fig: 6 Flexural strength of conventional concrete

TABLE: 7
Flexural strength of translucent concrete

Sample	Flexural strength at (N/mm^2)		
	7 days	14 days	28 days
S1	4.5	6.375	8.25
S2	4.125	6.75	7.5
S3	4.5	6.375	8.25
AVERAGE	4.375	6.5	8

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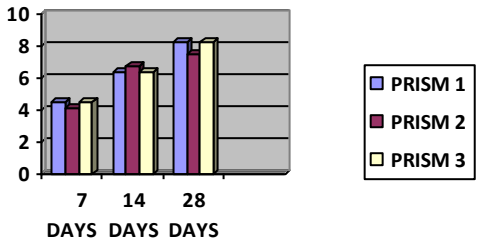

Fig 7.Flexural strength for 7 and 28 days

5. CONCLUSION

- A novel architectural material called translucent concrete can be developed by adding optical fibre or large diameter glass fibre in the concrete mixture.
- The translucent concrete has good light guiding property and the ratio of optical fiber volume to concrete is proportion to transmission.
- The translucent concrete not loses the strength parameter when compared to regular concrete and also it has very vital property for the aesthetical point of view.
- It can be used for the best architectural appearance of the building.
- Also used where the light cannot reach with appropriate intensity.
- This new kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional materials.

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