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Experimental Study Of Applying Translucent Concrete In Green House Building Concrete Using M-Sand

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Abstract: ***Concrete is a widely used structural material consisting essentially of a binder and a mineral filler. Concrete has been the leading material since it was used and is bound to maintain its significant role in the upcoming future due to its durability, adaptability to any shape and size and many other applications. It is a composite material produced by mixing cement, inert matrix of sand and gravel or crushed stone. Pervious concrete is a type of concrete that has a low water-cement ratio and contains none or very little amount of sand. This concrete has a light colour and open-cell structure because of which they do not absorb heat from the sun; they also do not radiate the heat back into the atmosphere, which reduces heating in the environment. Pervious concrete has low installation costs. In addition, it filters the storm water thus reducing the number of pollutants entering the rivers and ponds. Pervious concrete also improves the growth of trees. In the present study the behaviour of pervious concrete has been studied experimentally. Various mix proportions were prepared by replacing cement with silica fume (10% by the weight of cement), by adding super plasticizers (0.3%). Different properties of pervious concrete e.g. compressive strength, split tensile strength, permeability test at 7, 14 & 28 days have been studied experimentally.***

Keywords: Experimental Study, Concrete, Green House, M-Sand

1. INTRODUCTION

The concrete currently used in the construction industry generally consists of at least cement, water and aggregates (fine or coarse). As is well known, traditional concrete has a greyish colour, and its high density prevents the passage of light through it, which means that it is also impossible to distinguish bodies, colours and shapes through it. As can be imagined, concrete with the characteristic of being translucent will permit a better inter action between the construction and its environment, here by creating ambiences that are better and more naturally lit, at the same time as significantly reducing the expenses of laying and maintenance of the concrete. Along with the translucent characteristics, the paper confines its area towards the reinforcement method of this type of concrete such that they can be practically implemented as a load bearing structure. This new kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional materials.

Use of waste and by products in concrete will lead to green environment and such concrete can be called as "Green Concrete". There are various types of waste materials that can be considered for usage in concrete. The disposal of fly ash will be a big challenge to environment, especially when the quantum increases from the present level. Hence worldwide research work was focused to find alternative use of this waste material and its use in concrete industry is one of the effective methods of utilization. Increase in demand and decrease in natural resource of fine aggregate for the production of concrete has resulted in the need of identifying a new source of fine aggregate. The possibility of utilization of thermal power plant by product bottom ash as replacement to fine aggregate in concrete is taken into consideration.

The characteristic details of this novel concrete are studied under the following description and following the same reference signs for indicating it. A polymeric matrix is expected to be provided to enhance the binding capacity and also the mechanical strength. Preferable two polymeric mixture as per our studies are required. One, epoxy and the other is polycarbonate matrix. These together with the irrespective catalyst shall forma good binding strength. The aggregates used in the manufacture and formulation were fibre glass, silica, colloidal silica sol and optical fibres. Optionally, rocky elements can be used as aggregates, for example, gravels, sands, etc.

The setting agent used is diethylenetriamine (DETA), which has be dehydrated on molecular sieves prior to use. The optical fibres used in the formulation of this concrete are basically fine glass or plastic threads that guide the light. The communication system arises from the union between the light sources that is sufficiently pure for not being altered. The types of fibres used are mono mode and virgin fibres, in other words, those in the pure state and without any coatings, the aim of which is so that the light can pass through the concrete. Used as additives are: pigments; bridging agents for favouring the attachment to the matrix, giving resistance and protection against aging ; lubricant agents for giving surface protection agents for giving integrity, rigidity, protection and impregnation, metal salts, thixotropic agents (flakes of inorganic materials, glass microspheres, calcium carbonates, silicon dioxide, etc.),flame retardant agents (elements containing chlorine, bromine, phosphorus, etc.) and UV protection agents (stabilisers). Silicasol, also known as silica hydrosol, is a colloidal solution with a high molecular hydration of silica particles dispersed in water. It can be used as a binding agent. Silica of between 0.5 and 10% by weight of resin has to be used so that, once set, the silica used provides greater resistance and hardness to the concrete. According to the study the mechanical characteristics such as compressive resistance of a translucent concrete with epoxy matrix is upto220Mpa.The manufacturing process of this concrete consists of the mixture of two processes, one where the cement is mixed with water, and the other where the matrices are mixed. Figure 1 shows the integrated model of translucent concrete cube

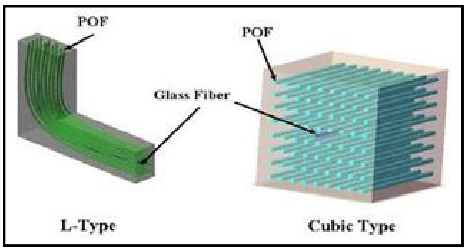

Figure 1 Integrated model of translucent concrete cube

Figure 2 shows the Form-work of wood and thermocol

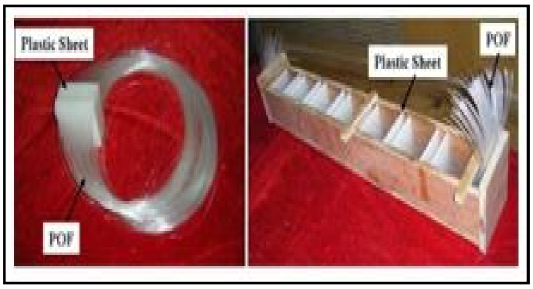

Figure 2 Form-work of wood and thermocol

1.1 General

Concrete, that traditionally solid, substantial building material, is getting a makeover. Engineers have now developed concrete mixtures that are capable of transmitting light. By switching the ingredients of traditional concrete with transparent ones, or embedding fibre optics, translucent concrete has become a reality. Light Transmitting concrete, also known as translucent concrete. It is the brightest building material development in recent years.

It is one of the newest, most functional and revolutionary element in green construction material. In this paper the manufacturing, uses and future scope of transparent concrete is widely given. However, this innovative new material, while still partially in the development stages, is beginning to be used in a variety of applications in architecture, and promises vast opportunities in the future.

Concrete has been used since Roman times, but its basic components have remained the same. Three ingredients make up the dry mix: coarse aggregate, consisting of larger pieces of material like stones or gravel; fine aggregate, made up of smaller particles such as sand; and cement, a very fine powder material that binds the mix together when water is added. Engineers have come up with several potential types of mixtures for translucent concrete. One approach is to exchange the traditional ingredients with transparent or translucent alternatives. Aggregates can be replaced with transparent alternatives, and the bonding material itself may be able to transmit light by incorporating clear resins in the mix. Another approach is the "combination of optical fibres and fine concrete". Sand is a vital ingredient in making two most used construction materials viz. cement concrete and mortar. Traditionally River sand, which is formed by natural weathering of rocks over many years, is preferred as fine aggregate .The economic development fuelling the growth of infrastructure and housing generates huge demand for building materials like sand. The in discriminateining of sand from river beds is posinga serious threat to environment such as erosion of river bed and banks, triggering landslides, loss of vegetation on the bank of rivers, lowering the underground water table etc. Hence, sand mining from river beds is being restricted or banned by the authorities. Controlling extraction along rivers has caused the illegal activities to spread into hillside and farmlands, creating public hazards such as landslide, deep ponds, and hanging cliffs.

This sand extracted from fields (popularly known as filter sand), in addition to depleting the fertile top soil, impairs the quality of concrete / mortar. Manufactured sand, which is obtained by crushing the rock, is emerging as available alternative to river sand. This material is in use for quite some time in developed countries. The use of this sand (also called artificial sand, M-Sand, Robot Sand etc.,) is picking up in India in major cities. Use of scientifically produced Manufactured Sand as an alternative to river sand is the need of the hour and will provide a long term solution to Indian Construction Industry.

1.2 Manufactured Sand

Manufactured sand is crushed fine aggregate produced from a source material and designed for use in concrete or for other specific products. Only source materials with suitable strength, durability and shape characteristics should be used. Production generally involves crushing, screening and possibly washing. Separation into discrete fractions, recombining and blending may be necessary.

1.3 Applications

Transparent concrete offer s advanced technical solutions, semi-natural and ecological concrete. This concrete has a wide range of utilization in construction, architecture, decoration and even furniture. Some of the feasible applications for the creative concrete are as follows:

- Transparent concrete blocks are best suited for floors, pavements and load-bearing walls.
- Interior wall cladding, dividing walls and facades based on thin panels.
- It can be used as partitions wall where the sunlight does not reach satisfactorily.
- Transparent on create can also be used in furniture for the any and creative purpose.
- Light hanging from ceiling
- Used to glow sidewalks at night.
- Increasing range of vision in dark subway stations.
- To light indoor fire exit in case of power failure.
- High lighting speed bump son freeways, highways and express way sat night.

1.4 Material Used For Manufacturing of Transparent Concrete

It is a combination of fibre optics and fine concrete. It can be produced as prefabricated building blocks and panels. Due to the small size of the fibres, they blend into concrete becoming a component of the material like small pieces of aggregate. Thousands of optical fibres strands are placed in concrete to transmit light, either natural or artificial, into all spaces enclosed by the translucent concrete panels. Figure 3 shows the optical fibres used in the study.

Figure 3 Optical fibres

1.5 Material Performance

- Concrete embedded with optical glass fibres running in a matrix while still retaining the strength of concrete.
- High density top layer concrete
- Infused with optical fibres
- Fire protection classification A2
- Highest UV resistance

1.6 How Transparent Concrete Made

- Strands of optical fibres are cast by the thousands into concrete to transmit light, either natural or artificial, into all spaces surrounding the resulting translucent panels. Light-transmitting concrete is produced by adding 4% to 5% optical fibres (by volume) into the concrete mixture. The fibres run parallel to each other, transmitting light between two surfaces of the concrete element in which they are embedded. Thickness of the optical fibres can be varied between 2 μm and 2 mm to suit the particular requirements of light transmission.
- Originally, the fibre filaments were placed individually in the concrete, making production time-consuming and costly. Newer, semi-automatic production processes use woven fibre fabric instead of single filaments. Fabric and concrete are alternately inserted into moulds at intervals of approximately 2 mm to 5 mm. Smaller or thinner layers allow an increased amount of light to pass through the concrete. Following casting, the material is cut into panels or blocks of the specified thickness and the surface is then typically polished, resulting in finishes ranging from semi-gloss to high- gloss.
- The concrete mixture is made from fine materials only: it contains no coarse aggregate. The compressive strength of greater than 70 MPa (over 10,000 psi) is comparable to that of high-strength concretes.

Figure 4 shows the optical fibres

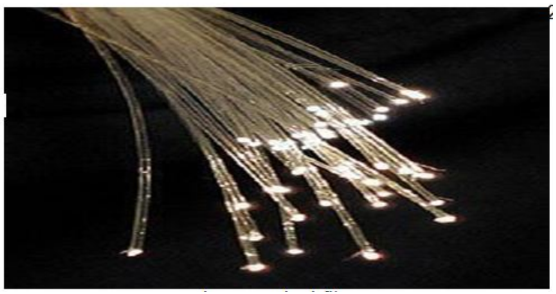

Figure 4 Optical fibre

Figure 5 shows the placing of fibre

Figure 5 Placing of Fibre

Figure 6 shows the transmission of light

Figure 6 Transmission of light

1.7 Used Of Translucent Concrete

Translucent concrete is not currently widely produced. There are only a select few companies, and the process is somewhat low- tech and slow. It can only be produced as pre- cast or prefabricated blocks and panels; it cannot be poured on site like traditional concrete. With its light-transmitting properties, however, translucent concrete has the power to potentially transform the interior of concrete buildings, making them appear fresh, open and spacious. Figure 7 shows the example of transparent concrete.

Figure 7 Example of Transparent Concrete

1.8 Traditional Uses

- Translucent blocks suitable for floors, pavements and load-bearing walls
- Facades, interior wall cladding and dividing walls based on thin panels.

1.9 Emerging Uses/Trends

- Partitions
- Furniture
- Light fixtures
- Light sidewalks at night
- Increasing visibility in dark subway stations
- Lighting indoor fire escapes in the event of a power failure
- Illuminating speed bumps on roadways at night
- Stairs
- Decorative Tiles
- Lamps

Blocks of LiTraCon can be produced in different sizes, giving builders a wide variety of options when working with the material. So far, the blocks have been used in many buildings, for everything from desks to interior and exterior walls to lamps, and even an outdoor memorial. The material transmits light up to 20 m, so the concrete can be very thick while still making use of its light transmitting capabilities. The possible uses for LiTraCon are nearly endless. The blocks may even be used in the construction of energy-smart homes to reduce electricity costs by allowing more daylight to penetrate the structure.

1.10 Benefits of Optical Fibre

- Safe - No electricity, heat, or ultraviolet light in the fibre optic cable. Ideal for use in and around water, precious artifacts, paintings, combustible surfaces, etc.
- Versatile- Multiple applications possible from one light source.
- Economical- Operates on less than two amps.
- User friendly- The cable is durable, UV protected plastic, so there is nothing to break or burn out. Virtually maintenance free.

1.11 Environmental Impact

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. Since the insulating capacity of the wall is unchanged, the result is a net energy gain.

1.12 Glowing Future

Several years ago, the material was featured in the "Liquid Stone" exhibit at the National Building Museum, and started opening peoples' eyes to all kinds of possibilities. While the material has distinct architectural and interior design appeal, some of the companies involved in light-transmitting concrete production envision using the distinct looks and unique abilities of this concrete for practical applications. Although translucent concrete has been used primarily as an interior decoration, its creators have "visions of cities that glow from within, and buildings whose windows need not be flat, rectangular panes, but can be arbitrary regions of transparency within flowing, curving walls". It can at the same time be building material and light source, can separate and connect, can be wall or floor, ambient lighting or eye-catcher. Translucent concrete is also a great insulating material that protects against outdoor extreme temperatures while also letting in daylight. This makes it an excellent compromise for buildings in harsh climates, where it can shut out heat or cold without shutting the building off from daylight. It can be used to illuminate underground buildings and structures, such as subway stations. Translucent concrete could provide safety applications in the future such as speed bumps that could be lit "from below to make them more visible at night", or to light indoor fire escapes in case of a power failure. It even has the potential to be sustainable; the aggregate can be replaced with crushed recycled glass.

1.13 Advantages

- The main advantage of these products is that on large scale objects the texture is still visible - while the texture of finer translucent concrete becomes indistinct at distance.
- 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.
- It has very good architectural properties for giving good aesthetical view to the building.
- Where light is not able to come properly at that place transparent concrete can be used.
- Energy saving can be done by utilization of transparent concrete in building.
- Totally environment friendly because of its light transmitting characteristics, so energy consumption can be reduced.
- Speed bumps in parking lots and driveways could be illuminated from below, making them more visible and therefore more.
- Translucent concrete walls on restaurants, clubs, and other establishment to reveal how many patrons are inside.

1.14 Objective

- To cast a special type of concrete with light transmitting properties.
- To study development in performance of concrete in light transmission by using optical fibre and improve performance of structure to derive natural light.
- To make concrete partially transparent by using optical fibres in it to impart good appearance to structure.
- To study cost effectiveness of this high performance concrete.
- To study Energy saving for illumination by using transparent block for building.

2. METHODOLOGY

Figure 8 shows the methodology of the study

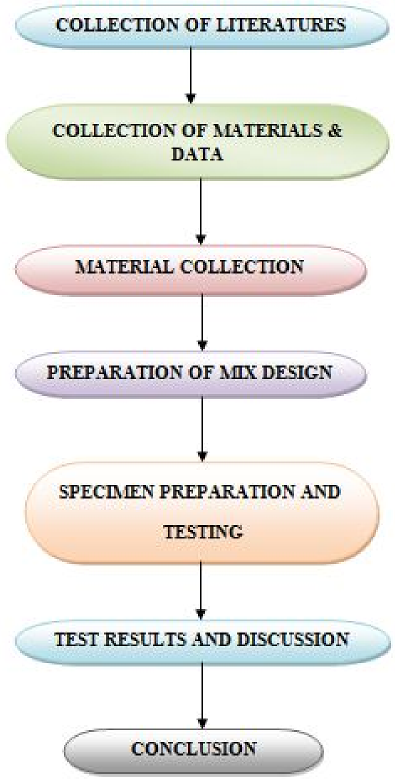

Figure 8 Methodology

3. MATERIALS USED AND MATERIAL PROPERTIES

3.1 Cement

The cement used was ordinary Portland cement 53 (OPC 53).All properties of cement were determined by referring IS 12269 - 1987. The specific gravity of cement is 3.15. The initial and final setting times were found as 55 minutes and 258 minutes respectively. Standard consistency of cement was 30%. Different types of cement also will produce concrete have a different rates of strength development. The choice of brand and type of cement is the most important to produce a good quality of concrete. The type of cement affects the rate of hydration, so that the strengths at early ages can be considerably influenced by the particular cement used. It is also important to ensure compatibility of the chemical and mineral admixtures with cement.

3.2 Fine Aggregate

The sand which was locally available and passing through 4.75mm IS sieve is used. The specific gravity of fine aggregate was 2.60. Locally available river sand conforming to Grading zone I of IS: 383 –1970.Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens.

3.3 Coarse Aggregate
20mm size aggregates-The coarse aggregates with size of 20mm were tested and the specific gravity value of 2.78 and fineness modulus of 7 was found out. Aggregates were available from local sources.

3.4 Water
The water used for experiments was potable water. Water used for mixing and curing shall be clean and free from injurious amounts of Oils, Acids, Alkalis, Salts, Sugar, Organic materials Potable water is generally considered satisfactory for mixing concrete Mixing and curing with sea water shall not be permitted. The pH value shall not be less than 6.

3.5 Manufactured Sand
When rock is crushed and sized in a quarry the main aim has generally been to produce coarse aggregates and road construction materials meeting certain specifications. Generally, this process has left over a proportion of excess fines of variable properties, generally finer than 5-mm size. The premixed concrete industry has for some time tried to find ways to utilize this material as a controlled replacement of natural sand.

Separation into discrete fractions, recombining and blending may be necessary. It is recognised from both local and overseas experience, that some quarry sources or some rock types within any particular quarry would not be suitable for use as manufactured sand in concrete. The research conducted has demonstrated that weathered and altered materials will adversely affect water demand in mixes, with predictable effects on mix strength, shrinkage and workability. Properties that are advantageous in crushed fine aggregate for some uses, e.g. low levels of plasticity for crusher dusts used in road bases, will be disadvantageous in crushed fine aggregate intended for use in concrete. Table 1 shows the physical properties of M-sand

Table 1: Physical properties of M-Sand

S.NO	PROPERTIES	VALUE
1	Specific Gravity	2.84
2	Fineness Modulus	2.82
3	Water absorption	5.6%

3.5.1 Geological and Mineralogical Properties Of Manufactured Sand
Most of the physical properties tested did not appear to be sensitive to rock type but were affected by the mineralogy developed in the rocks by either weathering or alteration. The clear exception was when the samples were tested by the Micro Deval apparatus. In this test the softer limestone had higher losses than most of the siliceous aggregates. This appeared independent of whether the limestone sample was weathered or not. The amount of testing conducted to date is limited but it would be advisable to avoid the use of limestone manufactured sands in circumstances that require high abrasion resistance in concrete.

Durability of manufactured sands, as for coarse aggregates, needs to address properties of hardness, strength, toughness and the ability to withstand abrasion. Although the fine aggregate will not tend to carry load in the concrete structure to the same extent as the coarse aggregate, the fine aggregate must be sufficiently durable that it will not fret or break. None of the durability tests mentioned are suitable for measuring 'hardness' or 'toughness' in manufactured sands; There is only a limited number of test machines currently in Australia and work in assessing the test procedure has only commenced. However, the test can be run on fine aggregate and it appears capable of distinguishing between 'soft' and 'hard' rock, as opposed to ‘altered' and 'weathered' mineralogy that tends to be the criteria of the other durability tests. It is hoped that the apparatus will allow for the assessment of abrasion resistance, particularly for manufactured sands that might be used in concrete pavements.

3.6 Optical Fibre
Flexible, transparent fibre made up of glass or plastic. It transmits light between two ends of the fibre. Optical fibre transmits light so effectively that there is almost no loss of light conducted through the fibres. For light transmission the thickness of optical fibre should be varied from 2 µm and 2 mm nearly equal to diameter of human hair. Concrete is produced by adding 4% to 5% optical fibre by volume in concrete mix. Figure 9 shows the total internal reflection.

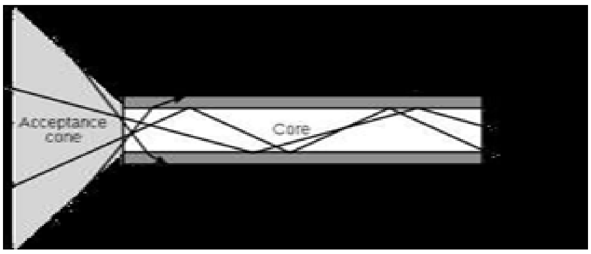

Figure 9 Total internal reflection

4. MIX DESIGN

Design Stipulations

Grade Designation M-30
Type of cement O.P.C-53grade
Fine Aggregate Zone-I
Sp. Gravity Cement 3.11
Sp. Gravity Fine Aggregate 2.65
Sp. Gravity Coarse Aggregate 2.75

Mix Proportion

Table 2 shows the Mix proportion

Table 2: Mix proportion

Cement (kg)/m^3	FA (kg)/m^3	CA (kg)/m^3	Water (kg)/m^3
531.43	602.71	1055.31	186

5. TEST PROCEDURE

5.1 Compression Test on Concrete Cubes

The determination of the compressive strength of concrete is very important because the compressive strength is the criterion of its quality. Other strength is generally prescribed in terms of compressive strength. The strength is expressed in N/mm^2. This method is applicable to the making of preliminary compression tests to ascertain the suitability of the available materials or to determine suitable mix proportions.

5.2 Flexural Strength Test

During the testing, the beam specimens of size 7000mmx150mmx150mm were used. Specimens were dried in open air after 7 days of curing and subjected to flexural strength test under flexural testing assembly. Apply the load at a rate that constantly increases the maximum stress until rupture occurs.

5.3 Reflectance Procedure

Reflectance or optical return loss (which has also been called "back reflection") of a connection is the amount of light that is reflected back up the fibre toward the source by light reflections off the interface of the polished end surface of the mated connectors and air. It is also called Fresnel reflection and is caused by the light going through the change in index of refraction at the interface between the fibre (n=~1.5) and air (n=~1). Reflectance is primarily a problem with connectors but may also affect mechanical splices which contain an index matching gel to prevent reflectance.

Connectors have different ferrule end finishes to reduce reflectance as well as loss. Mechanical splices have index matching gel to prevent reflections. Properly made fusion splices will have no reflectance; a reflectance peak indicates incomplete fusion or inclusion of an air bubble or other impurity in the splice. Reflectance is one component of the connector's loss, representing about 0.3 dB loss for a non-contact or air-gap connector where the two fibres do not make contact. Minimizing the reflectance is necessary to get maximum performance out of high bit rate laser systems and especially AM modulated CATV systems. In multimode systems, reflections are less of a problem but can add to background noise in the fibre.

Since this is more a problem with single mode systems, manufacturers have concentrated on solving the problem for their single mode components but multimode connectors benefit also since any reduction in reflectance also reduces loss. Several schemes have been used to reduce reflectance, mainly using a convex physical contact (PC) polish on the end of the connector ferrule, which reduces the Fresnel reflection and reduces reflectance to ~-40 to -50 dB. The technique involves polishing the end surface of the fibre to a convex surface to ensure proper fibre contact. On single mode fibre, PC finishes work even better at a slight angle (8°) to almost totally prevent reflectance (~ -60 dB). These connectors are called APC or angled physical contact connectors.

Reflectance is defined by the amount of light reflected compared to the power of the light being transmitted down the fibre. Thus a 1% reflectance is -20 dB, which is about what you get from a flat polished air gap connection, and 1 part per million would be -60 dB, typical of an APC connector. Return loss is the opposite, the amount of loss at the level of the return signal, so -20 dB reflectance is 20 dB return loss.

5.3.1 Measuring Reflectance

There are two ways to measure reflectance. One method uses a source and power meter with some accessories or an instrument called an optical CW reflectometer (OCWR), while the other method uses an optical time domain reflectometer (OTDR.) Neither method is particularly accurate, about +/-1 dB at best, but test equipment manufacturers often have readouts to 0.01 dB which only confuses people who think that the resolution of the instrument is the accuracy of the measurement. The problem with reflectance is the large range of the measurement which causes one of the two measurements to be a very low optical power.

Typical reflectance measurements require a large dynamic range, since reflectance is small for most current types of connectors as shown in the Table 3.

Table 3: Reflectance measure

Connector Type	Typical Reflectance
Flat with air gap	-20 dB
Physical Contact (PC)	-30 tp -40 dB
Ultra PC	-40 to -50 dB
APC (angled)	-60 dB or higher

Measuring over a 40 to 60 dB range is challenging, and reflectance testing adds another problem, how to minimize the errors from other reflecting parts of the cable being tested or even fibre backscatter on longer fibres. Furthermore, reflectance is sensitive to polarization effects which may not be controllable in all test conditions.

6. TEST PROCEDURE

6.1 Compressive Strength of Cube

Table 4 shows the compressive strength of cube

Table 4: Compressive Test Result

MIX DESIGN	% OF REPLACEMENT	COMPRESSIVE STRENGTH(N/mm^2)		
		7DAYS	14 DAYS	28DAYS
M_{30}	0	19.5	23.6	32.3
	10	21.2	26.6	35.3

Figure 10 shows the Compression Test Graph Result

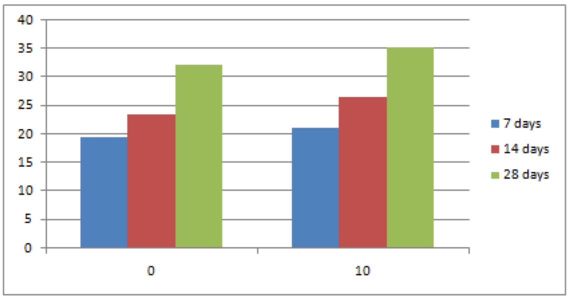

Figure 10 Compression test graph result

6.2 Flexural Strength Test for Cylinder

Table 5 shows the Flexural Strength Test Result

Table 5: Flexural Strength Test Result

MIX DESIGN	% OF REPLACEMENT	FLEXURAL STRENGTH TEST (N/mm^2)		
		7 DAYS	14 DAYS	28 DAYS
M_{30}	0	2.1	3.1	4.9
	10	2.34	3.5	5.12

Figure 11 shows the Flexural Strength Graph Result

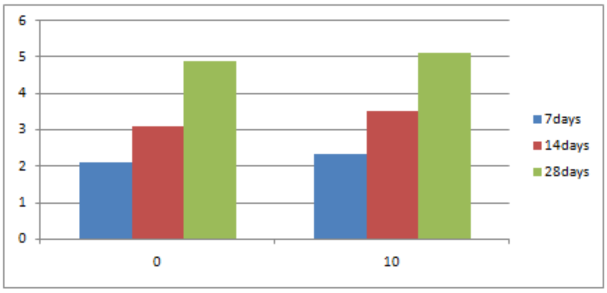

Figure 11 Flexural strength graph result

7. CONCLUSION

Translucent concrete blocks can be used in many ways and implemented into many forms and be highly advantageous. The transmittance obtained for the various translucent concrete specimens was seen to increase with the amount of optical fibres used.

- The transparent concrete has good light guiding property and the ratio of optical fibre volume to concrete is proportion to transmission.
- The compressive strength of Light transmitting concrete is equal to the strength of the ordinary concrete and it has the property to transmit light.
- The transparent 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.
- Compared to compressive strength results of conventional concrete and proposed mix, it attains optimum strength 35.3 N/mm^2 at 28days.
- Replacement of fibres 10% will increase in split tensile strength as compared to conventional concrete.
- 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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