

TRANSLUCENT CONCRETE AS A CONSTRUCTION MATERIAL

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Abstract: Concrete which is used traditionally consists of cement, water and aggregates (fine or coarse). Sometimes special additives or admixtures are used to make our outcome products. Traditional concrete is grey in color, and has high density which prevents light to pass through it. Translucent concrete will be able to permit a better interaction between the construction and its environment thereby, making to lit inside in a better and natural way. Optical fibers can easily be combined with concrete and also with POF (Plastic Optical Fibers) to provide a steady light transmitting ratio concrete. Furthermore, reducing the expense of operations like mixing, laying and maintenance of the concrete. Along with the translucent characteristics, reinforcement method of this type of concrete can also be practically implemented as in a load bearing structure. This advanced and innovative kind of building material can integrate the concept of green-buildings thereby reducing energy requirement and self-sustainability properties including relying more on renewable source of energies thus making this promising technology for field applications in civil engineering and infrastructure works.

Keywords: Green Building, façade, Aesthetics, Optical fiber, Nano-Optics, Scattered, critical angle, prefabricated mould, Theconcrete blocks , Vibrating-table, Light transmitting characteristics, Cladding materials, Decorative lamps

I. INTRODUCTION

Concrete being the versatile building material owing to its numerous properties, is being modified and improved as per our requirements and needs. In this century economic and financial development of any state is of extreme importance. With increasing population and limited space available vertical expansion is the only possibility thus paving way to built high rise buildings which also depict the development of any country. With this type of development we may face a number of problems primarily the increase in energy consumption, to overcome we now use idea of Green Building which is popularly growing in our country as well. One such idea is use of translucent concrete, which is primarily constructed by introduction of optical fibers in the concrete within the range of 5 to 8% [1]. Translucent concrete is used in architecture as a façade material and for newly designed objects and members to enhance and illuminate aesthetics of a structure. Translucent concrete works on principle of utilization of sunlight to emit light in the inner parts within and for nice esthetical works from front side. There are numerous techniques and procedures of introducing (optical fibers) where main motive of translucent concrete is utilizing Green Technology thus minimizing energy requirement and increasing reliability on renewable

and sustainable modes of energy.

II. MATERIALS REQUIRED FOR TRANSLUCENT CONCRETE

Translucent concrete has a specific property of allowing light to pass through it hence it has additional materials used within than that of traditional concrete. Translucent concrete is manufactured by combination of two basic materials i.e. fine concrete (without coarse- aggregates) and optical fibers [2]. Chemically translucent concrete is the mixture of epoxy materials and polycarbonate materials with optical fibers, colloidal silica-gel, diethylenetriamin and Ordinary Portland Cement, which provides higher compressive strength than traditional concrete. These are together used along with the specific catalyst forms an excellent binding strength. Usually a setting additive diethylenetriamine (DETA) is used, which are dehydrated on molecular sieves before their utilization [3].

2.1 Cement: - The role of cement is to work as a binding material in transparent concrete as it does in ordinaryconcrete. Ordinary Portland Cement (OPC) is most commonly used.

2.2 Water: - Water must be free from impurities as per the codal provisions specified for translucent concrete. Thuswater should be free from chlorides, solid-wastes, suspended solids, colloidal particles, acids and other organic impurities.

2.3 Sand: - There exists no specific provision for selection of sand. Only criterion is that it should be free from impurities like mud, clay, dirt etc

2.4 Optical fiber: - optical fiber is a thin fiber of glass or plastic material, usually cylindrical in shape which can transmit light easily through it. It works on the principle of internal refraction, thus allows sunlight to pass through it without consuming energy. The internal part of optical fiber is made up of glass or plastic which is highly refractive in nature. The outer part is called as cladding material and has very low refraction. Optical fibers allows light to pass even at an angle of more then 60*[4]. The most common diameter of optical fibers lie within range of .2 mm to 1 mm.

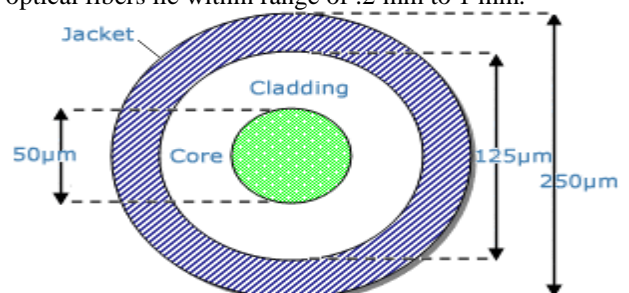


Figure2.1 Reflection mechanism of an optical fiber.

III. PRINCIPLE OF WORKING

Translucent concrete work is based on principle of “Nano-Optics” [5]. Optical fibers pass same amount of light when tiny slits are placed directly on top of one another as when they are scattered or irregular in their positions. Hence optical fibers within the concrete act as narrow tubes and carry the light across and within concrete. Transparent concrete basically works on total internal reflection. When a light ray travel from a denser medium to a rarer medium so that the angle of incidence is greater than critical angle, the ray reflects back to the same medium, and in optical fiber this total internal refraction repeats numerous times till it comes out from the other end of fiber [6].



Figure3.1 Fibers embedded within concrete

IV. MANUFACTURING PROCESS

Manufacturing of transparent concrete is not much specific and complicated procedure [7], it is almost same as of the traditional concrete. The only difference in translucent concrete is the presence of optical fiber in sand and cement mix. Fibers are placed in the form of layers within the prefabricated mould/cover (These moulds are usually made up of wood or steel) [8]. Small layers of concrete are filled first and then applied with fibers that are alternatively applied to each other and is finished up at top with a comparative thick concrete. Large amount of optical fibers are used to have maximum exposure of light and to maintain its strength. In general transparent concrete can be produced by adding 4% to 8% of optical fibers to the total volume of the concrete mix. Concrete mix is made up of only fine materials and coarse aggregate are not used. Thickness of the optical fibers lies within range of .002mm and 2 mm to fulfill the requirement of light transmission [9]. During concreting process along with fibers, concrete is poured slowly and carefully so that the position of optical fiber is restrained. Vibrating-table is used at the time of concrete pouring, so as to avoid or reduce voids at the time of casting. Formwork can be removed only after 24 hours of casting [10]. Proper curing, usually 2 times a day must be followed for consecutive 7 days, to achieve desired concrete strength. Edges of fibers from the surface of concrete blocks are cut manually or by using cutting machine [11]. The surface

obtained after cutting the edges of fiber is quit rough thus for smoothing of surface proper finishing is must. The optical fibers lead light rays between the two sides of the concrete blocks. The parallel position allows the light reflection on the bright side of wall appears unchanged at most of times on the darker side. An important form of this phenomenon is probably the sharp and clear display of shadow on opposite side of the wall. Thin layers allow an increase in amount of light passing through the concrete [12].



Figure 4.1 Formwork or mould used for laying translucent concrete with fibers already being placed.

V. ADVANTAGES

- The main advantage of translucent concrete products is that large scale objects the texture is clearly visible while as the texture of finer translucent concrete becomes unclear at a distance.
- When a solid wall is provided with the ability to transmit light, it means that at home we have to use fewer lighting system during daylight hours [13].
- It provides good architectural properties and aesthetical view to the building.
- Where lights are not able to come properly at that place translucent concrete is 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.
- It is a good technique, keeping in mind need of future generations.
- Translucent concrete uses sunlight as its light source, i.e. utilization of natural renewable source [14] of energy.
- The binding material and aggregates can be reused and reclaimed by proper melting and screening processes.
- Damages can be easily repaired as compared to traditional concrete.
- There is no need of utilization of complex equipments while concreting of translucent concrete.
- Translucent concrete posses' high resistivity against harmful ultra-violet (UV) radiations [15] thus making it user friendly.
- Perfectly environment friendly
- It provides clear visibility of texture in particular the macro level objects.

VI. DISADVANTAGES

- It requires skilled persons for the casting and concreting work of translucent concrete.
- Economically translucent concrete is more costly than traditional concrete because of use of optical fibers.
- Availability of optical fibers is also a concern thereby may increase the transportation costs if not available in respective location.

VII. APPLICATIONS

- Suitable for operations like flooring, pavement laying, interior design works and load bearing walls as well.
- Construction of Facades, interior wall cladding materials and dividing walls are based on thin panels and blocks.
- Also used in furniture for achieving more durability, decorative and aesthetic purpose.
- Light fixtures owing to presence of optical fibers [16].
- It remarkably increases visibility in dark subways and underground stations.
- Helps in lighting indoor fire escapes in the event of a disaster or power failure.
- Translucent concrete is used in illuminating speed breakers [17] and diversions on roadways, which is important in managing traffic system and preventing accidents particularly during night hours.



Figure 7.1 and 7.2; Aesthetic attractive interior view provided by using translucent concrete panels.

VIII. CONCLUSION

Translucent concrete is an innovation in concrete. In appearance it is not heavy, grey material with zero transparency. However with advancements in concrete it is more innovated and reformed as nice looking, lovely and beautiful concrete with more strength, toughness, lighter in weight, multi-colored, etc. Translucent concrete is produced by mixing optical fibers of wider dimensions in the fine concrete mixture. It has good light transmitting property, which is directly based on the ratio of presence of optical fiber to the total concrete mix. It can be used as an awesome architecture work, with nice and pleasing aesthetics. Usually used in an area where natural sunlight cannot reach up to the expected intensity. This type of concrete represents the concept of "GREEN BUILDING" with self-sustaining and energy conservation property [18]. These days translucent concrete is often used as a material to create objects of day to day use as well as decorative household items e.g.; decorative lamps, illuminating panels etc. Higher costs, doesn't make it possible to apply or use translucent concrete on a larger scale. However with more advancement in construction world, the modifications in the production technologies and reduction in the costs can solve our problem thus making its use on wide scale. Translucent concrete can be regarded as an art in future course, which could be used in museums, historically important places and specific exhibitions rather than traditional concrete.

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