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International Journal of Advanced Research in Civil,Structural,Environmental and Infrastructure Engineering and Developing

Volume: 3, Issue: 1,Special Issue: 1 ,Mar,2017 ,ISSN_NO: 2320-723X

TRANSLUCENT CONCRETE

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ABSTRACT— *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 interaction between the construction and its environment, thereby 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.*

INDEX TERMS- *Translucent, Reinforcement, load-bearing*

INTRODUCTION

Today we are living in a world where energy expenditure and environmental problems have escalated to global scale. In today's developed world our built environment takes energy; energy to make the materials that go into the buildings, energy to construct them (Embodied energy) and energy to heat, cool & light them (Operating energy). Our project of casting translucent concrete aims at reducing this operating energy by exploiting vast amount of potential energy in the form of sunlight. Another additional feature is its pleasing aesthetics that can change the image of the concrete which is generally perceived as dull, pale, opaque grey material.

OBJECTIVE

To cast a special type of concrete with light transmitting properties, to study their characteristics and to develop a functioning material which is not only energy saving but gives out artistic finish.

FORMULATION FOR OBTAINING A TRANSLUCENT CONCRETE MIXTURE

The invention relates to a formulation for obtaining a translucent concrete mixture comprising a mixture of polycarbonate and epoxy matrices as well as glass fibers, optical fibers, colloidal silica, silica and diethylentriamine (DETA) and Portland cement. This invention has greater mechanical strength properties than those of a standard concrete, with lower density and mechanical characteristics that enable same to be used in both a structural and architectonic

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Volume: 3, Issue: 1,Special Issue: 1 ,Mar,2017 ,ISSN_NO: 2320-723X

manner. The inventive formulation used to obtain the translucent concrete mixture comprises a type of concrete that is different from those currently available, which combines the advantages of existing concretes with translucency

DESCRIPTION

The concrete generally used in construction generally consist of at least cement, water and aggregates (fine or coarse). As is 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 interaction between the construction and its environment, thereby 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. With the aim of eliminating these and other drawbacks, thought has been given to the development of a translucent concrete, which concerns a formulation of concrete which, as well as permitting the passage of light through it, also works more efficiently in the mechanical sense than traditional concrete.

INGREDIENT CHARACTERISTICS

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 their respective catalyst shall form a good binding strength. The aggregates used in the manufacture and formulation were fiberglass, silica, colloidal silica sol and optical fibers. Optionally, rocky elements can be used as aggregates, for example, gravels, sands, etc. The setting agent used is diethylenetriamine (DETA), which has to be dehydrated on molecular sieves prior to use. The optical fibers 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 fibers used are monomode and virgin fibers, 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 and filmogenic gluing 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). Silica sol, 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 up to 220 Mpa. The mechanical characteristics such as compressive resistance of a translucent concrete with polycarbonate matrix is up to 202 MPa, as well as allowing light to

Volume: 3, Issue: 1,Special Issue: 1 ,Mar,2017 ,ISSN_NO: 2320-723X

pass through without any distortion at all. The good dispersion of the aggregates, additives and, above all, of the matrix, can be appreciated. The direction of the layers is parallel to the direction of the moulding. It has a laminar drying in the same direction in which it is cast. It displays good crystallisation in the highest parts, and decreases a little when approaching the lower end. 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.

EXPERIMENTS ON TRANSLUCENT CONCRETE

LIGHT GUIDING PROPERTY ON TRANSLUCENT CONCRETE.

The following are the factors to be considered for the performance of the transparency of the concrete: a.Transmittance b. Haze c.Bi-fringence d. Refractive index. e.Dispersion. The transmittance can be directly calculated by the ratio of the incident energy and transmission energy of light expressed as following equation: (1) $\rho=\xi\times (J1/J0)\times 100\%$ Where ρ, ξ, J1 and J2 are transmittance, correction coefficient of measurement equipment, transmission energy and incident energy, respectively. While the translucent concrete studied by us is heterogeneous, its transmittance cannot be obtained by equation (1), because the number of POFs in unit area is different at different area, that is, the transmittance in unit is related to the arrangement of POF in translucent concrete. Improvement in the calculation method for transmittance are as follows. a) Incident light energy per unit area (ρ0): (2) $\rho 0 = W0/A$Where W0 and A0 are light energy of incident probe and area of incident probe. b) Incident total energy of concrete section at the side of light (Js 0): (3) $J s 0= \rho 0 \text{ x } A1= (W0/A0)\text{x } A1$ Where A1 is the cross-section area of translucent concrete. c) Transmitted light energy of single POF (ρ1): (4) $\rho 1 = (W1/n1)$ Where W1 and n1 are light energy of transmission probe and the number of POFs covered by transmission probe. d) Transmitted light energy of translucent concrete (Js 1): (5) $Js\ 1 = \rho 1 \text{ x } N = (W1/ n1) \text{ x } N$ Here N is the total number of POFs in the translucent concrete. Then based on equation (3) and (5), we can obtain the transmittance (ρs) of the translucent concrete. $\rho\ s = \xi\times(Js\ 1/Js\ 0)\text{x } 100\ \% = [\ (\xi \text{ x } N \text{ x } W1 \text{ x } A0)/(W0 \text{ x } A1 \text{ x } n\ )\ ] \text{ X } 100\ \%$

TEST OF GLASS FIBER'S STRESS ELASTO-OPTIC EFFECT.

Glass fiber with 15mm diameter is chosen to test its elasto-optic property under radial stress. Before test, the cross-section of glass fiber is polished to ensure the surface smooth. Under the plane polarized optical field, the glass fiber is applied radial load of 0.4kN and 0.8kN respectively. Keeping the polarizer and the analyser mirror orthogonal, the series of isoclinic of glass fiber at 0-90 degree with the step of 10 degree are obtained by synchronously rotation of the corresponding orthogonal polarization axis. To separate the isochromatic from the colour coupled photo elastic patterns, the series of isochromatic of fiber glass are obtained under the circularly polarized optical field, where the glass fiber is applied 0.2-1.6kN with step of 0.2kN.

Volume: 3, Issue: 1,Special Issue: 1 ,Mar,2017 ,ISSN_NO: 2320-723X

TEST OF SELF SENSING PROPERTY OF TRANSLUCENT CONCRETE BASED ON STRESS ELASTO-OPTIC EFFECT.

The diameters of glass fiber and POF are 15mm and 2mm respectively. The glass fiber is considered as stress-sensing element in the concrete. Like the test described in the 3.2.1, the isochromatic and the isoclinic of the glass fiber are monitored under plane/ circularly polarized optical field, which can reflect the stress state of the concrete. In order to test the self-sensing properties of the translucent concrete, the elasto-optic effect of the translucent concrete under different damage modes are studied. Figure 7b shows the damage modes of concrete, where a crack with size of 0.5mm is produced. Figure 8 gives three loading modes: • Un-damage mode (I) • "Longitudinal" damage mode (II) • "Lateral" damage mode (III). The "longitudinal" damage mode is that the crack is parallel to the loading direction, and the "lateral" damage mode is that the crack is vertical to the loading direction.

IMPERMEABILITY PROPERTY OF TRANSLUCENT CONCRETE.

After the vacuum water saturation, the initial current strength of the plain concrete, the translucent concrete with 3% POF volume ratio, the translucent concrete with 3% POF volume ratio and POF covered by epoxy resin, the translucent concrete with 6% POF volume ratio and the translucent concrete with 6% POF volume ratio and POF covered by epoxy resin are 70.4mA, 104.5mA, 79mA, 117mA and 114.9mA, respectively. After six hours conduction time, the corresponding current strengths of the above six concretes increase to 113.6mA, 181.7mA, 126.4mA, 201.6mA and 1944.2mA, respectively

The total electric energy of the plain concrete, the translucent concrete with 3% POF volume ratio and that with 6% POF volume ratio are 1897.8C, 3152.6C and 3602.2C, that is, there are some minor gaps between the POFs and concrete which cause the decrease of the anti-permeability shown in figure 24. It also can be seen that the anti-permeability is greatly improved by using the epoxy resin to cover the boundary of the POFs and concrete, and the total electric energy of the translucent concrete with 3% and 6% POF volume ratio covered by epoxy resin are reduced to 2147C and 3357.8C. In field application, the anti-permeability index of translucent concrete is very important for the long-term service. We can improve the anti-permeability by two methods: one is to seal the boundary of POFs and concrete with translucent waterproof material such as epoxy resin; the other one is to make the POF's coating rough to increase the compactness of interface between the POF and concrete.

CHARACTERESTICAL OVERVIEW OF THE PRODUCT

1. Formulation for obtaining a translucent concrete mixture, comprising a mixture of epoxy and polycarbonate matrices, plus fiberglass, optical fibers, colloidal silica sol, silica and diethylenetriamine (DETA) and Portland cement.

2. Formulation for obtaining a translucent concrete mixture, wherein the content of the components is: epoxy matrix from 0% to 90%, and the polycarbonate matrix from 0% to 60%, fiberglass from 0% to 10%, colloidal silica sol from 0.5% to 5%, silica from 0.5% to 10%, diethylenetriamine (DETA)

3. The ratio of the polymer matrices and the mortar is at least 1.5:1, and the mixing is done manually or mechanically.

4. According to study maximum water absorption range is within 0.35%. 5. s mechanical and optical characteristics, can be used for purposes that are both architectural and aesthetic, and also structural and under conditions of service equal to and even different from those of a traditional concrete. In accordance with the above description, it is possible to affirm that the light refraction characteristics, or translucidity, as well as the mechanical resistance to compression of the formulation of the concrete of the present invention, have not been achieved by any other concrete, thereby meeting the optical and mechanical characteristics for calling it translucent concrete. Other unique characteristics of the formulation of the concrete forming the object of this invention are that it can be used for structural purposes at the same time as being translucent; in other words it can be used in any kind of construction permitting colours, shapes and outlines to be seen through it. IX. APPLICATIONS Thanks to new features this material presents innovative technical solutions, semi-natural and ecological, for the traditional construction problems allowing a wide area of applications in construction, architecture, decoration and even furniture. Some of the possible applications for this new material are spread over several areas creating new possibilities to various products such as: 1.Translucent concrete blocks suitable for floors, pavements and load-bearing walls. 2. Facades, interior wall cladding and dividing walls based on thin panels. 3. Partitions wall and it can be used where the sunlight does not reach properly. 4.In furniture for the decorative and aesthetic purpose. 5.Light fixtures. 6.Light sidewalks at night. 7.Increasing visibility in dark subway stations. 8.Lighting indoor fire escapes in the event of a power failure. 9.Illuminating speed bumps on roadways at night.

ADVANTAGES AND DISADVANTAGES

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 translucent concrete can be used. • Energy saving can be done by utilization of translucent concrete in building. • Totally environment friendly because of its light transmitting characteristics, so energy consumption can be reduced. • The main disadvantage is these concrete is very costly because of the optical fibers. • Casting of translucent concrete block is difficult for the labour so special skilled person is required.

Volume: 3, Issue: 1,Special Issue: 1 ,Mar,2017 ,ISSN_NO: 2320-723X

CONCLUSION

A novel architectural material called translucent concrete can be developed by adding optical fiber or large diameter glass fiber 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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