Candescent concrete

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Abstract-Candescent concrete is a type of concrete that absorbs sunlight or ultraviolet light during the day and stores light energy. In the evening it releases the stored light energy in the form of visible light. Candescent concrete can be applied to road signs or highway dividing lines for directing pedestrians and cars at night. Candescent concrete also plays the role of beautification and illumination by laying out a variety of patterns when it is applied to housing precast or cast-in-place stairs plaza, park, and amusement and leisure places. Preparing candescent concrete mainly lies in the addition of luminescent substance, i.e. Phosphorescent material. Concrete is the most commonly used material in the construction industry. It is widely applied in the construction of public facilities. Hence addition of phosphor in concrete itself is considered effective. The results show that with the growth of phosphor dosage, concrete compressive strength and flexural strength decrease. Hence an amount of 8% of the cement is mixed with phosphor. This reduces the cost of painting over dividers and road markings. The usage of street lights is also reduced considerably. The maintenance cost is not required as it has a lifetime of 10 years. The intensity of light emitted is measured by using a lux meter.

I. INTRODUCTION

Candescent concrete is a relatively new and little-researched variation. Concrete possessing luminous properties has the potential for applications in a variety of civil, structural, and design areas. In addition to its potential for aesthetic and creative use, luminous concrete has applications in coating buildings, bike lanes, highways, interiors, and even swimming pools in order to improve vehicular and pedestrian safety, as well as in reducing the need for energy Intensive Street and building lighting.

II. OVERVIEW

Candescent concrete is a type of concrete which during the day it absorbs sunlight or ultraviolet light and stores light energy, in the evening it releases the stored light energy in the form of visible light. Preparing candescent concrete mainly lies in the preparation of long afterglow material that is phosphor. Long afterglow material itself cannot be directly used as end products. It must be combined with other materials in order to have an effect.

Concrete is the most commonly used material in the construction industry. It is widely applied in the construction of public facilities.

As it is the core supporting member materials in the building, the development and innovative research of concrete are very important.

Rare earth ion-activated luminescent material has excellent properties such as chemical stability, high- luminous intensity and chromaticity properties. It is an important class of long-lasting light-emitting materials. Preparation of long after glow phosphor matrix is divided into many types.

A lot of research results shows that CaO is expected to become a promising new type of light-emitting matrix material .CaO is inexpensive and relatively easy to get. Therefore, this paper is concerned with CaO (xDy^{3+},yNa^{+}) phosphors preparation and the prepared material when added to the concrete constituents generate the light emitting concrete.

III. LITERATURE REVIEW

LOW COST CANDESCENT CONCRETE- Su Zhao, Yaqing Li and Qian Wang.(Materials science and Engineering, Shenyang Architectural University, Shenyang, 110168, China)

The luminous concrete was made by doping phosphors into the raw concrete materials. The CaO (xDy^{3+} yNa^{+} series) phosphors were compounded by high temperature solid state method. Florescent powder phase, excitation and emission spectra were analysed. The results show that the peak of florescent powder emission spectrum locates at 480nm or so, corresponds the transition 4F9/2→6H15 /2 of Dy^{3+}. There are a series of lines in the range of 240-420nm by monitoring the excitation spectrum of 480nm emission. Strong excitation peaks are at 360nm and 375nm. Influences of doped phosphors on concrete mechanical properties were studied. The results show that with the growth of phosphor dosage, concrete compressive strength and flexural strength decrease. SEM images show that the fluorescent powder particle is approximately spherical, and uniformly mixed in concrete. Researchers have been investigating the possibility of creating candescent

concrete. This material has the potential to drastically reduce the need for artificial light as it could produce light through the faces of exterior walls or interior dividers.

For our ENGR-090 Senior Design project, we experimented with cement mixtures containing a phosphorescent material which absorbs and subsequently emits light.We investigated mixture formulas and processes which are currently proposed and under patent by researchers in the field. By assessing how different methods of applying phosphorescent materials, we determined the application method most suitable for a structure. This project builds on research in order to investigate new concrete materials. These materials have extensional applications to concrete exterior building walls, pedestrian safety infrastructure, and any number of other design applications where light emission or transmission is desired. In the future, a material like this could have the potential to reduce artificial light inside buildings, while also adding anaesthetic design appeal to interior fixtures and building.

IV.MATERIALS

A. Cement

Concrete is a mixture of cement, sand or other fine aggregate, and a coarse aggregate that for most purposes is up to 19 to 25 mm (3 / 4 to 1 inch) in size, but the coarse aggregate may also be as large as 150 mm (6 inches) when concrete is placed in large masses such as dams. Mortars are used for binding bricks, blocks, and stone in walls or as surface renderings. Concrete is used fora large variety of constructional purposes. Mixtures of soil and portland cement are used as a base for roads. Portland cement also is used in the manufacture of bricks, tiles, shingles, pipes, beams, railroad ties, and various extruded products. The products are prefabricated in factories and supplied ready for installation.

Because concrete is the most widely used of all construction materials in the world today, the manufacture of cement is widespread. Each year almost one ton of concrete is poured per capita in the developed countries. Portland cement consists essentially of compounds of lime (CaO) calcium mixed with silica (silicon dioxide, SiO_2) and alumina (aluminum oxide, Al_2O_3). The lime is obtained from a calcareous (lime-containing) raw material, and the other oxides are derived from an argillaceous (clayey) material. Additional raw materials such as silica sand, iron oxide (Fe_2O_3), and bauxite—containing hydrated aluminium, $Al(OH)_3$ —may be used in smaller quantities to get the desired composition.

B. Sand

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example, aragonite, which has mostly been created, over the past half billion years, by various of life, like coral and shellfish. For example, it is the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years like the Caribbean.

While sand is generally non-toxic, sand-using activities such as require precautions. Bags of silica sand used for sandblasting now carry labels warning the user to wear respiratory protection to avoid breathing the resulting fine silica sand.

C.Aggregate

Preferred are the bituminous aggregate sizes for road construction are given in EN 13043 as d/D (where the range shows the smallest and largest square mesh grating that the particles can pass).

These products include specific types of coarse and fine aggregate designed for such uses as additives to asphalt and concrete mixes, as well as other construction uses. State transportation departments further refine aggregate material specifications in order to tailor aggregate use to the needs and available supply in their particular locations.

D. Powder

Powder coating is a type of coating that is applied as a free-flowing, dry powder. The main difference between a conventional liquid paint and a powder coating is that the powder coating does not require a solvent to keep the binder and filler parts in coating and is then cured under heat to allow it to flow and form a "skin". The powder may be a thermoplastic or a thermoset polymer. It is usually used to create a hard finish that is tougher than conventional paint. Powder coating is mainly used for coating of to be powder coated using different methods. The powder coating process was invented around 1945 by Daniel Gustin US Patent 2538562

Because powder coating does not have a liquid carrier, it can produce thicker coatings than conventional liquid coatings without running or sagging, and powder coating produces minimal appearance differences between horizontally coated surfaces and vertically coated surfaces. Because no carrier fluid evaporates away, the coating process

emits few volatile organic compounds (VOC). Finally, several powder colours can be applied before curing them all together, allowing colour blending and bleed special effects in a single layer.

V. PREPARATION OF POWDER

(i). Accurately weigh CaCO3, Na2CO3 (are analytically pure) and Dy2O3 (99.99%, analytically pure) at a molar proportion of Ca: Dy: Na=l: x: y (x =0.005, 0.01, 0.015, 0.020, y= 0.05, 0.10, 0.15, 0.20), and then placed them in an Compressive test of concrete

(ii). Add a small amount of anhydrous ethanol as the aids, place the thoroughly grinded mixture in 110℃ oven, and then sufficiently dry them to obtain a precursor.

(iii). A small amount of precursor is used as differential thermal analysis. The rest precursor is placed in a corundum crucible, and respectively baked at 950℃, 1050℃, 1150℃ and 1250℃ for 1.5-3h. Finally, sufficiently grinded and cooled the precursor to obtain the required sample.

VI.CONCRETE PREPARTION

Production of quality concrete requires care exercised at every stage of manufacturing of concrete. It's interesting to note that the ingredients f good concrete and bad concrete are the same. If care is not exercised and good rules are not taken to exercise control the resultant concrete is going to be of bad quality.

The various stages of manufacture of concrete are

- **Batching**
- **Mixing**
- **Transportation**
- **Placing**
- **Compacting**
- **Curing**
- **Finishing**

VII. SPECIMEN TEST

A.Compressive test of concrete:

Compressive strength formula for any material is the load applied at the point of failure to the cross-section area of the face on which load was applied.

Compressive Strength = Load / Cross-sectional Area

Table 1. Compressive strength values

COMPRESSIVE STRENGTH(N/mm^2)			
%Powder in terms of cement	0%	4%	8%
7days	23.49	18.10	15.17
14 days	26.42	20.36	17.07
28 days	35.23	27.15	22.87

B.Flexural strength of concrete:

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending.

Computation of Modulus of Rupture

The following expression is used for estimation of modulus of rupture:

Modulus of Rupture of Concrete

$$MR = \frac{3PL}{2bd^2}$$

Where,

MR: modulus of rupture

P: ultimate applied load indicated by testing machine

L: span length

b: average width of the specimen at the fracture

d: average depth of the specimen at the fracture

Table 2. Flexural strength values

FLEXURAL STRENGTH			
	S I	S II	S III
0%	3.40	2.9	2.74
4%	3.6	3.15	2.9
8%	4.16	3.63	3.42

Finally, the following equation can be used to compute modulus of rupture, but it must be determined through laboratory test if it is significant for the design:

$$f_r = 0.7\sqrt{\quad}$$

where,

fr=flexural strength fck=compressive

strength of concrete

A. Lux Test

Where lumens measure the amount of light a light source emits, lux tells how much that light source illuminates an object or workspace that is one square meter in area and placed one meter away from the light source.

Procedure:

Determine the distance from the light source to the work plane in both feet and meters. Measure the work area being lighted, calculating one square foot (1 sqft) and one square meter (1 sq. m.) area at the center of the work plane-where the luminance is brightest. Record these on a piece of paper. Switch on the light meter, allowing the display to zero out. Next, remove the cover from the light sensor.

VIII.RESULTS

The light emitted is found enough for getting identified easily. When measured with a lux meter it shows a lux of 1.7. This lux is got when 8% of the weight of cement is added as phosphorescent powder. This lux can be increased by increasing the amount of powder.

Phosphorescent powder can be made easily with the readily available chemicals such as CaCO3, Na2CO3 and Dy2O3. It can be prepared easily with proper guidance. Skilled labour is not required. Here approximately 100g of powder cost for Rs.10. Hence the extra cost required for a cube is about Rs.20.

IX.APPLICATIONS

- Dividers
- Pavement markings
- Swimming pool
- Aesthetic appearance

X.CONCLUSION

As the world is travelling towards energy conservation, candescent concrete is an excellent idea. This conserves energy that is required to lighten roads and to save cost required for various illumination works. This concrete reduces the maintenance cost and has a good life time. Candescent concrete also does not require skilled labour and hence production of candescent concrete is very simple. The aesthetical appearance of structures can be well improved by the application of candescent concrete. The major disadvantage of candescent concrete is that the strength of concrete is lessened. This in turn can be improved by altering the mix design of the concrete. Hence when brought into use, this sure to create a big impact in the innovative part if civil engineering structural forms.

XI.REFERENCES

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Fig 1 Candescent Concrete

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