Course Name: Building Materials as a Cornerstone to Sustainability

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Lecture 04

Light emitting materials - concrete

Hello everybody. Last class we saw agro bricks in great detail. Agro bricks as an innovative building material. In today's class we will see yet another innovative building material which is light emitting materials or light emitting concrete. Now, light emitting concrete refers to a type of concrete that has the ability to emit light. This is achieved by embedding light emitting elements such as optical fibers or phosphorescent materials within the concrete mixture.

The result is a material that can absorb and store light energy and then release it in the form of visible light. There are a few different approaches of creating light emitting concrete. First is the optical fibre based concrete. Optical fibers which are thin flexible strands that can transmit light can be embedded within concrete to create pathways for light to travel.

These fibers can carry light from a source such as LEDs to the surface of the concrete making it appear illuminated. Second is phosphorescent concrete. Phosphorescent materials also known as photoluminescent materials can absorb and store light energy. Then slowly they release it over time as visible light. These materials can be mixed into the concrete mixture and they will glow in the dark after being charged by natural or artificial light sources.

Third is electroluminescent concrete. This type of concrete contains embedded electroluminescent wires or panels that emit light when an electric current is applied. This is a more complex technology that requires power source and electrical components. Let us look at some of the production methods. Now optical fiber based method.

Light can be transmitted by thin transparent strands called optical fibers. Optical fibers are included into the concrete mixture using this technique prior to casting. To create diverse lighting effects, these fibers can be oriented or placed in different patterns. Usually, light sources like LEDs are positioned at the margins of the concrete element.

The light is then passed via the fibers giving the impression that the concrete is illuminated.

The second is embedded light diffusing aggregates. You can incorporate light diffusing aggregates into the concrete mixture by adding things like glass beads or translucent polymers. As light travels through the material, these aggregates scatter and dilute it, producing a softer and more consistent lighting effect. The quality of light transmission can be impacted by the selection of aggregate size, type and concentration. Third is translucent polymers and resins.

To improve the concrete mixes ability to transmit light, translucent polymers or resins can be added. These substances which can be applied as a thin layer on the concrete surface are frequently transparent or translucent. They can be used to imprint particular patterns, images or design components inside the concrete while still allowing light to pass through. For this, the textured surface treatment. To improve the finished concrete surface ability to transmit light, surface treatments like etching or texturing can be performed.

By performing patterns or designs, these treatments let light permeate the surface and produce ornamental effects. This process works especially well for creating elaborate or creative designs. Fifth one is the molded patterns and shapes. Certain patterns, shapes or spaces that let light through can be molded or cast into concrete pieces. When the concrete is lit from behind or within, designers can create unique lighting effects by carefully positioning openings or patterns within the concrete framework.

Let us now look at their properties and characteristics. The first and very important characteristic is the light transmission capacity. One special quality of light emitting concrete is that light may pass through it. The degree of light transmission might change according to the materials and the production process. The study may address the various aspects that affect light transmission such as the quality of the concrete matrix or the density of the light transmitting devices.

Second is the aesthetic appeal. The capacity of light emitting concrete to produce visually arresting and compelling effects is one of its main features. It may enhance the aesthetics of both indoor and outdoor settings by turning architectural elements, surfaces and walkways into lit focal points. Third is energy efficiency. By lowering the dependency on conventional artificial lighting sources, light emitting concrete can help achieve energy efficiency.

Now, it may lessen the need for external lighting by absorbing and storing solar energy

throughout the day, which is subsequently released as light at night. Fourth is its longevity and durability. Any study should address how long lasting light emitting concrete is. It would probably address things like the materials ability to withstand weathering, UV rays, moisture and mechanical strains as well as any possible effects these things might have on the way the material emits light. Fifth is structural performance.

The overall structural performance of light emitting concrete is mostly determined by the characteristics of the concrete matrix itself, such as its strength, composition and durability. The impact of adding light transmitting components on these characteristics should be discussed in any future studies. Let us now look at the advantages. The advantages include its aesthetic quality. As we look through the cases, you will be able to understand what I mean by aesthetic quality.

These can be low in cost when you look at it as a combination of material as well as its light emitting properties. So, as a material and with a capacity to emit light when we look at it in combination its cost will be very effective. Then these can be used for safety and wayfinding in areas where it is difficult to have artificial lighting. It has environmental advantages because these give a lot of energy efficiency. Their disadvantages include durability and longevity as well as lack of technical expertise.

Let us look at the applications of light emitting concrete. As a promising, smart and sustainable low carbon concrete, light emitting concrete has excellent performance in terms of long duration of light emitting and long lifespan without consuming any electricity. Because of the concrete's gentle light emission and reduced light pollution, both people and wildlife are less disturbed at night, allowing us to create more liveable and environmentally friendly environments. Unlike electricity-powered lamps, light-emitting concrete can glow in the dark without complicated supporting devices. And it does not require frequent maintenance.

Therefore, the three primary areas of use for the concrete are the decoration of built environment which is the aesthetic parts, lighting of roads and lanes, functional and highway signs and safety. So, in graphics, graffiti and signage, expos and other mega events like world fairs and significant athletic or cultural events, these are often framed as urban strategies for building and enhancing the perception of a local city. Scholars have studied this extensively, analyzing the strategic relationship between major events and a city branding and describing how a new city brand is created through people, say both local and foreign recognition of a new identity superimposed onto an existing one. Developing the pavilion exterior can help control public perception by drawing attention to the country's manufacturing prowess.

As a matter of fact, certain countries are already known for being the birthplaces of exceptional architects and surface and facade technologists. The use of this light emitting concrete can have a major role in trying to have an icon for a city. Now, with the total surface area of 1,887 square meters. The Shanghai Expo features 3,774 transparent panels constructed from 189 tons of transparent cement which is dry ready mixed product light. The building will let light from the interior to bleed through when viewed from the outside.

Yet during the day, when viewed from within, it will display variations in the amount of daylight. The transparent effect is more noticeable in the dark. This material was originally used in Shanghai and its potential uses in the future include internal lighting for shading or light diffusion techniques. The articular processing process which is utilized to the ingredients like cement, admixture and application resins have enabled the cements transparent qualities. As previously discussed a lot of panels say 1887 meter square of surface area is covered with 3774 semi-transparent panels which has 50 percent reduced transparency levels due to the architectural considerations and you can see the effect it has at night.

Additionally, the Shanghai Corporate Pavilion features an outside skin that changes color and illumination throughout the day. The interior spaces of the pavilion are designed as a sequence of free-flowing forms and are surrounded by both static wall and a dense cube volume of infrastructure. This includes LED lights and a mist making system that can be programmed through a computer to change the building's appearance at any given time. The pavilion becomes less tangible as a result of the abundance of materials and lighting that make up the exterior face. The building's appearance is created by the visual contrast between the primary cubic volume and its indistinct edges.

It provides a thoughtful response to the plenty of visual experience with the pictorial language of communication reigning supreme and the almost unrestricted and instant accessibility of iconographic material which is the aim of this pavilion. Now about 40% of the pavilion's 3600 m3 square layout which is elevated to a height of 18 m is dedicated to producing a constantly changing series of lights and shadows during the day. Shanghai's panels are 500 x 1000 x 50 mm in size with 20% of their surface area being transparent. Based on laboratory studies, a 3-point flexural test demonstrates that the panels can withstand an elastic load of approximately 2 KN as compared to static performance.

Each panel weighs around 50 kgs. Each transparent cement panel has 50 chains of plastic resins roughly inserted in accordance with the technology which is patented by

Italcementi group in addition to the cement ingredient and other additives. Chain thickness ranges from 2 to 3 mm. Let us look at some of the other uses of these concrete. The first picture shows use of this concrete on dark highways or on roads inside wildlife sanctuaries. This concrete can be very useful in guiding people.

Similarly, the second picture is that of a parking area and one can see how this concrete can be used for guiding people. Third is - In areas where you do not expect too much of human habitation, yet you need light to indicate the presence of a structure such as below bridge, these concrete can be used. And the fourth is aesthetically, for aesthetic purpose and to create drama, we can use it in our architecture. Let us look at yet another building by Lucem and in this project the owner of the building desired a facade that could convey the innovation of the structure by periodically displaying fresh surface light situations. When dusk falls, the structure appears to glow either as a single glowing section or with moving lights.

During the day, the facade appears to be a natural stone facade in the sophisticated hue of anthracite. Figure 1 shows the building during day and figure 2 shows the building at night. You can see in figure 1 the building is pretty simple and of a modern architecture language made with grey colour. But at night the buildings becomes very colourful and there is control over change of these colours too. And the next example is a facade with calligraphic letters set into light-emitting concrete at the Al-Aziz Mosque in Abu Dhabi, UAE.

The first picture represents the mosque during daytime and the second represents the mosque at night time. So, in this building, pigmented and sandblasted panels are used to match the local stone used elsewhere on the facade. So during the day, the mosque takes on a nearly monolithic appearance. But at night, the light-emitting concrete panels glow a golden hue against the building's early tones. So Al-Aziz Mosque in Abu Dhabi illustrates the communicative potential of the medium, which will surely see similarly expressive applications.

So, in today's class we saw clearly the use of light emitting concrete as an innovative building material. We saw its advantages and limitations and we saw its architectural applications and we discussed that. Such technologies can make even a city get its imageability by virtue of its application on any iconic building. And in that context we saw the example of the Shanghai Expo. With this we will stop today's class and continue with yet another topic in the next class. Thank you.