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THE BIMONTHLY NEWSLETTER OF THE DAYLIGHTING COLLABORATIVE

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DAYLIGHTING collaborative®

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FIBER OPTIC DAYLIGHTING

Fiber optic daylighting systems are an evolving technology that may provide a solution for daylighting designers. These systems use fiber optics combined with solar light collectors to transmit daylight to spaces historically difficult to daylight using sidelighting or toplighting strategies. A range of companies now offer fiber optic systems for capturing and transmitting natural light deep within the interiors of buildings. Fiber optic light transmission systems include a collector, reflectors, filters, lenses to direct light to the fiber optic cables and a fixture to distribute the light in the area to be illuminated. The term "remote source lighting" has been used to describe these types of systems that carry light to a destination not directly accessed by the light source.

HOW DOES OPTICAL FIBER TRANSMIT LIGHT?

Light in a fiber optic cable travels through the core by bouncing off the cladding. Because the cladding does not absorb any light from the oscillating wave it can travel a great distance. The light signal can degrade due to impurities in the glass or plastic material from which the cable is made. How much the signal degrades depends on the quality of the cable material, the wavelength of the light and the length of the cable.

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DAYLIT PROJECT PROFILED...

Daylit Project Profiled in October Issue of *eco-structure*

Tate Walker of the Energy Center of Wisconsin describes the integrated design process used to incorporate daylighting in a project in Milwaukee, Wisconsin's Historic Third Ward. The project designed by Engberg Anderson houses their office space as well as leased space. Daylighting was incorporated not only for aesthetic reasons but because of the significant role integrated daylighting design played in reducing whole building energy use and peak demand. Tate's article, "Let There Be Light" can be found on page 63 of the October issue: **http://eco-structure.com**

DID YOU KNOW...

When evaluating a daylighting design, it is necessary to evaluate the balance of luminance levels throughout the space. Surface luminance balances and illuminance levels are major factors in overall lighting quality and mood, task performances and comfort. For visual comfort the luminance ratios of the immediate surroundings should not be less than 1/5 nor greater than 5 times the task luminance (a 5:1 ratio). The general surrounding area should not be less than 1/10 nor greater than 10 times the task luminance (a 10:1 ratio).

Luminance: amount of light coming from a surface; the light reflected in a particular direction. The photometric quantity most closely associated with brightness. Measured in units of luminous intensity (candelas) per unit area (square feet or meters).

Illuminance: the amount of light incident on a surface, expressed in lumens per area unit. One lumen per square foot equals one footcandle.

Luminance ratio: relationship between different brightnesses in the visual field.

Brightness: an impression of the appearance of a light source or an illuminated surface, described in terms of its perceived relative luminosity.

IESNA Lighting Handbook. Reference and Application published by the Illuminating Engineering Society of North America, 2000 Edition.

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Fiber optics can be side-emitting, series-source-emitting or end-emitting. In side-emitting fibers, light refracts out of the fiber at deliberate points along the cable where perforations have been made in the cladding. Series-source-emitting fibers incorporate multiple small surfaces that emit light along their length. End-emitting fibers emit light at the end of the cable and are used for most fiber optic daylighting systems. End-emitting fibers require fixtures to distribute the light. The most common fixtures used are downlights, wall washers or accent lights.

LIGHT COLLECTORS

Remote-source lighting manufacturers employ different strategies to collect and concentrate the light that will be transmitted through the fiber optic cable. The two main collector types use parabolic mirrors or Fresnel lenses.

PARABOLIC MIRRORS: The mirror reflects direct/non-diffuse sunlight onto a second optical element in focus for the parabola. The second element is a spectrally selective cold mirror, which separates out the visible portion of the solar spectrum. It reflects the visible portion of the sunlight onto a number of fibers located in the center of the dish. Some manufacturers using the parabolic mirror collector harness the infrared rays to generate electricity through a photovoltaic cell.

FRESNEL LENS: A Fresnel lens focuses the sunlight onto the end of the fiber optic cables. It concentrates the light and filters out some of the infrared and ultraviolet portions of the light spectrum. This filtering occurs because light with different wavelengths focalize at different distances from the lens. The fiber ends are placed in the focus for the visible wavelengths where the infrared and ultraviolet rays are less dense. Fresnel lens collectors can be a single large lens or multiple smaller lenses combined in a single collection area. Fresnel lens collectors tend to be smaller than parabolic mirrors and can be used in smaller areas due to their relatively compact design.

INCORPORATING FIBER OPTIC DAYLIGHTING SYSTEMS IN YOUR PROJECTS

There are some key questions to ask when considering a new technology or design strategy. First, as with all energy saving design elements, calculate whole building energy performance and first cost versus building operation savings in order to make an informed decision. Specifically, when evaluating a fiber optic system consider the following:

- Fiber optic systems are often more costly than standard daylighting design strategies. However, a cost-savings analysis weighing lighting cost savings will provide a key piece of information.
- Fiber optic solutions make daylight available to spaces previously inaccessible, such as interior spaces of multistory buildings, areas with specific lighting requirements (e.g., spaces that need to minimize exposure to ultraviolet rays).

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TRAINING UPDATE

The Energy Center of Wisconsin Hosts *Lighting and Daylighting Design with Efficiency* at GreenBuild 2008

Join Jim Benya, renowned lighting designer and teacher, and Abby Vogen Horn, voice of the Daylighting Collaborative, for a one-day workshop on revolutionary lighting strategies.

Where: Greenbuild Conference and Expo 2008, Boston, MA
When: Tuesday, November 18, 2008
Time: 8:30am–5:00pm

The Energy Center is a USGBC Education Provider and our workshop is open to the public. Learn more about Greenbuild at **www.greenbuildexpo.org**. Register for our workshop at **https://register.greenbuildexpo.org/portal/newreg.ww** (choose the workshop in section "USGBC Approved Education Provider Programs" in step 3).

This USGBC approved course has the following available credits: AIA—6 Learning Units.

Lighting and Daylighting Design with Efficiency is a level 300: Application/Implementation course. It is designed for those who are implementing and applying the LEED Rating System. Level 300 programs all use case studies, interactive exercises, tools, and resources to help you immediately apply your new knowledge.

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- Length of the system will determine its cost effectiveness. The longer the distribution system, the less light it can deliver. End-emitting fibers usually need to be 60 feet or shorter in length.
- Some wavelengths of light tend to be absorbed through the transmission. The longer the length, the more absorption takes place. This can affect the color quality of the light in some cases.
- The often unwanted heat associated with natural light is not transmitted through fiber optic cables. This can reduce the need for space cooling.
- Fiber optic systems are mostly "active" rather than "passive" systems. The collectors track the sun throughout the day using computers programmed to move the collectors to the most advantageous collection position.
- Some fiber optic systems offer hybrid fixtures that incorporate electric lighting for nighttime use or when limited natural light is available.
- Check with the manufacturer regarding cleaning and maintenance of the solar collectors to maintain lighting quality.

Remote-source lighting systems such as fiber optic daylighting systems can solve the challenge of bringing natural light into all interior spaces and can potentially reduce energy and maintenance costs in some applications. As energy costs increase as a line item in building operation, these lighting systems may quickly become more cost-effective. They can be used in both new construction and retrofit applications for almost all building types and occupancies. ■

TECHNOLOGY AND RESEARCH UPDATE

VERIFYING POTENTIAL SAVINGS FROM A FIBER OPTIC DAYLIGHTING SYSTEM

The California Lighting Technology Center (CLTC) is conducting a demonstration evaluation of the Hybrid Solar Lighting System, which can then be used to derive cost effectiveness for varying solar availability and electricity cost. In the future, CLTC is proposing to perform a review of similar technologies and identify similarities, differences and performance potential with a focus on potential energy savings and peak demand reduction. The research is currently in progress. Visit the CLTC website to learn more: **http://cltc.ucdavis.edu/content/view/90/198/** ■

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