

GLAZING WITH INTEGRAL HONEYCOMB BAFFLES

Demonstration and Evaluation of Lighting Technologies and Applications ▲ Lighting Case Studies

This window glazing product, manufactured by Panelite, integrates translucent honeycomb baffles between panes of clear glass. The product (“ClearShade™ IGU”) is typically used to reflect solar heat, to diffuse light from the sun, or to limit view (“privacy glass”). When viewed directly, this glazing provides clear view; when viewed obliquely, the glazing appears as the color of the honeycomb baffles. Although often used in a vertical orientation as clerestory or curtain wall glazing, this product can also be used in skylights. Researchers from the Lighting Research Center’s DELTA program performed a field evaluation of glazing with integral honeycomb baffles used in a skylight.

Application Profile

In 2012, the Parrish Art Museum relocated to Water Mill, New York. The museum specializes in art from Eastern Long Island. On the north slope of the roof, clusters of three skylights use glazing with integral honeycomb baffles to prevent direct sun from entering the galleries, while allowing view of the sky. On the south slope of the roof, conventional translucent skylights diffuse the direct sun. Neutral density film was installed on all skylights (visible transmittance 60%). When skies darken, continuous lines of fluorescent strip lights contribute to the illumination of the galleries. The museum aims for 20 to 25 footcandles (fc) on paintings.¹ Works on paper are limited to 7 to 10 fc, so skylights are blocked for galleries in which works on paper are shown.

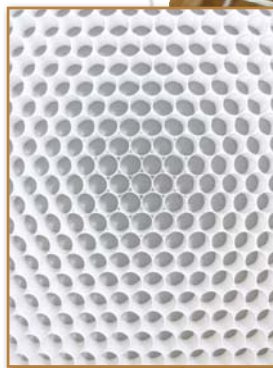
Design Objectives

- Use skylights to feature daylight, in a manner evocative of a classic Long Island artist’s studio
- Diffuse direct sun, while allowing a view of the sky

Skylights with Integral Baffles

- Size (each): 3'-4" x 6'-0" (1.0 m x 1.8 m)
- Visible transmittance (VT): 0.58 max (effective VT= 0.35 including neutral density film)
- Solar heat gain coefficient (SHGC): 0.10 (excluding neutral density film)
- U-value: 0.31
- Honeycomb baffles: Tubular white, 3/8" (10mm) diameter

¹One footcandle = 10.76 lux



An art museum that uses honeycomb glazing (inset) in its ceiling panels



Skylights with integral honeycomb baffles on north slope of the roof

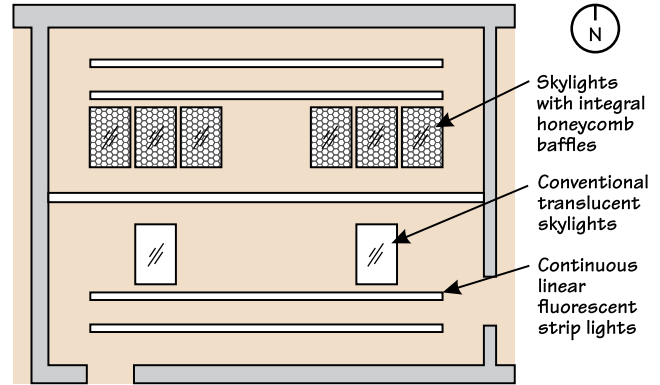
Conventional translucent skylight on south slope of the roof

When the sky darkens, the staff turns on electric lights



Electric Lighting

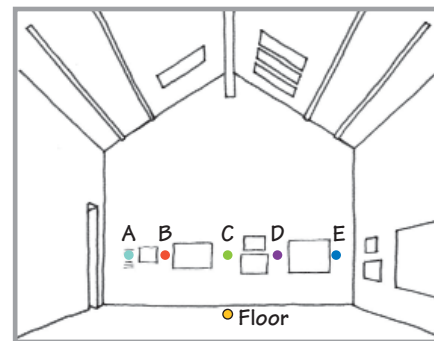
The design team used daylight as the primary lighting strategy instead of a conventional strategy of highlighting individual artworks with accent lights. Exposed strip lights are custom-designed to house specialty fluorescent lamps with side-mounted sockets. Dimming ballasts and a hand-held scene controller allow the museum to adjust electric light levels with changes in exhibits and seasonal daylight availability. Most of the day, electric lighting is turned off. When skies darken, the museum staff use the lighting scene controller to progressively step-up output of electric lighting. A time clock shuts off electric lighting after closing.



Typical gallery reflected ceiling plan

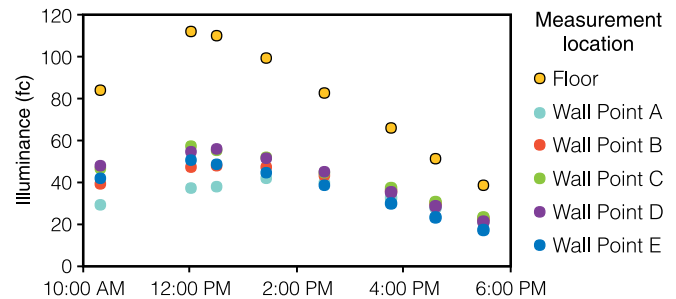
Daylight Measurements

DELTA researchers measured daylight illuminance in one typical gallery on a clear day near summer solstice with electric lights off. Illuminance on the floor peaked at 110 fc at noon, and diminished over the rest of the day. Illuminances along the wall at eye height (5 ft. [1.5 m]) ranged 40 to 60 fc at noon.² The illumination strategy planned for the museum accounts for fluctuating light levels due to changes in daylight conditions over the day and season to ensure exposure to artwork is within acceptable conservation limits. The museum continuously monitors illuminance, and will be rotating art in permanent collection galleries to limit light exposure.

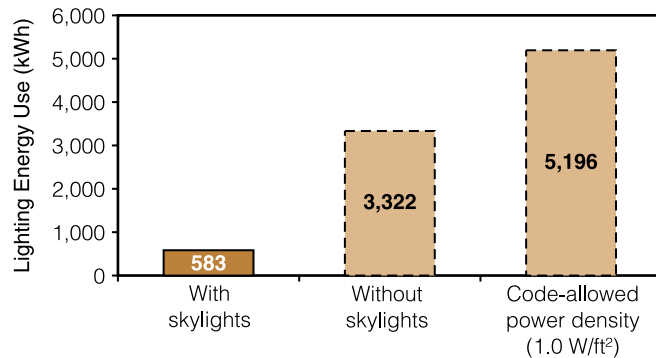


Electric Lighting Power and Energy

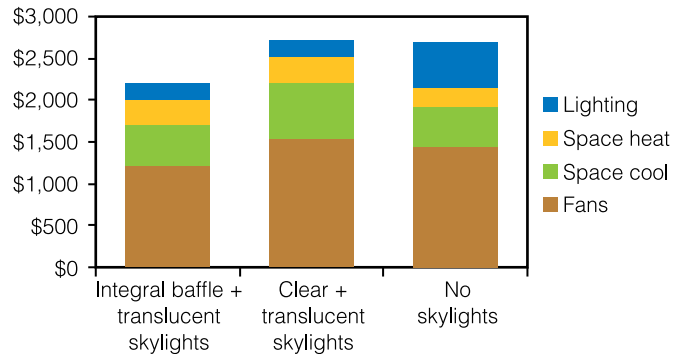
DELTA monitoring showed that 81% of the time the museum was open in spring, the skylights allowed the museum to keep the electric lights off in the galleries.³ For the remainder of the time, electric lights were dimmed from full output. Therefore, for the seven galleries using skylights for illumination in spring (April to June), DELTA estimates that the skylights and use of lighting controls resulted in 82% lighting energy savings. Energy savings would have been even greater (89%) if compared to the maximum allowable power density used for all hours the museum was open.⁴ Less lighting energy savings is expected during the darker winter months.



Light levels near summer solstice, clear sky condition



Electric lighting energy use (Galleries 4-10, April-June 2013), actual vs. comparisons (calculated)



Estimated annual energy cost for one gallery

² West-facing wall, thus with contribution from both types of skylights.

³ Skylights in galleries 4 to 10 were unobstructed from late March through the June site visit. Temporary exhibitions in Galleries 1 to 3 required blocking of skylights and longer hours of use of electric light.

⁴ Power density in the galleries was 2.5 W/ft². Per applicable building code at the time of design (ASHRAE 90.1-2007), lighting power density limit for museums was 1.0 W/ft²; according to the lighting specifier, the building as a whole met lighting power density requirements.

The annual impact of the daylighting and switching of lights on heating and cooling energy was analyzed using DOE2.1E computer simulations. The models showed that skylights with integral honeycomb baffles reduced the total energy use. The same gallery without skylights would have cost 22% more to operate.⁵ If north-facing skylights had been clear instead of integral honeycomb baffles, it would have cost 23% more to operate annually.

Occupant Feedback

DELTA researchers administered questionnaires to 62 museum visitors on spring and summer visits, while the electric lighting was off, between 11 a.m. and 6 p.m. Spring and summer results are aggregated in the figures at right. Ninety-seven percent of visitors agreed or slightly agreed that they can see the art clearly. Fifty-six percent agreed or slightly agreed that the view of the sky enhances their visit to the museum.

“Lovely light for viewing works of art.” However, only 28% of visitors agreed or slightly agreed that they could see the sky through the skylights with integral honeycomb baffles. Inexplicably, 78% of visitors looking through the translucent skylights agreed or slightly agreed they could see the sky, particularly during the summer.⁶

Eighty-seven percent of visitors considered the galleries to be acceptable (“neutral”) rather than “too bright” or “too dim.” When asked to look at a skylight with the integral honeycomb baffles, 84% rated it as neutral, that is, not too bright to look at. Only 52% of visitors rated the south-facing translucent skylight as neutral, while 42% rated it as “too bright” or “slightly too bright.”

“Feels like a hazy day inside (despite) bright sun outside.”

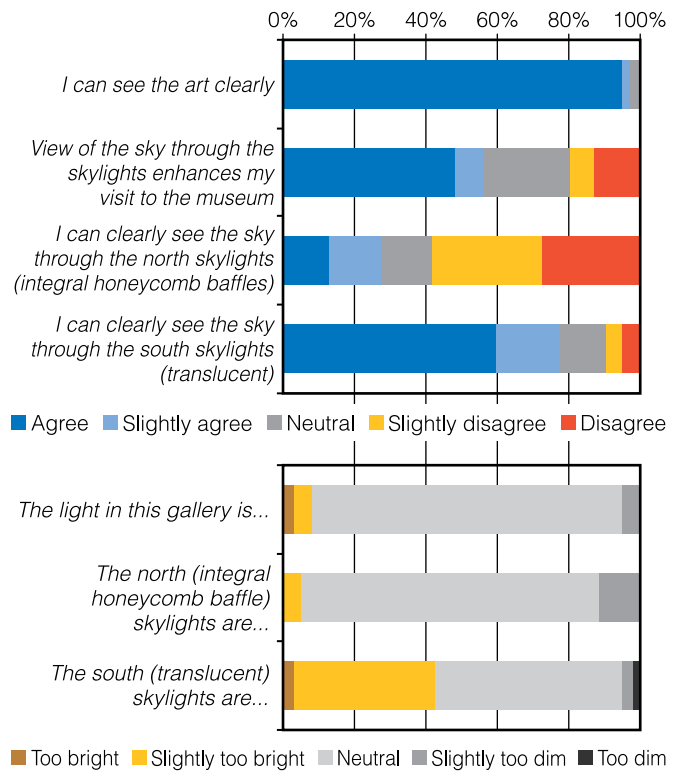
Visitors were asked which type of skylights they prefer; 66% preferred the combination installed, rather than just the integral honeycomb baffle or just the translucent skylights.

Overall, 73% of visitors considered the illumination of the Parrish galleries to be better than other museums. Comments showed that visitors noticed differences between conventional museum lighting and the Parrish Art Museum.

“(I am) used to having the artwork illuminated as opposed to the entire space being brightly illuminated.”

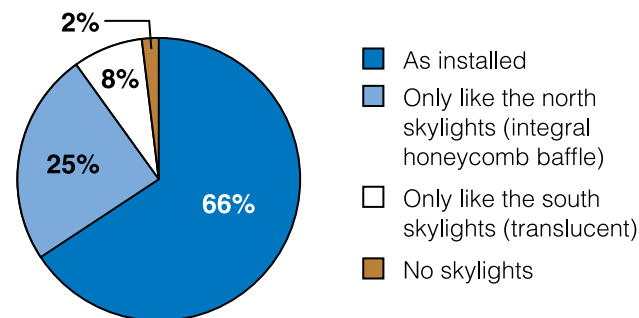
“A lot of museums are a little too dim. But at this time of day, here, it is comfortable.”

“Having art in the Hamptons naturally lit is the way to go; a lot of the art is nature.”

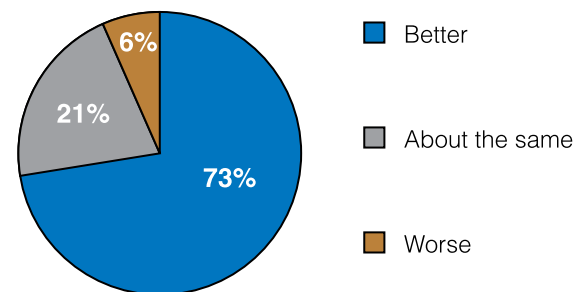


Survey responses at the Parrish Art Museum on a sunny day (n = 25, spring; n = 37, summer)

In this gallery, I would prefer skylights...



Overall, compared to other museums I have visited, the illumination of this space is...



⁵ Assuming \$0.15/kWh and \$0.76/therm.

⁶ For all but this question, analysis showed no statistical difference between spring and summer responses. In the summer, significantly more visitors reported that they could see the sky through the translucent skylights.

Pollution Avoided

Energy savings due to minimizing the use of electric lighting in Galleries 4 to 10 during the spring months resulted in reduced air pollution.

	Pollution Avoided					
	SO ₂		NO _x		CO ₂	
	lbs	kg	lbs	kg	lbs	kg
Savings, compared to galleries with dimming but no skylights	2.7	1.2	3.1	1.4	3,693	1,675
Savings, compared to galleries with fixed 1.0 W/ft ² and no skylights	4.6	2.1	5.2	2.4	6,219	2,821

Sulfur dioxide (SO₂) is associated with visible pollution (haze) and acid rain.

Nitrogen oxides (NO_x) are one of the main causes of ground level ozone (smog) and acid rain.

Carbon dioxide (CO₂) is a possible contributor to global warming.

Maintenance

There have been no complaints of skylight leaks in the first year. However, because humidity must be maintained at a high level in the galleries, there were issues with condensation on the underside of both types of skylights during winter. To avoid water droplets falling beneath the skylights, the museum will be installing additional equipment to heat the air in the skylight wells. (The energy use of this equipment may ultimately increase total heating energy.)



Lessons Learned

- The skylights with integral honeycomb baffles were part of a system that succeeded in providing diffuse illumination in the Parrish Art Museum.
- Visitors rated the skylights with integral honeycomb baffles as comfortable to look at.
- 73% of visitors considered the illumination of the galleries to be better than other museums.
- 28% of visitors agreed or slightly agreed they could clearly see the sky through the integral honeycomb baffles.
- Maintenance of the skylights has not been problematic, but condensation due to high humidity requirements created water droplets during the first winter of use.
- The skylights allowed electric lighting in the galleries to be turned off for most of the day in the spring and summer, thus reducing electric lighting energy use.
- Overall annual energy use is predicted to be less using glazing with integral honeycomb baffles than if galleries had either clear glazing in north-facing skylights or no skylights.

Field Test DELTA Snapshots
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Glazing with Integral Honeycomb Baffles

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Field Test DELTA evaluates new energy-efficient lighting products to independently verify field performance claims and to suggest improvements. A primary goal of the Field Test DELTA program is to facilitate rapid market acceptance of innovative energy-efficient technologies.



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