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High-Performance Design with Polycarbonate Glazing Systems

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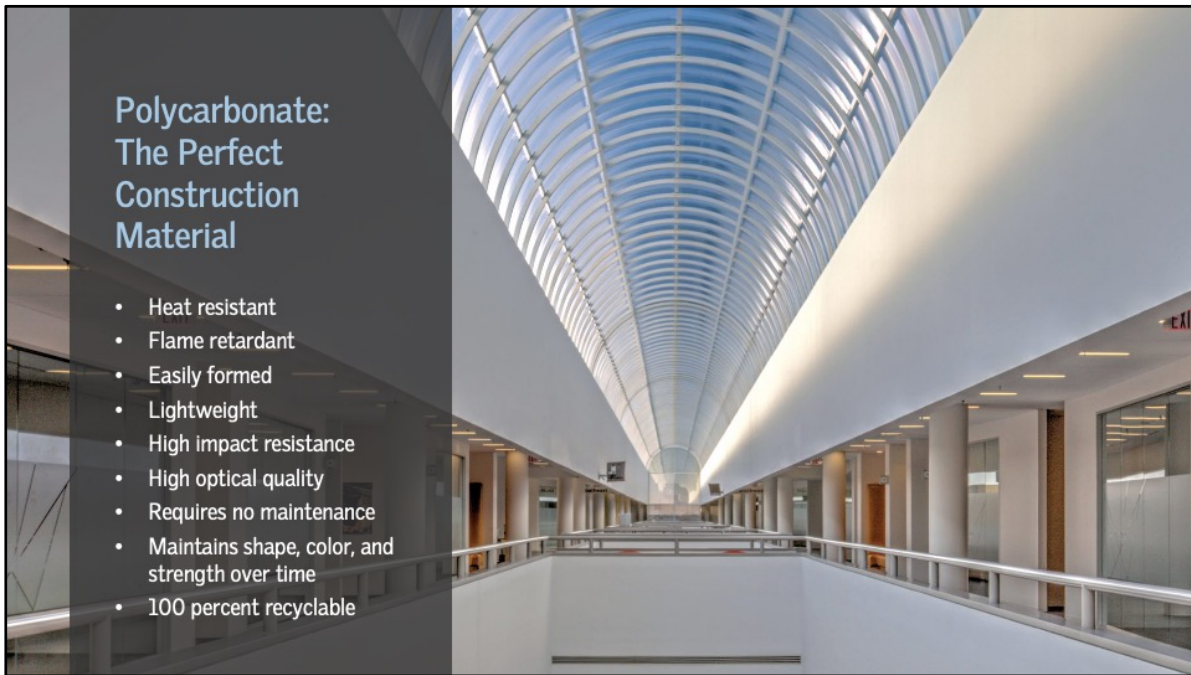


Objectives

1. Define multiwall polycarbonate (MWP) glazing.
2. Assess design considerations and the wide range of polycarbonate glazing systems.
3. Describe the performance, attributes, and sustainability of polycarbonate glazing systems.
4. Discuss wellness and sustainability, as polycarbonate glazing systems improve occupant health, safety, and welfare.



Multiwall polycarbonate (MWP) panels offer a wide range of panel options when considering your choice of skylight systems. Panels may be flat or in a standing-seam configuration. Panel thicknesses vary as well as the number of "walls" in the panel. The panels are available in many color options. MWP are also conducive to an aerogel in fill.



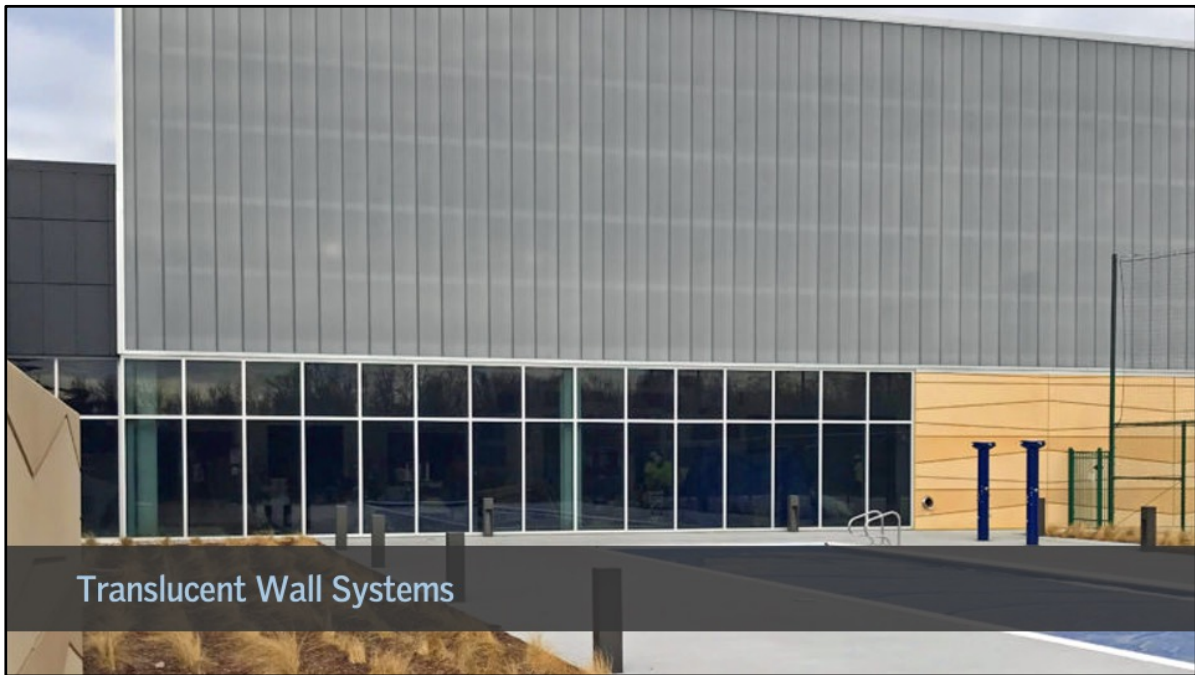
We know that many industries use polycarbonates. In fenestration, MWP attributes include very low flame spread and smoke development, easily formed, lightweight, high impact resistance, and high optical quality. MWP provides diffused daylight, maintains its shape, color, and strength over time, and is 100 percent recyclable.



This is a standing-seam example. Note the continuous sheet. Glass might require two or three lites up the slope. Standing-seam panels are lightweight and easy to install.



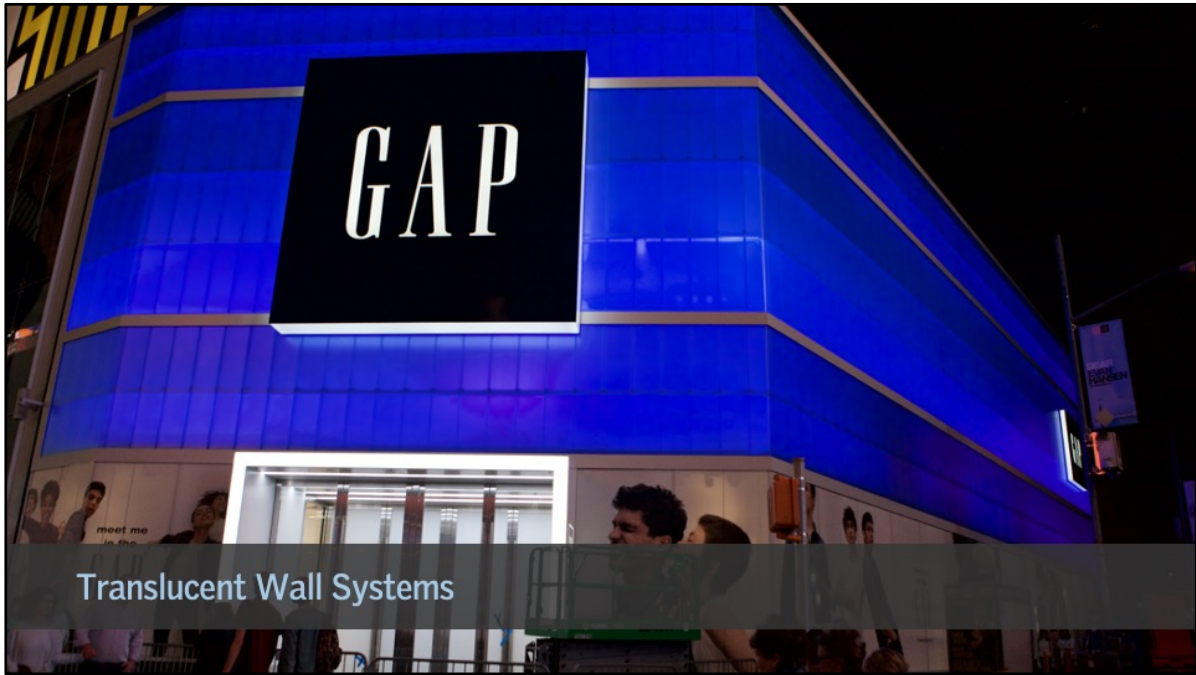
This is another example of the standing-seam system used on a canopy. In this case, the panels are 30-foot continuous sheets. They are mechanically attached to the structure and captured at sill and head with a simple aluminum extrusion.



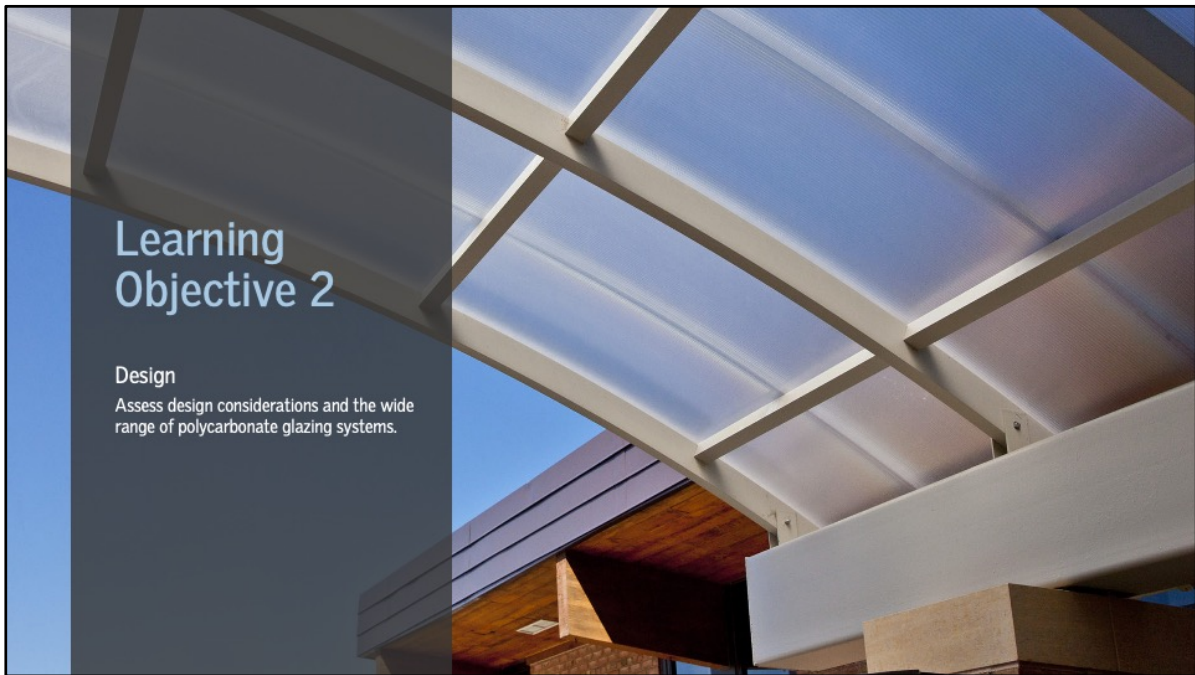
Here we have a vertical system utilizing 40-millimeter flat panels. The panels have a tongue and groove configuration and snap together. Note that there are no mullions. These are 28-foot continuous panels that are mechanically attached with clips to the horizontal interior supports.



Note the flat panels in irregular shapes on this polygon. The flat panels are 25 millimeters (1 inch thick) and conducive to metal-framed skylights.



Again we are seeing 40-millimeter tongue and groove panels, here with blue tints. MWP has distinctive backlighting characteristics.



As we have seen, the use of MWP lends itself to a wide range of design options.

Vault Skylights Unit Skylights Metal-Framed Skylights Canopy Systems Vertical Systems

10mm - 2 Wall 16mm - 3 Wall 16mm - 5 Wall 25mm - 3 Wall 25mm - 6 Wall 40mm - 7 Wall

Flat Panels Standing Seam Tongue and Groove

Design
Eight core modular skylight solutions, with advancements ever year in new configurations.

There are multiple design options both in terms of multiwall panel choices and skylight configurations.

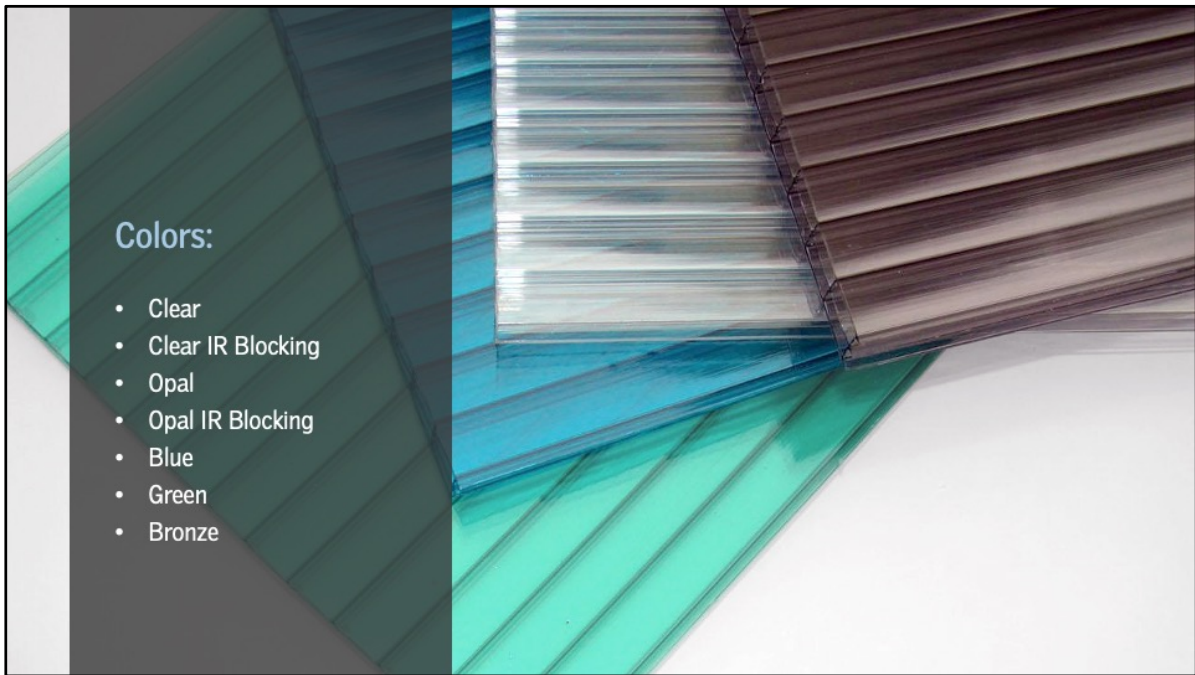


Advanced Technology – Aerogel

- Light transmitting
- Insulating silica
- Cradle to Cradle certified
- Fills multiwall panels

Aerogel provides high-performance insulating values, high daylight transmission, and diffused natural light. In a granular form, aerogel can be used to fill the flutes of multiwall panels to greatly enhance thermal values. 25-millimeter panels (1 inch thick) have an R-value of 6.3—greater than the R-value of polyisocyanurate, which is 5.6.

Aerogel is cradle to cradle in its manufacture and reusable.



Color may be important to your design considerations. Custom colors are available.



Multiple colors are used in this vertical application example.



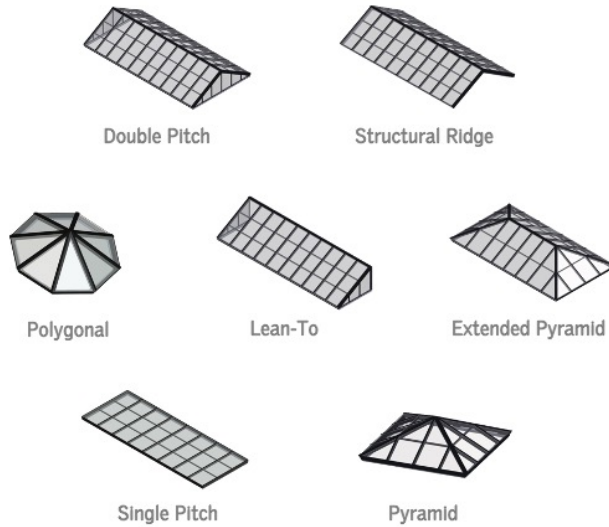
MWP can be produced in custom colors providing wide-ranging aesthetic opportunities, allowing architects to create dynamic and expressive facades.



Translucent MWP provides diffused natural daylight through the building interior, creating a bright and useful space with less intensity— which means more comfort and a more pleasing, natural aesthetic. Contrast and uneven illumination are completely eliminated.

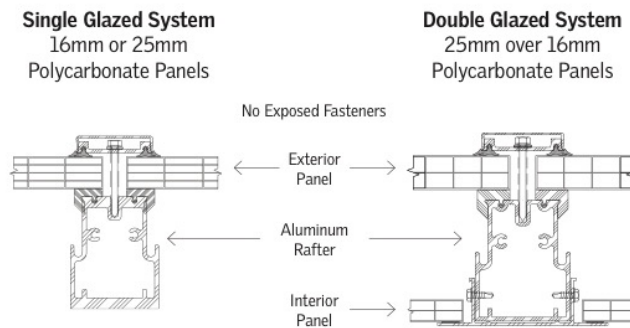
Polycarbonate Skylight Structures

- Single or double glazed
- Aesthetically pleasing narrow profiles with no exposed fasteners
- Reduces labor and material costs in new construction, retrofit, or renovation projects
- High impact resistance, excellent UV protection
- Extensive glazing color and customized performance options



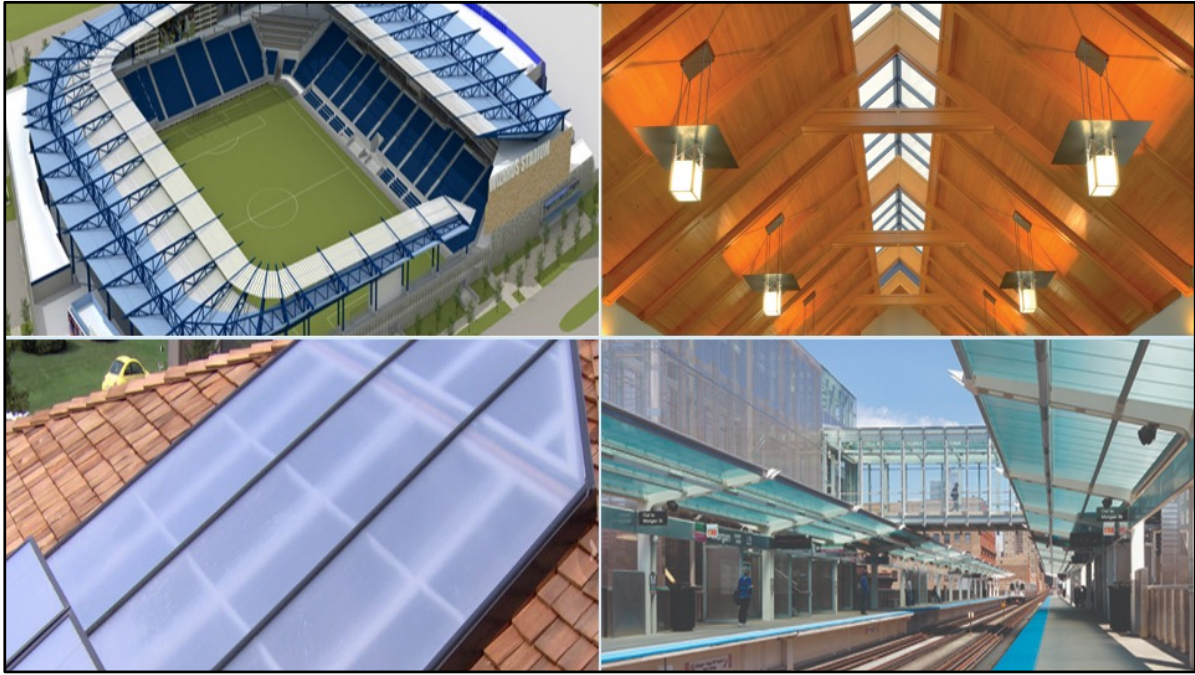
Polycarbonate can be used in flat-panel sloped applications and cold formed to raftered configurations. Single- or double-glazed options are available. They have UV protection and high impact ratings. Due to its lightweight, it is easy to install.

Flat Panel Spans

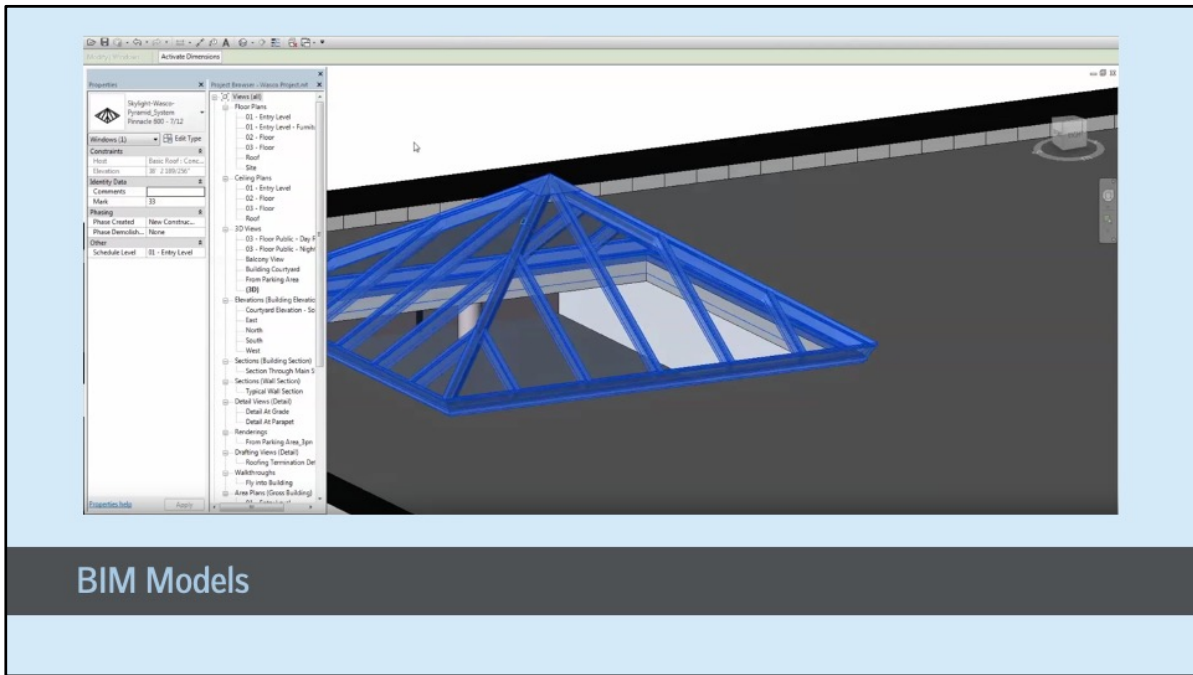


Design:

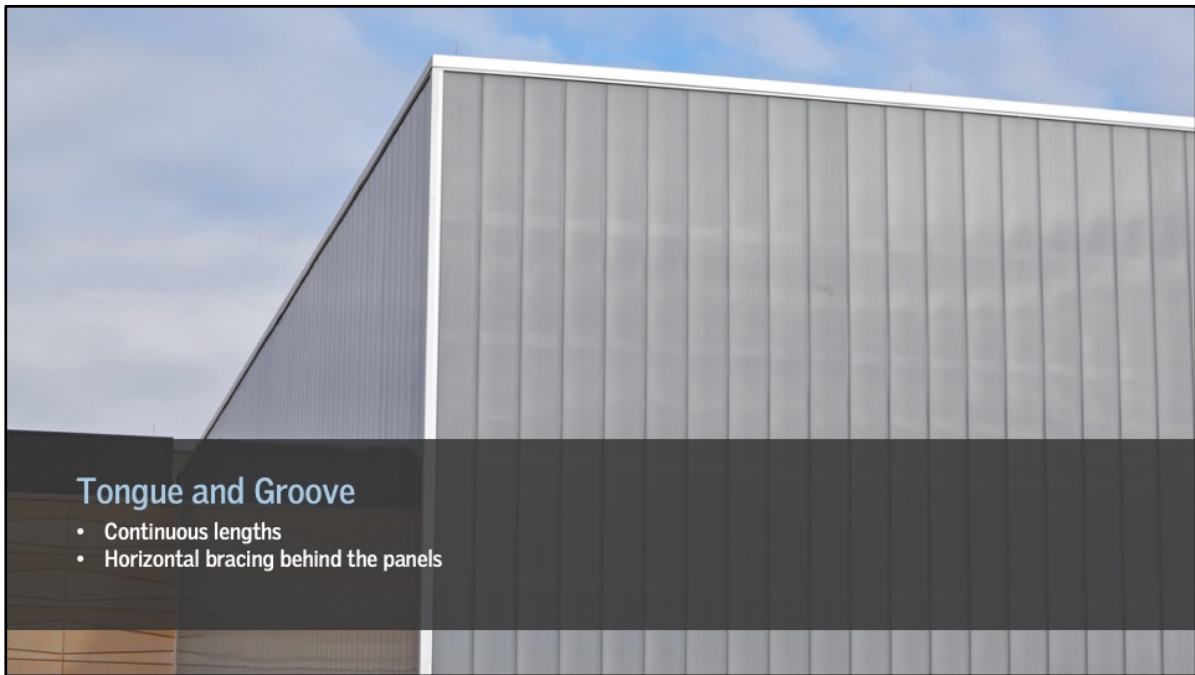
- Custom-configured structural skylight system with standardized engineering, construction, and installation
- Single or double MWP panel systems
- Double-glazed spans up to 30 feet wide; single glazed spans up to 40 feet wide*
- Fully customizable control over light transmission, solar heat gain, and R-value
- Aerogel filled panels are available for even greater thermal performance
- Available with a wide range of frame finish color options
- Smaller sizes can ship preassembled and glazed



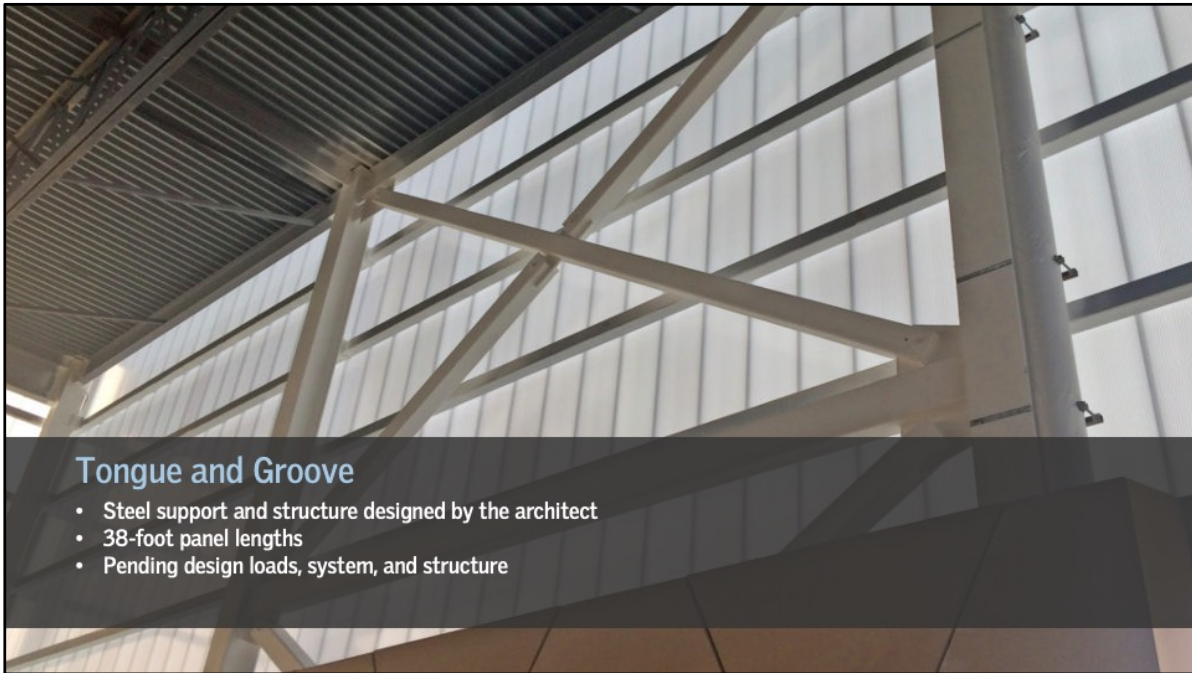
Here are various examples of MWP in action.



The systems are engineered and designed to perform to energy codes.



As mentioned, tongue and groove panels attach to the structure with aluminum clips to address wind loads and deflection.



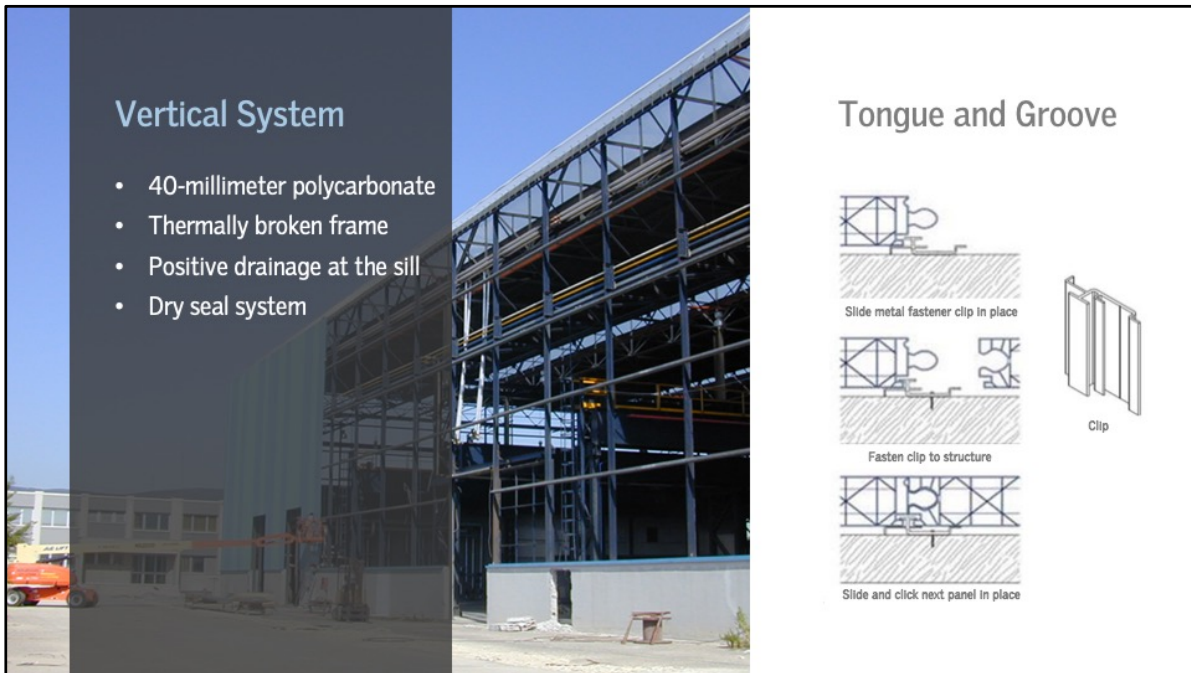
Tongue and groove panels are horizontally braced for wind loads and deflection. The steel support and structure are designed by the architect. 40-millimeter panels are continuous from head to sill.



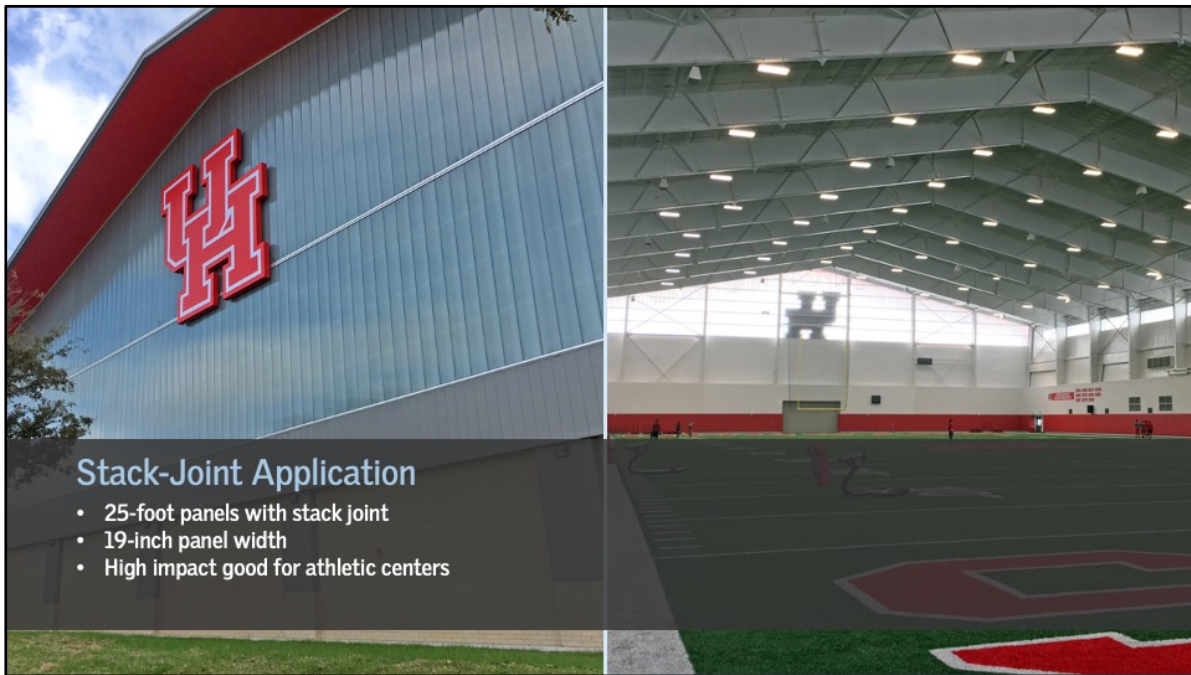
Thermally broken frame system. Subsill with weeps. Dry seal installation. No exposed fasteners.

Design:

- Lightweight, interlocking, 40-millimeter, tongue and groove MWP panels
- System depth: 2¾-inch panel frame, 4-inch subsill
- Standard subsill for trouble free installation
- Sloped sill nose with recessed weeps for maximum drainage
- Extruded aluminum frame with polyurethane thermal breaks for improved thermal performance
- Two separate assembly points create a tight attractive corner
- Factory finishes meeting all AAMA finish standards
- No exposed fasteners
- Available with a wide range of color choices.



Shown is an example of how vertical system tongue and groove polycarbonate panels may be attached in the field using clips. Slide the clip in place, fasten it to the support structure, then slide and click the next panel into place.



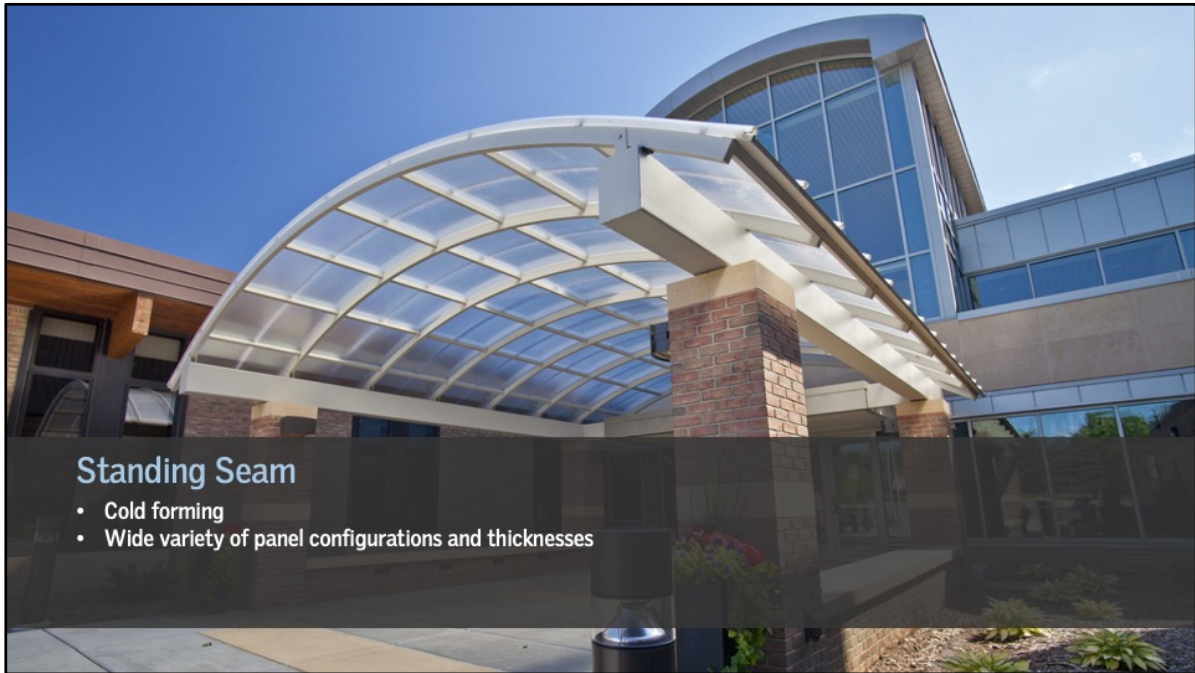
Shown is an example of a stack-joint application. In this case, the dimension from head to sill was 50 feet, exceeding maximum panel lengths. Stack joints were installed to utilize two 25-foot panels, both 19 inches wide. These panels have an IR inhibitor to reduce solar heat gain. With its excellent impact attributes, multiwall glazing lends itself to athletic facilities.



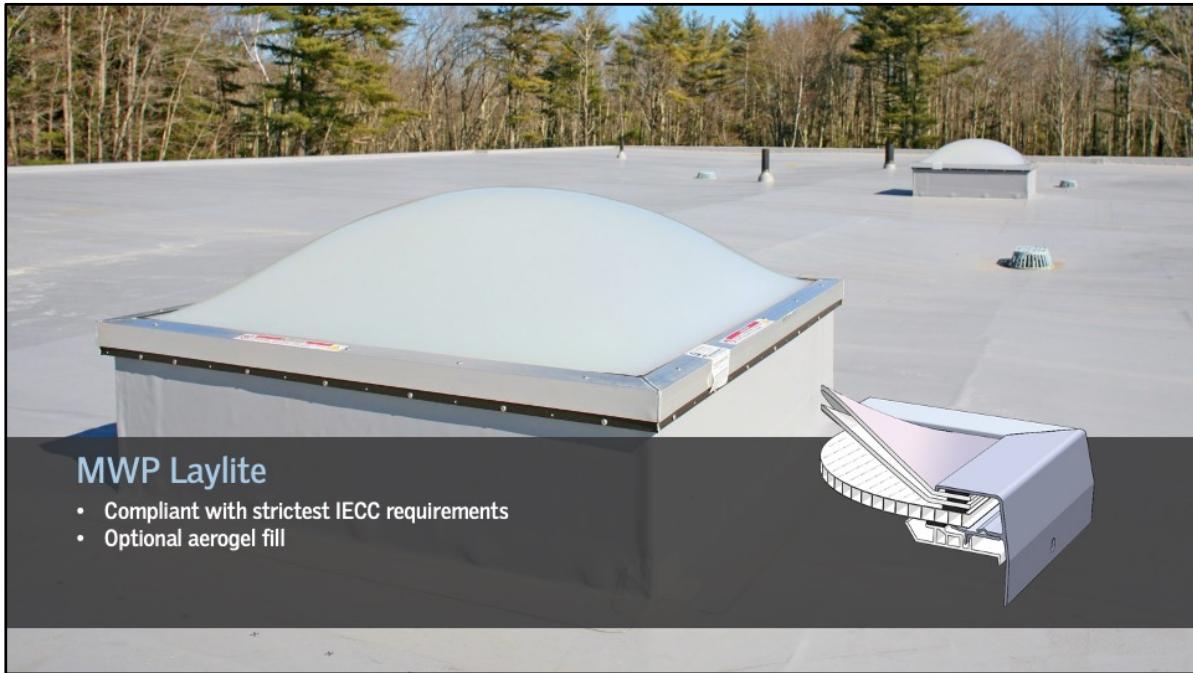
Opal 40-millimeter tongue and groove multiwall as clerestory.



Multiple colors can be incorporated into a facade design. Many different effects can be achieved, depending on the chosen colors and the building's design.



Polycarbonate offers a wide variety of panel configurations and thicknesses, and can be cold formed down to a 13-foot radius.



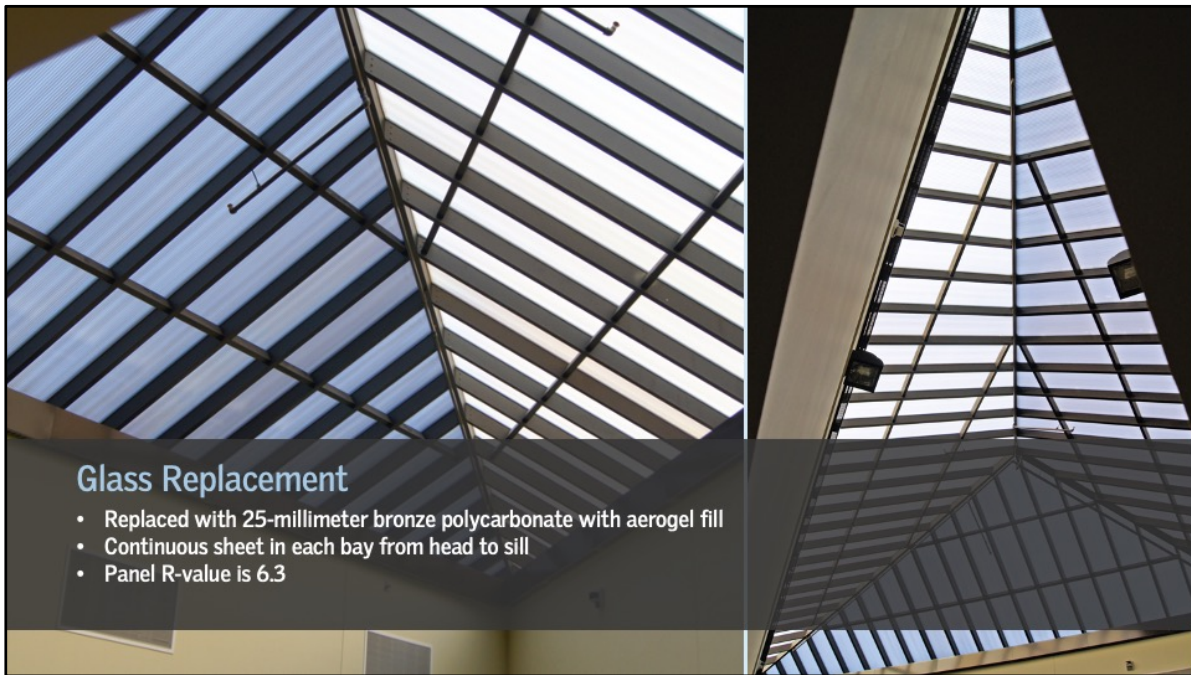
To meet energy codes, unit skylights can add a MWP panel filled with aerogel.



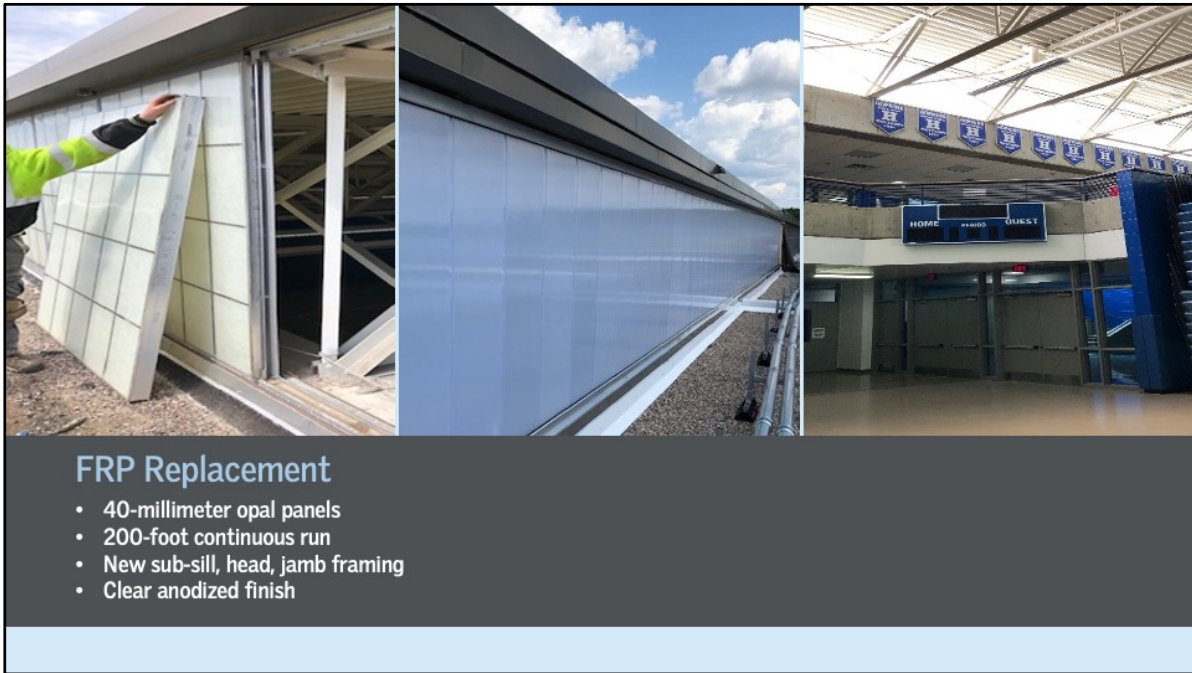
Laylights with aerogel provide high thermal performance while creating excellent diffused daylight. This is a good option for unit skylights.



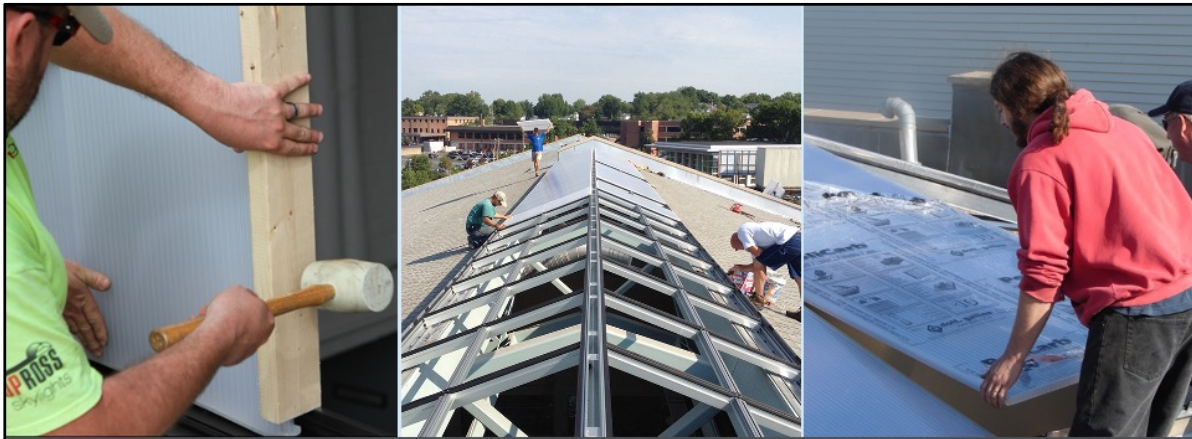
MWP provides an economical replacement option. Other glazing systems may require yearly maintenance to reapply a UV coating. If not properly maintained, it can break down, causing yellowing over time. MWP is extruded with a UV inhibitor that does not require annual maintenance.



MWP was used to replace seal-failed insulated glass on a metal-framed skylight. Bronze tinted 25-millimeter polycarbonate with aerogel fill. Panel R-value is 6.3. Note one continuous sheet each bay from head to sill. Lightweight reduces replacement costs. Bronze tint with aerogel.



Multiwall replacing FRP panels on high school gymnasium, adding thermally broken framing system. Providing more than three times the visible light transmission.



Easy to Install

- Lightweight
- Field cutting
- Installers who work with glass every day will love working with lightweight polycarbonate

MWP is lightweight, easily installed, and virtually unbreakable.



In this learning objective, we will discuss p

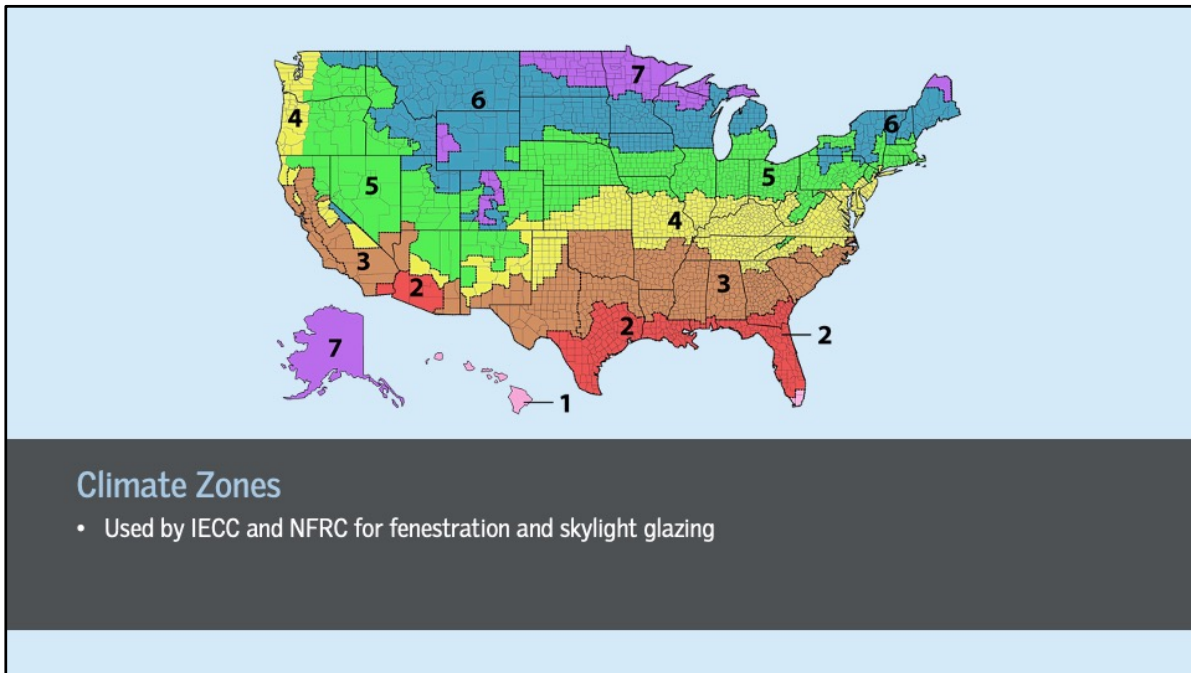
Relevant Codes, Standards, and Tests

Building Codes:

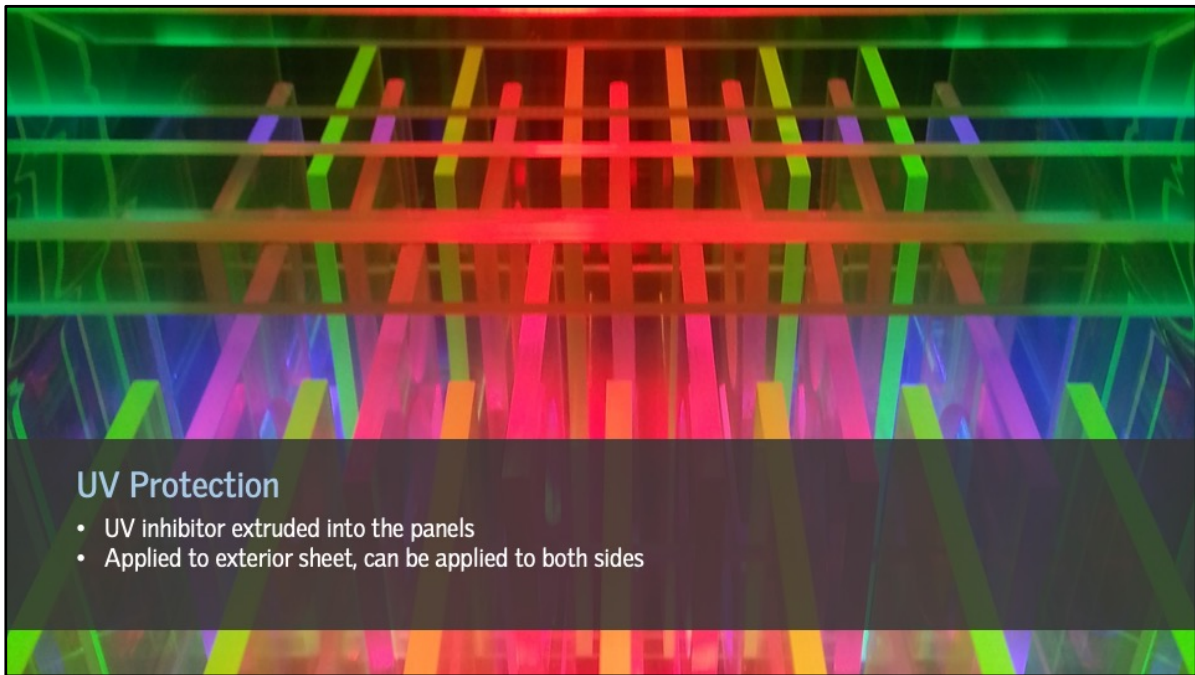
- International Building Code, International Code Council
- State-specific code compliance to Florida, Texas, California, and Washington
- Dade County (Florida)
- International Energy Code Council (IECC)



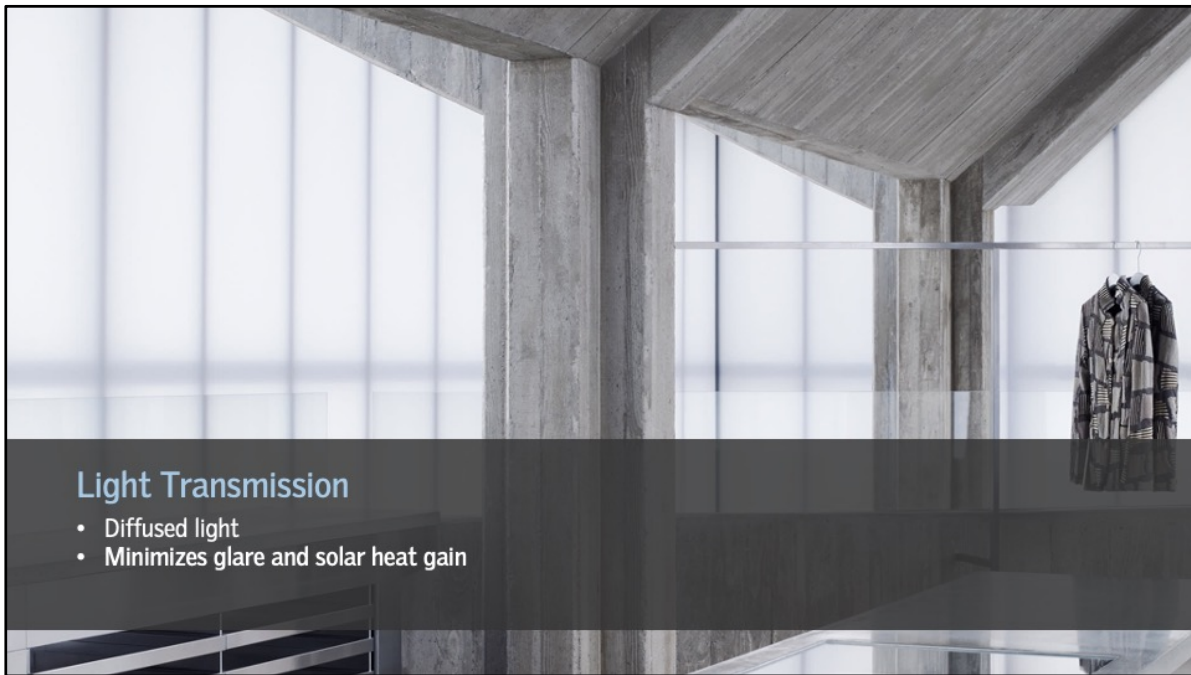
To quickly review the complex U.S. building codes for glazing, keep in mind that states and local municipalities adopt various versions of the code voluntarily, therefore the following building codes can be applicable based on your region and even state and county. ASHRAE 90.1 and IECC recognize eight climate zones in the United States.



The 2012, 2015, and 2018 IECC have this climate zone map, which relates directly to a matrix for fenestration and skylight glazing. The codes address thermal performance and solar heat gain coefficients (SHGCs). The National Fenestration Rating Council (NFRC) publishes a Certified Products Directory of fenestration products that have been tested as systems for both thermal and SHGC performance. The directory has listing for windows and skylights. You can search by manufacturer to be sure of code compliance.



Ultraviolet is addressed in multiwall panels by co-extruding a UV inhibitor into the panels. It provides a layer to the exterior sheet and can be applied to both sides as well.



Diffusion not only minimizes glare but also factors in solar heat gain, which is addressed by the energy codes. Note the large-size dome in relationship to the space. Reduction of solar heat gain and glare is essential to the glazing selection.



Impact Test: 6.5-pound steel ball dropped from 30 feet, bounces off the MWP panel

Polycarbonate Systems: Impact

- High impact performance, including hail
- Meets rigorous Miami-Dade County building codes

MWP has high impact performance, including hail.

Polycarbonate glazing panels were one of the first to be certified under the rigorous Miami-Dade County building codes for hurricane resistance. In fact, hurricane test results show the material survives an impact of a 2.4-meter (8-foot) long 2 × 4 fired from an air cannon at 55 km/h (34 mph).

Specifically, polycarbonate barrel-vault skylight was impact-load and high-pressure tested to 19,727 Pa (412 pounds per square foot)—the equivalent to 571 km/h (355 mph) winds.

Source: The American Chemistry Council

Flame Spread and Smoke Development

- Self ignition: ASTM 1929
1,000 degrees Fahrenheit
- Polycarbonate is self-extinguishing and will not support combustion without a flame source
- Burn extent: ASTM D635-98 CC1 rating
- ASTM E-84/UL 723 Class A/Class 1



Unlike many other plastics, polycarbonate does not burn, create thick, black smoke, or aid in the spread of fire. Without an outside heat source, polycarbonate will extinguish itself, making it an ideal material for exterior glazing and interior applications. Polycarbonate far outperforms product such as acrylic and fiberglass-reinforced plastic in large-scale field tests.

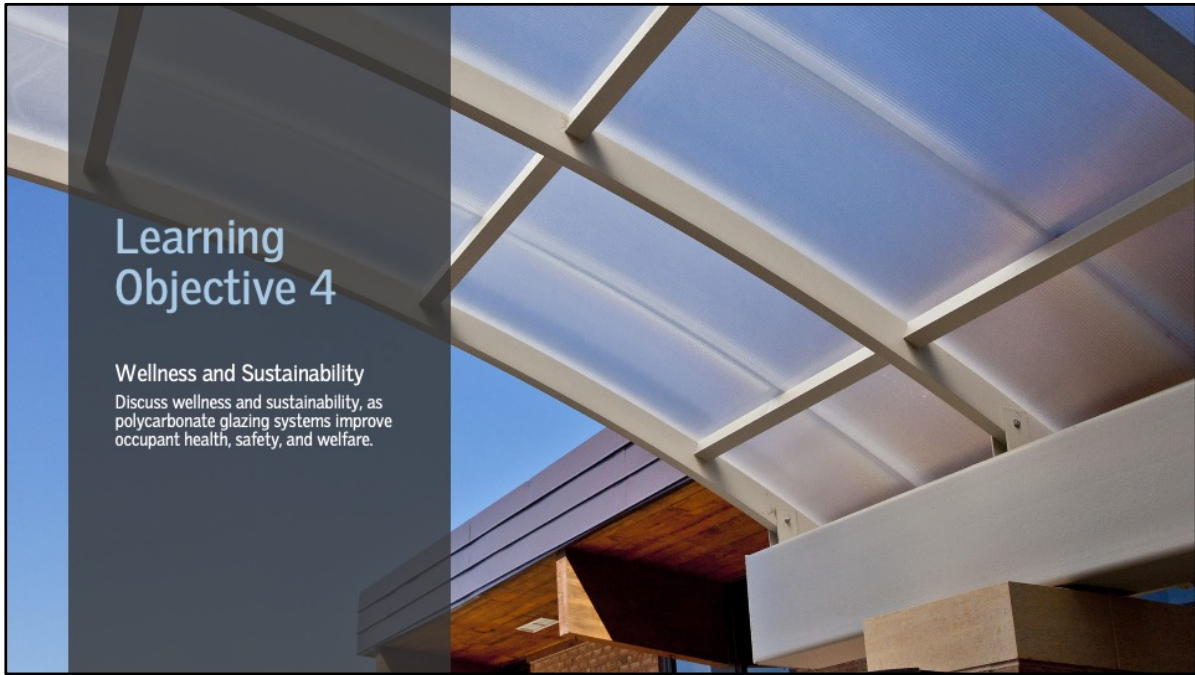
MWP meets the highest safety requirements of these common classifications and often dies so by a significant margin.

Class A: ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials. Flame spread and smoke density development for interior surface material: Class A, flame spread 25 or less, and smoke density developed rating of 450 or less.

Class C: ASTM D635: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastic in a Horizontal Position. Burn extent for plastic materials; Class CC1, burn extent of 1 inch or less.

Class A and CC1 standards can be met and surpassed with a wide variety of

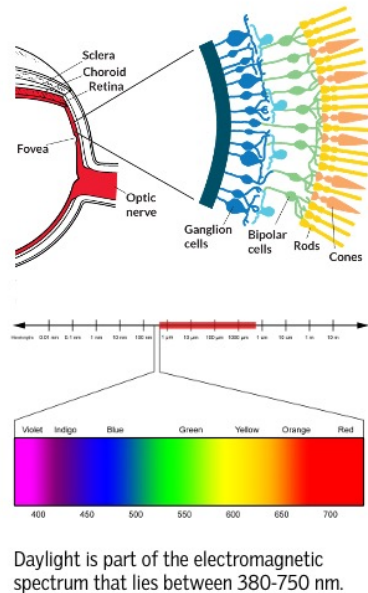
polycarbonate sheet sizes and profiles.



In our final learning objective, we will address the wellness and sustainability topics.

Circadian Rhythm

- 24-hour "clock" or sleep/wake cycle is controlled by the suprachiasmatic nucleus (SCN)
- Eye has rods and cones, which are for sight
- Ganglion cells are the other receptors, which are directly photosensitive
- Ganglion cells report directly to the SCN, which is located in the hypothalamus



Daylight has a whole host of benefits. When we are outdoors, our skin absorbs the rays and converts the solar energy into vitamin D. The most impactful aspect of daylight is how it impacts our entire human operating system (endocrine system, neurotransmitters, gene expression.) This all anchors back to our circadian rhythm. The circadian rhythm is our internal time clock supporting our wake sleep cycle. We learned early in life that our eyes have cones and rods to support our vision. There is a third receptor in the eye that uses the spectrum of light (specifically the cyan bandwidth). This receptor is called the ganglion cells. These cells send data to the suprachiasmatic nucleus (SCN) is a tiny region of the brain in the hypothalamus, which regulate many areas of the body in a 24-hour period cycle. The wake/sleep cycle being the most impactful for improving productivity, attention span, healing of the body, establishing the sleep patterns, etc.

Daylighting via the MWP glazing allows for the diffused full spectrum of light to enter the building, while controlling the stress of glare and aiding in visual comfort of the interior space. This offers a one-two punch in the wellness category.

Sustainability

- Multiwall is 100 percent recyclable
- Aerogel – Cradle to cradle certification
- No VOC, dry-sealed system
- Provides opportunities for diffuse lighting and glare reduction

Lead Architect: Rick Ames, AIA, LEED

Consultant: Gunnar Hubbard, AIA, LEED AP,
President, Fore Solutions

Daylighting Consultant: Dane Sanders, EIT, LEED
AP, Clanton & Associates



When we move past wellness of the occupants to wellness of the environment, we can reference the learning journey of many sustainable rating systems (LEED, Well Building, Living Building Challenge, BREEAM, ENERGY STAR, and more). The MWP contributes a 100 percent post consumer recycled/1–40 percent pre-consumer recycled solution. The install has no VOC off-gassing as it is a dry-seal system at the time of installation. The option to insulate with aerogel adds a insulation solution that is Cradle to Cradle certified.

Environmental Sustainability

MWP impacts sustainability in the following areas:

- Thermal insulation properties
 - Decreases heat loss outside the building
 - Limits heat input inside the building
 - Lowers carbon emissions
 - Saves money on heating and cooling
- Excellent acoustics
 - Dampens sound
 - Reduces noise from outdoors
- High light transmission
 - Provides natural, diffused daylighting
 - Reduces need for artificial lighting
- Maintains physical characteristics
- Keeps its appearance—no yellowing
- Impact resistant—difficult to break
- Long shelf life, recyclable—reduces landfill usage



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