Polycarbonate Glazing Systems, an Energy Efficient Daylighting Solution

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Daylighting and Energy Efficiency through “Sustainable “ Polycarbonate Solutions

Learning Objectives

1. What is polycarbonate and how is it produced
2. Characteristics and performance
3. Daylighting and sustainability
4. Polycarbonate glazing Systems
What is Polycarbonate

- Polycarbonate is a thermoplastic polymer – 100% Recyclable
- Very strong, 200 times stronger than glass
- Multiwall is extruded into light weight panels
- High light transmittance and low U-Values
Polycarbonate Manufacturing

Extrusion Technology

• Screw drives push material through metal dies
• Hoppers at start of machine combine polycarbonate, additives and recycled material
• Polycarbonate is melted by heaters and friction of system
• Different dies produce different product profiles
Co-Extrusion Process

- Co-Extrusion process adds a similar material to polycarbonate before passing through the die.
- Co-Extrusions can provide UV protection, different colors and Infrared reduction.
- Coatings are added after the extrusion process and can include UV protectors and other performance enhancing additives.
Polycarbonate Sheeting Materials

Extrusion produces solid and multiwall sheet products
Polycarbonate Sheeting Materials

Characteristics and Performance

- Widths - 4’ to 6’, can be cut to order
- Lengths - 24’ to 48’, limited by shipping
- Profiles - twin, triple, five ........
- Visual and thermal performance
- Fire ratings
- Loading and application guidelines
- Warranties
- Specialty features
Polycarbonate Sheeting Materials

Some typical flat sheet designs
Multiple layers and thickness

Some more specialized panels may include a standing seam or tongue and groove design
Clarity and visual performance

- Standard Colors: Clear, Opal, Bronze
- Custom colors available, panels can be direct printed
- Maintains high light transmittance with increased size and structure
# Polycarbonate Sheeting Materials

<table>
<thead>
<tr>
<th>Product</th>
<th>Structure</th>
<th>R-Value</th>
<th>LT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10mm Twin Wall</td>
<td><img src="image" alt="10mm Twin Wall Structure" /></td>
<td>1.89</td>
<td>81</td>
</tr>
<tr>
<td>16mm Triple Wall</td>
<td><img src="image" alt="16mm Triple Wall Structure" /></td>
<td>2.50</td>
<td>74</td>
</tr>
<tr>
<td>16mm Three X Wall</td>
<td><img src="image" alt="16mm Three X Wall Structure" /></td>
<td>2.78</td>
<td>67</td>
</tr>
<tr>
<td>25mm Triple Wall</td>
<td><img src="image" alt="25mm Triple Wall Structure" /></td>
<td>2.94</td>
<td>72</td>
</tr>
<tr>
<td>25mm Five X Wall</td>
<td><img src="image" alt="25mm Five X Wall Structure" /></td>
<td>3.85</td>
<td>57</td>
</tr>
<tr>
<td>50mm Thermoclick</td>
<td><img src="image" alt="50mm Thermoclick Structure" /></td>
<td>5.68</td>
<td>47</td>
</tr>
</tbody>
</table>
Polycarbonate Sheeting Materials

Flame Retardant

Acrylic vs Polycarbonate

Multiwall Polycarbonate
Flame Retardant

- **Class A**: ASTM E 84 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 CC1**: ASTM D635 Burn extent for plastic materials: Class CC1, Burn extent of 1” or less

- **Class A and CC1** can be achieved with wide variety of sizes and profiles.
Polycarbonate Sheeting Materials

Impact Resistance

- Hail Resistant: Can withstand a .79” Ball impact at greater than 69 ft/s (terminal velocity of hail)
- Many products are Miami-Dade County accepted and ICC ES 3286 compliant
Polycarbonate Sheeting Materials

Bend and Fabricating on Site

Curved Glazing Systems/Sheet Thickness Selection

LEXAN II Thermoclear sheet can be successfully cold curved over curved support glazing profiles, to suit many glazing applications, e.g., domes, roof lights etc. Providing the radius is not below the minimum recommended value of 175 times the thickness, then the introduced stress by cold curving is not expected to have any adverse effect upon the mechanical performance of the sheet. Sheets must always be bent longitudinally, never across the width of the sheet.

The minimum radius values are outlined below in Fig. 51.

Fig. 51

<table>
<thead>
<tr>
<th>Lexan Sheet Thickness (inches)</th>
<th>Min. Radius (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>41</td>
</tr>
<tr>
<td>8</td>
<td>55</td>
</tr>
<tr>
<td>10</td>
<td>59</td>
</tr>
<tr>
<td>16</td>
<td>110</td>
</tr>
<tr>
<td>20</td>
<td>110</td>
</tr>
<tr>
<td>25</td>
<td>113</td>
</tr>
</tbody>
</table>

The following load charts are based upon curved glazing applications clamped on all four edges. The charts show linear buckling load values calculated with a safety factor of 2.5 against installation radii.

Sheet length “L” needs to be greater than sheet width “W” to facilitate curvature; in practice, a ratio of 1:2 or less is virtually never encountered because of the peculiarities of installation geometry.

How to read the charts.

Curved Glazing

The design information in the following pages is organized in graph form for each thickness of Thermoclear and is based on the cold formed glazing radius and the specified design load, to determine the required rafter spacing. Find the graph that represents the desired sheet thickness and locate the line on the graph that represents your loading requirement. Start from the design radius fixed on the X axis, and go up to the line that represents the specified loading and locate your maximum rafter spacing on the Y axis.
Polycarbonate Manufacturing

Lightweight

25mm 5wall Polycarbonate = .8 lbs./sf
1” Insulated Glass Unit = 6.5 lbs./sf
2.75” Fiberglass Reinforce Plastic = 2 lbs/sf

Multiwall Polycarbonate
Polycarbonate Sheeting Materials
Polycarbonate Sheeting Materials

Weather Resistance

Warranty Issues

- Protection from co-extrusion or coatings
- Can be applied to one or both sides
- Standard test ASTM D1003
- Verified through weathering acceleration test and long term case studies

Sample 1: $\Delta Y_i = 0$

Sample 2: $\Delta Y_i = 2$: Advanced sheet warranty

Sample 3: $\Delta Y_i = 10$: Typical Multiwall PC sheet warranty
Polycarbonate Manufacturing

Improved Polycarbonate performance against other translucent glazing options.

- Lighter
- Cost effective
- More light transmittance
- Better thermal performance
Aerogel

- Invented in 1931, not until late 1990’s was it safely produced on a large scale.
- Aerogel holds Guinness Book of World Records for the lightest, most insulating material known.
- 97 percent AIR – just 3 percent silica solids.
# Polycarbonate Sheeting Materials

<table>
<thead>
<tr>
<th>Aerogel</th>
<th>Insulated Glass Unit</th>
<th>Standard 25mm Panel</th>
<th>Aerogel Filled 25mm Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal (R-Value)</td>
<td>R 2.85</td>
<td>R 2.94</td>
<td>R 6.25*</td>
</tr>
<tr>
<td>Acoustic (STC Value)</td>
<td>na</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Light Transmission</td>
<td>74%</td>
<td>72%</td>
<td>49%*</td>
</tr>
<tr>
<td>Solar Heat Gain Coefficient</td>
<td>.71</td>
<td>.57</td>
<td>.54*</td>
</tr>
</tbody>
</table>

*Values verified by NFRC Testing for 25mm filled panel

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Multiwall Polycarbonate
Polycarbonate Sheeting Materials

Aerogel – Light Diffusion

Base model

Model with 16mm aerogel filled panel
Polycarbonate Manufacturing

Specialty Products

- Hammered
- Easy Clean
- Anti-Drip
- Custom Printing
Daylighting and Sustainability

Improved Productivity

According to studies done by the Heschong Mahone Group from California, diffused daylighting increased retail sales up to 40% for one major retailer. For another, daylighting achieved profits 19 times more than energy savings.
Daylighting and Sustainability

Reduced Energy Consumption

- Rule of thumb: Each kWh of electricity used for commercial lighting adds .5 kWh of electricity needed for cooling - **daylighting** saves both lighting and cooling loads.

Cost

| Lighting | Cooling |

Multiwall Polycarbonate
Daylighting and Sustainability
Daylighting and Sustainability

Translucent Glazing reduces glare
Human Health

Human Heath and Natural Light

- Circadian System
  - Sleep / Wake Cycle
  - Circadian Rhythm
- Natural Light Varies in intensity throughout day
- Changes effect sleep patterns, metabolism, immune system
Daylighting and Sustainability

LEED and Energy Codes

LEED Credits
• Recycled Content – Up to 30% pre consumer
• Increased Thermal Performance
• Daylighting
• 100% Recyclable

Energy Efficient Codes
• NFRC Testing
• Improved thermal performance and light transmittance
  • Less openings provide increased light
Systems and Applications

Multiwall Polycarbonate
Systems and Applications

- DESIGN FLEXIBILITY
- DESIGN AESTHETICS
- DESIGN PERFORMANCE
- DESIGN VERSATILITY
Systems and Applications

- Skylights / Monitors
- Canopies/Walkways
- Vertical Glazing
- Curtain walls
- Clerestories
- Illuminated Walls
- Partitions

The industry’s widest applications of translucent daylighting technology.
Systems and Applications

Unit Skylights

Wasco: Giant Food, Fredericksburg, VA
Systems and Applications

Custom Skylights
Systems and Applications

Stadiums

- Light weight minimizes structure
- Lets controlled light in
Stadiums: Amsterdam Arena

15 years – No discernible change in color

2010 TNO Science and Industry Report
Systems and Applications

Vertical Glazing
• Frame System
• Tongue and groove
• Standing Seam
Systems and Applications

Multiwall Polycarbonate
Systems and Applications

Barrel Vault canopy

Multiwall Polycarbonate
Systems and Applications

POP and Signs
- Printable
- Durable
- Light weight (portable)
- Sound attenuation for partitions
Interior Applications
Multiwall Polycarbonate

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1. Provide Spec and Drawing information
2. Provide Loading and Performance Data
3. Chose the right product for your project
4. Connect to the right “systems manufacturers”
5. Get samples and literature
6. Get fire testing and other certificates
7. Get AIA credit

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