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EXAMINATION OF THE USE OF POLYCARBONATE IN COMMERCIAL SKYLIGHTS

RESEARCH BY ENEREF INSTITUTE SHOWS THAT BETTER-
PERFORMING POLYCARBONATE FOR SKYLIGHTS IS WORTH
STRIVING FOR DESPITE INDUSTRY MISPERCEPTIONS.

Durable against heavy impact and highly resistant to sun damage, polycarbonate is a superior but underutilized polymer in skylight lens applications. More commonly

used acrylic lenses, on the other hand, are far more brittle and therefore much more likely to be damaged by wind-borne debris and fall accidents.



POLYCARBONATE SKYLIGHT

High-performance prismatic skylights are ideal for commercial applications

IMPACT TESTING DEMONSTRATES STRENGTH

One test used by the plastics industry to measure polymer toughness is Instrumented Impact, ASTM D3763. In this standardized test, forces and displacements are monitored during a high-speed dart impact. One of the values calculated from the force and displacement data is the amount of energy absorbed by the plastic material during the impact event. Polycarbonate demonstrates a total impact energy of 50 ft.-lbs., while acrylic gives a much lower impact energy, only 2 ft.-lbs.

“With enough impact energy, you can cause any material to fail,” explains Ted Trautman, Ph.D., Covestro Technical Director. “The question is, how much energy does it absorb before it fails? Under the same test, acrylic samples

fail, absorbing 25 times less energy than polycarbonate.” Covestro is a leading manufacturer of polycarbonate materials.

“We recommend polycarbonate Prismatic skylights, especially in hail zone areas, where strength and safety are key,” explained Pete Shannin, Vice President, Daylighting Product Solutions at Acuity Brands.

POLYCARBONATE SURPASSES OSHA REQUIREMENTS

OSHA (Occupational Safety and Health Administration) mandates the safety requirements of rooftop skylights. Unlike acrylic, polycarbonate’s impact resistance far surpasses OSHA’s guidelines for fall protection or accidents in skylights.

OSHA’s position is that any company that puts a person on a rooftop

is responsible for the safety of that individual. Some experts interviewed for this report consider liability management an important reason to choose polycarbonate. Exceptionally safe and stronger than other skylight polymers on the market, polycarbonate is the industry-recommended material for fall protection. The strength of the polymer ensures the least chance of injury from falls.

CASE STUDY: The construction team of furniture retailer Rooms To Go examined samples of skylight plastics prior to installation at their warehouse facility in Dunn, North Carolina. “We felt the polycarbonate was a stronger, more durable product,” said Senior Construction Manager Bruce Wallick. “We had product samples in the office, and we stabbed them with a knife, twisted and bent them. The polycarbonate wouldn’t snap or break.” The facility installed VELUX skylights.

Wallick said they selected polycarbonate skylights for their impact rating over other polymer lenses. "With little structural steel and no fall protection bars on our roofs, the choice for polycarbonate lenses was primarily a safety decision."

NEW TECHNOLOGY ELIMINATES YELLOWING

Though new polycarbonate technologies all but eliminate discoloration, polycarbonate is still seen as a material that degrades over years from sun damage.

When unprotected polycarbonate is exposed to sunlight, it begins to slowly yellow. However, the color change only occurs on the surface of the polycarbonate sheet. Studies suggest that UV exposure from the sun causes chemical reactions on the polycarbonate surface. These reactions, in turn, create a range of products that

strongly absorb UV light. Many of these reaction products also absorb visible light and are therefore responsible for the observed yellow coloring.

UV-ABSORBING "CAP LAYER" IS A TECHNOLOGY BREAKTHROUGH

A significant advance in polymer technology is a UV-absorbing "cap layer" that nearly eliminates sunlight damage to polycarbonate. By nullifying the effects of UV deterioration, this thin, highly concentrated polymer layer co-extruded and fused onto a solid polycarbonate sheet has changed industry thinking on polycarbonate and its use in daylighting skylights.

Testing proves that a co-extruded UV cap layer of at least 15 um in thickness absorbs 99% of harmful UV light. Polycarbonate sheet manufacturers produce sheets with UV caps in excess of 150 um thick to allow for thinning of this cap layer during thermoforming and erosion due to weathering.

With the UV light absorbed by the cap layer, the polycarbonate no longer yellows, hazes or degrades. Any observable change in appearance is in the cap layer itself, leaving the polycarbonate layer below strong and virtually undamaged.

MISCONCEPTIONS OF POLYCARBONATE

Though capping polycarbonate with UV absorber has become a

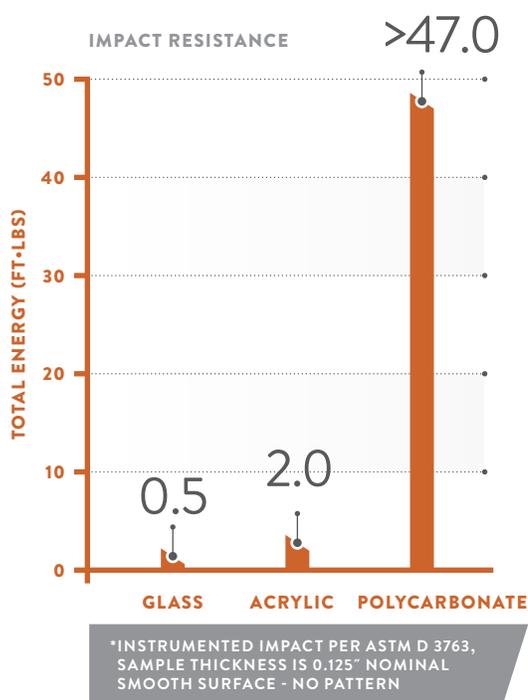
market standard, polycarbonate still suffers from the dated perception of a product that yellows faster than acrylic.

"Some architects prefer polycarbonate and often specify it, but if polycarbonate is not required by the architect or code, then acrylic is typically the most common choice," says Eric Huffman, a Senior Fellow with Eneref Institute and President of Daylighting Solutions.

Facility owners' resistance to polycarbonate is partly due to the perceived higher cost of the material. Polycarbonate skylights are typically marketed as a more expensive premium product. In reality, due to its strength, polycarbonate may not require the excess investments that the use of other plastic glazing such as acrylics could need to meet fall protection guidelines, such as the installation of steel screen mesh. In addition, steel screen mesh will significantly reduce visible light transmission, resulting in a reduction of the amount of daylight reaching the interior of the building.

CASE STUDY: Tim Reidy, an architect with the prominent Hayes Design Group Architects, recommended polycarbonate skylights for the West Allegheny School District in Pittsburgh in 2015. "After attending a continuing education course on the importance of fall protection and the changing requirements of OSHA, we introduced the polycarbonate skylights to the district."

"I'd rather do it right and not worry," Reidy says. Since fall protection for



WHEN THERE'S A HURRICANE OR HAILSTORM. THAT'S WHEN POLYCARBONATE GETS REALLY POPULAR, AFTER A TRAGEDY.

ERIC HUFFMAN | *Eneref Institute, Senior Fellow*

acrylic could mean investments in railings and steel mesh—themselves causing roof penetration and light obstruction—polycarbonate was a less expensive option for the school district.

POLYCARBONATE IS SPECIFIED AFTER WEATHER EVENTS

It is often in the eventuality of damage to acrylic skylights that property owners select polycarbonate. Says Huffman, “When there’s a tornado, hailstorm or hurricane, or if a school gets broken into through the skylight, people say, ‘How can we get a skylight that won’t break next time?’ That’s when polycarbonate gets really popular, after a tragedy.”

WEATHER-RELATED EVENTS GROWING MORE DANGEROUS

Within the United States today, polycarbonate skylights are prevalent in coastal areas, such as Florida, where the material’s durability protects buildings from flying hurricane debris.

Kerry Emanuel, MIT hurricane expert, has calculated that Atlantic hurricanes have become 60% more powerful in the

last 10 years. The maximum wind speeds of these storms have increased by 25%. Hurricanes Sandy, Jeanne, Charlie and Katrina measured wind speeds as high as 200 mph.

As storms increase in intensity, so will the damage that they create. The World Meteorological Organization (WMO) has found that the extent of areas affected by extreme weather events has grown and will continue to do so over the next 10 years. Forecasting increased strength of tropical cyclones over the next decade, The National Oceanic and Atmospheric Organization (NOAA) reports many US coastal areas are particularly vulnerable.

MIAMI-DADE AND CODING FOR STORM SAFETY

“If the project is in a coastal area, I always recommend polycarbonate,” says Huffman.

In some coastal counties, such as Miami-Dade in Florida, the required performance levels mandate polycarbonate for plastic glazed skylights. Florida’s mandates are now being

considered by other states, including North and South Carolina, Massachusetts, New York and regions in the Atlantic and Gulf Coast.

ACRYLIC HAS A LIMITED LIFESPAN

Based on many industry tests, acrylic is incapable of meeting storm-performance requirements such as those prescribed by Miami-Dade. Acrylic often breaks in hail and missile impact tests. The fragility of acrylic is one reason some manufacturers do not offer warranty against breakage.

MODIFIED ACRYLIC DEGRADES IN THE SUN

So-called impact-modified acrylic (IMA) is mixed with styrene butadiene, a rubber that makes the polymer more pliable. While IMA is often substituted for polycarbonate, test results reviewed by Eneref Institute found polycarbonate surpassed the strength of IMA by as much as 50 times.

“Due to dissimilar testing geometries and impact velocities, some impact tests will rate polycarbonate’s advantage over impact-modified acrylic differently. I’m comfortable saying polycarbonate has 10 times the toughness of impact-modified acrylic,” says Trautman of Covestro. “That’s a conservative estimate.”

IMA also exhibits the same degradation tendencies as the now-outdated “uncapped”

POLYCARBONATE IS ABLE TO WITHSTAND IMPACTS OF OVER 50-70 FT. LBS, WHILE ACRYLIC BREAKS AT 2 FT. LBS.

polycarbonate material, since the styrene butadiene used to give acrylic its strength suffers UV damage as well.

CASE STUDY: Paul Simony, Vice President of Sales and Marketing for SkyCo, a Californian skylight distributor, said impact strength is a “major concern” for his customers. “Acrylic is the weakest component out there as far as skylights are concerned. All skylights we situate in industrial warehouses or distribution centers are polycarbonate. To us, safe daylighting means polycarbonate.”

NEW POLYCARBONATE COULD OUTLAST ROOF

It is typical to replace skylights with roof retrofits. While no skylights last forever, a 15-20 year potential lifespan for UV-capped polycarbonate skylights means they could be replaced during the next roof retrofit.

“The extra time in the life cycle of polycarbonate which the UV cap affords ties it perfectly with the lifespan of even long-lasting roofs,” says Huffman.

“And some roofs, depending on where they are, might only get 10 to 15 years of life,” meaning the polycarbonate could actually outlive the structure.

CURB MOUNTING SKYLIGHTS ASSURE EASY RETROFIT

Even if not coincident with roof replacement, curb-mounted skylights significantly reduce retrofit costs.

A curb mount is a protective frame attached to the roof and sealed around the skylight, lifting it off the roof surface for greater visible light transmittance and preventing leakage through seamless flashing. Skylights are easily removable from the mount and can be quickly replaced. This feature equates to significantly reduced labor costs.

BEYOND CODE MINIMUMS

Due to the increase in the force of storms currently impacting the coastal areas of the United States, it is prudent to exceed rather than simply meet code minimums.

CASE STUDY: American Skylights Company, based in Arlington, Texas, specifies skylights according to TDI standards. The company often recommends polycarbonate across the region, both to resist the high wind and hail of the Texas climate and to avoid breakage leading to fall on public structures.

Polycarbonate components exceed standard safety codes for rooftop skylights as prescribed by OSHA and the Texas Department of Insurance (TDI).

Factory Mutual (FM) approves skylights according to test Standard 4431 (based on ASTM E108, Fire Tests of Roof Coverings) and test Standard 4473 (Hail Impact Resistance Testing).

According to ASTM D-635, acrylic is more flammable than polycarbonate with a burn rate of 2.5 inches per minute, whereas polycarbonate burns at 1 inch or less. Further, acrylic is combustible at 850°F and should be treated as a combustible material. The ignition temperature of polycarbonate, with a UV cap layer, is 1070°F. It is also self-extinguishing when the flame source is removed.

TDI is an independent authority that accredits the strength of polymers by firing a 2x4 from an air cannon into multiple impact points. They offer classifications for measuring skylight impact safety.

Only polycarbonate passes all test classes. Acrylic often fails the lowest level (Class 1). The highest level (Class 4) is known as the “hurricane test” or “large missile test.”

CONCLUSION

Polycarbonate’s unique combination of durability and weather resistance make it a safer, longer-lasting and cost-effective choice for commercial skylights.



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