Online exclusive

Avoiding Pitfalls with Large Skylight Design and Maintenance

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This paper was presented at the 2024 IIBEC International Convention and Trade Show.

INTRODUCTION

Modern skylights are complex building envelope elements that allow natural light to enter buildings, while providing environmental separation for water, air, and heat. Beyond these basic functions, skylights offer the potential for architects and designers to blend interior and exterior spaces, transform atriums, and bring natural light into the core of large buildings. The impact large skylights have on the way a building feels and functions can be significant. However, the design of these complex systems can have costly and disruptive effects to building operations teams if they are not designed with maintenance in mind.

Skylights consist of three basic components, including the structure or frame, the glazing material, and the sealants. Skylight frames are designed to support and retain the glass, and in drained systems they are also designed to collect rainwater and drain it to the exterior. In cold climates the glazing materials almost always consist of sealed insulated glazing units, which eventually fail and require replacement. Skylight sealants also fail over time, and depending on the skylight design, they can sometimes require diligent maintenance to remain watertight. In order for skylights to function properly, they require maintenance, and good skylight design considers not only their aesthetics, but also their durability and maintenance requirements.

LARGE SKYLIGHT DESIGN

Large skylight systems can typically follow one of a few common industry principles to remain functional and exclude water. Common skylight types include:

- Face-sealed skylights, which have one layer of sealant to prevent water entry. These systems are often designed for easy access to maintain exterior seals.
- Simple framed drained rainscreen skylights, which follow a dual barrier approach, but often rely on sealants at hidden joints without raised/shingled/continuous drainage channels. These systems utilize framing often found in commercial curtain wall systems, with little if any design changes to accommodate the increased rain loads that skylights experience.
- Modern drained skylights with raised/shingled/continuous drainage channels, which follow an improved dual barrier approach and incorporate frame detailing to reduce reliance on sealants. These systems typically feature dual-barrier frame connections that are shingled and raised where one drainage channel connects to another.

Face-sealed skylight systems reduce complexity by relying on one seal at the outer face of the glass-to-glass surface. These joints do not offer redundancy, but they can be easier to diagnose and repair when water leaks occur. Because there is only one seal, the leak location can be traced at the interior, and the area requiring repair can be quickly diagnosed. These systems are often designed to support maintenance personnel loads, to permit sealant repairs to be readily undertaken.

Simple framed drained skylight systems utilize extrusions that have not been significantly modified or adapted from vertical glazing applications for use as skylights. The reason for their use is often related to manufacturing cost, as one simple extrusion profile can be used for rafters (verticals) and purlins (horizontals), but they do not include raised and overlapped drainage channels. The joints of these systems rely on difficult-to-access sealant, which requires maintenance to remain watertight and reduce leakage over time. Despite these limitations,

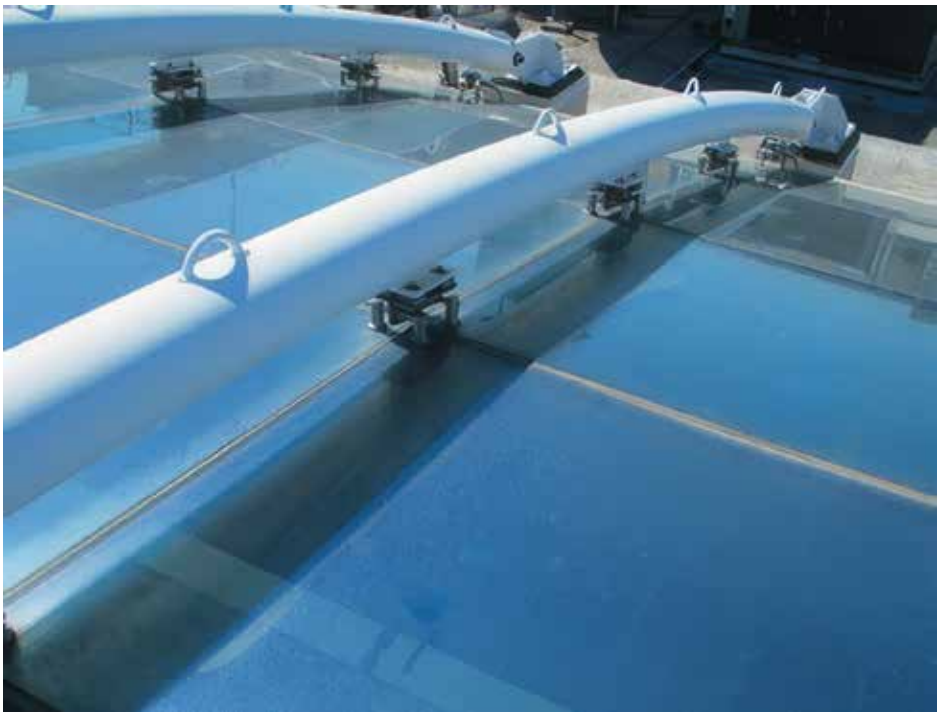

Figure 1. *Face-sealed skylight.*

Figure 2. *Simple framed skylight with curtain wall framing.*

simple drained skylights are not uncommon due to their low cost.

Modern drained skylight systems can be designed to include raised and overlapped drainage channels, where each layer shingles over the next and is raised out of the drainage pathway below, providing a pathway for water to drain in the system, with minimal reliance on sealants. These framing systems are more expensive than adapted curtain wall frames, as different extrusions are used for rafters, purlins, and others, but they can significantly improve long-term performance and reduce the frequency of leaks. In certain design situations, variations of these skylights have been used in bent profiles to eliminate joints in rafters altogether, such as the bent-rafter skylight design.

Detailing of skylight glass retention can also impact the risk of water entry. Low-profile caps are common at skylight purlins to reduce the volume of water that can be trapped above each mullion as they impede drainage over the exterior skylight surface. Modern two-sided structural silicone skylight systems take this approach one step further, by eliminating the caps altogether. By eliminating the caps, structural silicone systems allow water to easily drain from one glazing unit to the next, without presenting a risk or water retention or entry at leading-edge gasket seals.

SKYLIGHT DESIGN FOR MAINTENANCE

Regardless of the skylight design implemented, all skylights will require some form of intermittent maintenance such as cleaning, sealant repairs, and sometimes localized glass replacement. Undertaking these procedures is often complicated by the fact that skylights are often in elevated, hard-to-reach places, and may present fall hazards to maintenance personnel. For that reason, the first step in designing skylights for maintenance should be to maximize the durability of the skylight system, to reduce its maintenance needs.

Minor cleaning and sealant repairs are often undertaken using poles, with no access to the skylight required. High-slope skylights can often be cleaned via bosun chairs or boom lifts. Use of bosun chairs or platforms that transfer load to skylights should always be reviewed by a qualified engineer to confirm that the skylight surface is designed to support anticipated loading. Regardless of the cleaning method, all personnel accessing the areas around skylights should be made aware of whether the skylight presents a fall hazard or can be used as a working platform.

Large skylight sealant replacement and leak repairs often require access to portions of skylight systems glazing, which can be difficult to reach. During this work, tradespersons need to reach portions of the framing that cannot easily be accomplished from adjacent roof areas, and they often require the use of an engineered scaffold, crane, or boom lift. The difficulty in working and accessing sealants for replacement is a good reason for designers to ensure that reliance on hidden sealants is minimized. Replacement of hidden sealants frequently requires removal of glass, as the joint sealants requiring repair are at the back of the skylight framing sections.

Glass replacement typically requires both a crane to lift the glass and a safe working

Figure 3. *Skylight with overlapped raised drainage channels.*

Figure 4. *Leak repairs from bosun chair.*

platform for the contractor. Often the systems designed for personnel support are inadequate to support skylight glass on their own. In order to reduce the frequency of glass replacement, designers should consider the durability of the components in use by considering the following:

- Minimize water potential for reaching and sitting against edge seals or laminate interlayers. When detailing framing, ensure that there is adequate clearance for water to drain around the glass, drainage tracks are not filled with sealant, and glass setting—blocks do not restrict drainage.
- Utilize durable edge-seal construction for insulated glass units. Skylight glazing unit edge seals undergo greater heat and loading stress than window glazing units due to their orientation and should be sufficient for their intended use case.
- When specifying tempered glass ensure units are heat-soak tested. Specify materials and use manufacturers with a proven history of quality control and consider undertaking plant visits to confirm manufacturers are following fabrication standards.

SKYLIGHT ACCESS METHODS

Skylight access methods will depend on the work being completed, the skylight design, and local health and safety requirements of authorities having jurisdiction. When access to a skylight system is required, the method of access will depend on the skylight configuration, capacity, and type of work required. Common access methods will include one of the following: a permanent engineered moveable platform (such as a gantry system), temporary working platforms (such as scaffolding), or glass design for maintenance loads. In some situations, cranes can also be used for skylight access or to support skylight materials.

Gantry systems are engineered moving scaffolding systems, which can be used to allow regular access for skylight cleaning, maintenance, or inspections. These systems are typically designed by specialist structural engineers and should be incorporated from the outset of the skylight design. The high initial cost of gantry systems is often justified based on the high cost of repeated temporary scaffolding, or in situations where structural support conditions are too complex for temporary scaffolding to be installed. These systems are typically not sufficient or designed to support loads of glass replacement, and separate scaffolding or craning is often required in those situations.

Temporary scaffolding work platforms are expensive if used on a repetitive basis, and although they can often be designed to suit the specific repair, they are time-consuming and have limitations in their configuration. Scaffolding systems can be designed to support glass and personnel loads and may be designed so the use of a separate crane is not required during glass replacement. As a result, temporary scaffolding is a very common method of access used for glass replacement work.

The cost of installing temporary scaffolding work platforms or a permanent moveable gantry system can be a considerable expense when considered on a per-use basis, which we have observed exceeding $40,000 CAD for a single glazing unit. In order to reduce access costs, it is becoming more common for modern skylight glass to be designed to support maintenance

loads directly. Although the design of glass as a work platform requires complex structural glass analysis, the cost premium can be more than offset by maintenance savings. By designing glass for maintenance loads, the expense of separate access systems or temporary scaffolding access can sometimes be eliminated, saving money and reducing the financial burden of skylight maintenance.

New glass designed as a working platform is typically designed to support a single worker per glass unit and not the load of replacement glass, which is typically supported by a crane. One additional benefit of this approach is that it also reduces the risk to unknowledgeable trades that may be working near skylights—whether it be sitting on, falling, or tripping onto the skylight, there is a reduced risk to other workers.

Glass designed for maintenance loads can vary in its design applications, but it is commonly used in face sealed structural glass systems where regular access is anticipated. It has been our experience that many older skylight designs have the potential to be retrofitted to accommodate personnel loads, by analyzing and upgrading glazing components with modern high-performance laminates that are compatible with fully tempered glass. In northern climates where snow loads are significant the base skylight structures are often adequate to support personnel loads, and it is often the glass that is the limiting factor in supporting maintenance loads. Structural glass analysis and design can confirm whether this is a practical solution, and the limitations of this approach should be confirmed with a qualified engineer.

CONCLUSION

In summary, there are many solutions available for the durable design, maintenance, and access of large skylight systems. Commercially available skylight systems vary significantly in their performance, cost, and longevity, and it is important for the correct skylight system to be chosen for each application. Although the industry has developed retrofit and temporary solutions to undertake skylight maintenance, the most cost-effective approach is to consider skylight durability and maintenance from the start.

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