the construction specifier

10 Key Questions about Exterior Shading

by Richard Wilson, B.Sc.

OVER THE LAST DECADE, EXTERIOR SHADING HAS BECOME MORE POPULAR IN THE U.S. CONSTRUCTION MARKET. HOWEVER, A NUMBER OF ARCHITECTS AND BUILDING OWNERS STILL HAVE LIMITED KNOWLEDGE ABOUT THESE SYSTEMS AND WHY THEY SHOULD BE CONSIDERED PART OF THE BUILDING DESIGN.

This article explores 10 frequently asked questions about exterior shading, while providing insight into available systems and how they can be an important part of the building's environmental control.

1. What types of exterior shading systems are available?

A wide range of exterior shading systems are available, but they can be broken down into three broad categories of systems:

- fixed louver;
- adjustable louver; and
- retractable.

Fixed louver systems include projecting sunshades generally installed at the head of the glazing (*i.e.* brise-soleil systems), as well as fixed vertical or horizontal louvers installed in front of the glazing. These systems are designed to remain in place at all times and need to be able

This project features an exterior venetian blind assembly.

Photo courtesy Draper Inc.

to withstand all weather, including wind, ice, and snow. The shading performance varies depending on the system's projection and the louver profile selected, as well as the angle of the louvers and the spacing between them. These items need to be evaluated during the design process to ensure the system provides sufficient shading during periods when solar gain is an issue.

Brise-soleil systems only address high sun angles and, as a result, they generally will only be effective on south or near south-facing elevations. They also only provide shading during the summer. During the winter months, the low sun angles mean these systems provide little or no shading.

The effectiveness of fixed horizontal or vertical louvers depends on louver size, angle, and spacing. These systems normally only shade higher sun angles in order to allow views to the exterior, and are most effective on south-facing elevations. They can be installed on east and west elevations, but will normally not protect occupants from the low sun in the early morning or late afternoon.

Vertical and horizontal adjustable louver systems can be motorized, allowing louver angles to be adjusted to give more responsive shading, particularly if they are connected to an automated control system. The systems do not retract—they will always remain in front of the glazing—but can be moved between the fully open and closed positions.

The method of control can range from switch operation, where occupants operate the system according to their needs, to a fully automated system that responds to the sun conditions and adjusts the louver angle to prevent any direct sun penetration. The systems are generally controlled independently of the interior lighting systems; ideally, levels are automatically adjusted to supplement natural daylight where required. Since the systems only operate from time-to-time, and only for a few seconds to adjust the louver angle, energy usage is not significant, particularly compared with the savings that can be achieved through a reduction in HVAC requirements.

Retractable systems are exterior versions of interior shading systems, notably roller shades and venetian blinds. These systems can be deployed and retracted, and can be responsive to the sun conditions. This is particularly the case with exterior venetian blinds, where the slat angle can be adjusted to give effective solar control. All these systems are engineered for exterior use. Unlike fixed systems, however, they retract when the wind speed is too high. They also need to be protected from ice by retracting into a head box or a pocket that forms part of the façade construction. When inside the head box/pocket, the risk of the system getting wet and the slat pack freezing as temperatures fall is effectively eliminated.

2. Why is an exterior system more effective than an interior one?

In broad terms, an exterior system is better than an interior one because it prevents a large part of the sun's energy from reaching the glazing and entering the building. If the solar energy does not get into the building, it does not have to be dealt with.

Energy from the sun is short-wave and carries little heat. Heat is only produced when the solar energy is absorbed by a surface (*e.g.* carpeting, furniture, clothing, or skin) and is then radiated as long-wave infrared (IR) energy.

An interior shading system can:

- allow solar energy to pass through;
- absorb solar energy; and
- reflect solar energy back through the glazing.

The reflected solar energy is not an issue—it remains short-wave and does not cause any heat gain. The transmitted energy is absorbed by surfaces in the building and is radiated as heat. The energy absorbed by the

shading system is then radiated as heat and most of this heat is then trapped inside the building, particularly if low-emissivity (low-e) glazing is used.

An exterior system is similar to an interior one with regards to the transmittance, absorption, and reflection of solar energy. Anything absorbed by the shading system, however, is radiated as heat on the building's exterior. Since glass is not transparent to long-wave energy, little of this radiated heat gets inside the building. Accordingly, an exterior system eliminates one of the two sources of heat gain, resulting in much greater reduction in solar gain inside the building.

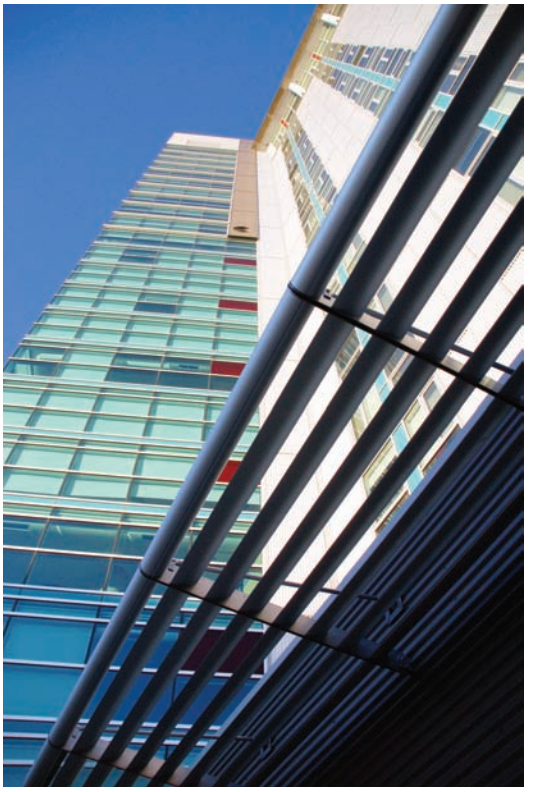
Performance data is readily available for shading fabric. Consider a popular fabric in a grey-white color and a particular type of glazing (*e.g.* low-e, argon filled, double-glazed unit), the 'g' value is 0.13 when the fabric is installed on the exterior, but increases to 0.43 when installed on the interior. The 'g' value is the sum of the direct and secondary solar transmittance into the building. The secondary transmittance comprises the amount of solar radiation absorbed by the combination of glazing and shading system which is then convected or radiated into the building. In North America, the 'g' value is also known as the solar heat gain coefficient (SHGC).

Even with a white fabric, which has the highest level of reflectance, the comparison is 0.16 for an exterior installation compared with 0.36 for an interior one.

The message is therefore straightforward—for the most effective solar control, the shading system should, wherever possible, be installed on the exterior. There will be some situations where this is not practical—for example, high-rise buildings with 25 floors or more. In these cases, the use of a shading system inside a ventilated double façade is a potential approach, although shading is just one of many influencing factors when pursuing this type of façade construction.

3. What are the main benefits of an exterior shading system?

The primary benefit of an exterior shading system is a reduction in HVAC requirements. As discussed earlier in this article, exterior shading blocks a large part of the solar gain before it comes through the glazing and into the building. If there is less solar gain, then the size of the HVAC system can be reduced. This results in a saving in the initial capital cost—which can wholly or partly offset the shading system's cost—as well as the ongoing running costs. The most effective shading systems, such as exterior venetian blinds, can block more than 90 percent of solar gain, having notable impact on reducing the HVAC requirements.



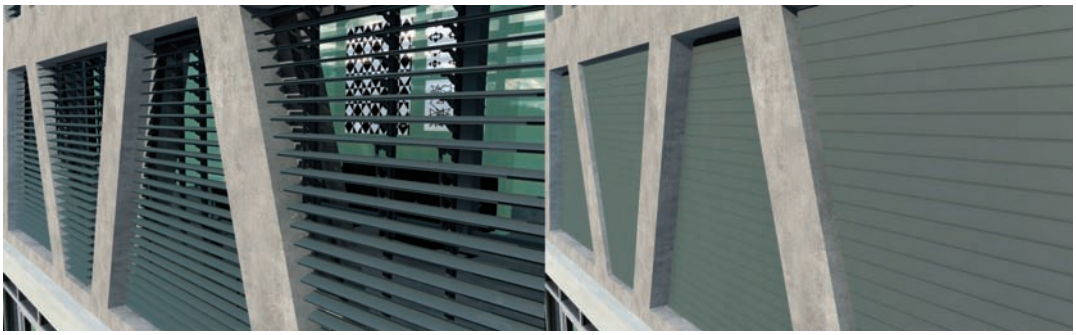
This brise-soleil system was installed at the Southern Alberta Institute of Technology (SAIT) in Calgary, Alberta.

Photo © Ralph Wilson. Photo courtesy Draper Inc.

Some buildings, however, need to be cooled in the summer, while also have heating requirements in the winter. If a retractable exterior shading system is used, it can be turned off in the winter months, allowing the solar gain into the building and providing an element of free heating. During those months, glare and light control issues would be addressed with an interior shading system such as a roller shade.

Another benefit is natural daylighting. Exterior shade systems can help optimize the use of diffuse daylight to illuminate interiors, reducing the need for artificial lighting. More than 30 percent of the energy costs of an office building relate to artificial lighting, so if the lighting needs can be reduced, significant savings can result.

A well-designed shading system also contributes to comfortable working conditions which can lead to increased productivity. A good shading system manages both heat and glare while providing access to outside views. Finally, using exterior shading systems can significantly contribute to a building's



These louvers were designed for custom window shapes.
Images courtesy Draper Inc.

appearance; it can become a design feature as well as one bolstering efficient building performance.

4. Can exterior shading systems be used on both new and existing buildings?

It is always easier to apply exterior shading systems to a new building, as integration issues can be reviewed and connection details developed during the design phase. Fixed exterior louver systems can exert significant loads on the façade, and if they are being attached to the curtain wall, mullions might need to be reinforced to support them. Even with lighter, retractable systems, such as venetian blinds, it is helpful to be able to discuss attachments with the curtain wall contractor during the design phase so brackets can be specified to avoid problems such as cold bridging.

However, it is possible to apply external shading to existing buildings. While the original building design would not have anticipated exterior shading, structural elements can be incorporated as required, to allow installation onto the existing façade. The structure, rather than the façade, would then accommodate applied loads (*i.e.* wind, ice, snow) as well as the weight of the system itself.

If an operable system is going to be used with an existing building, it will be necessary to look at the electrical requirements and determine how conduit and electrical cabling can penetrate through the façade to allow connections to be made to the blinds or shades.

5. What are the most common methods of attachment to the building façade (and what issues need to be considered)?

For new and existing buildings, installation of an exterior shading system might involve attaching directly to the curtain wall mullions, to brick or concrete masonry units (CMUs), or through cladding to steel structure. It is probable different brackets will be required for each situation, and these will often be developed to meet the specific project requirements.

Exterior roller shades and venetian blinds are generally installed just above or at the top of the glazing. They are relatively lightweight and, because they are retracted when the wind speed exceeds a defined level, they do not apply significant loads to the façade. This means lighter aluminum brackets can normally be used to connect the head box to the façade. Pre-tensioned side guide wires are also generally used to prevent movement of the shading system under wind load (the other option is extruded side guides) and each of these will be tensioned to approximately 22.7 kgf (50 lbf).

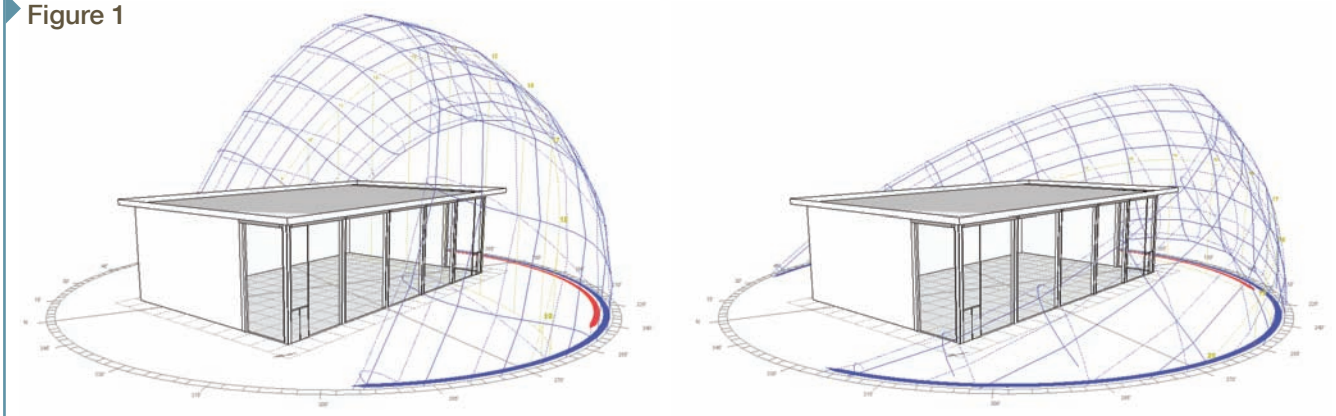
Since exterior louver and brise-soleil systems remain fixed in place in all weather conditions, they apply more significant loads to the façade. The brackets for the system will therefore be designed in accordance with the loads defined in local building codes, and bolts or other fasteners will also be selected based on the maximum loads. If the systems are being connected to the curtain wall, it is possible the mullions will need to be reinforced with steel. This is particularly the case with brise-soleil systems, which project some distance from the façade and, as a result, generate significant turning moments and shear forces at the connection points. With these types of systems, structural calculations will always be undertaken to determine the applied loads and the impact on the façade design and building connections.

Other issues that need to be considered include separation of dissimilar metals, cold bridging, and water penetration, as well as relative expansion and contraction between the shading system and the façade. Because of these issues, it is strongly recommended the shading requirements are reviewed and discussed during the early stages of the design process.

6. Will the building's location and the glazing's orientation influence the choice of exterior shading system?

There are many factors influencing the choice of

Figure 1



The movement of the sun during the year differs significantly based on location. Shown above are two extremes in the United States—Miami, Florida (left), and Anchorage, Alaska (right).

an exterior shading system. Two significant ones are building location and glazing orientation.

As seen in Figure 1, the sun's movement during the year (shown by the blue lines) is significantly different between two extremes in the United States—Miami, Florida, and Anchorage, Alaska.

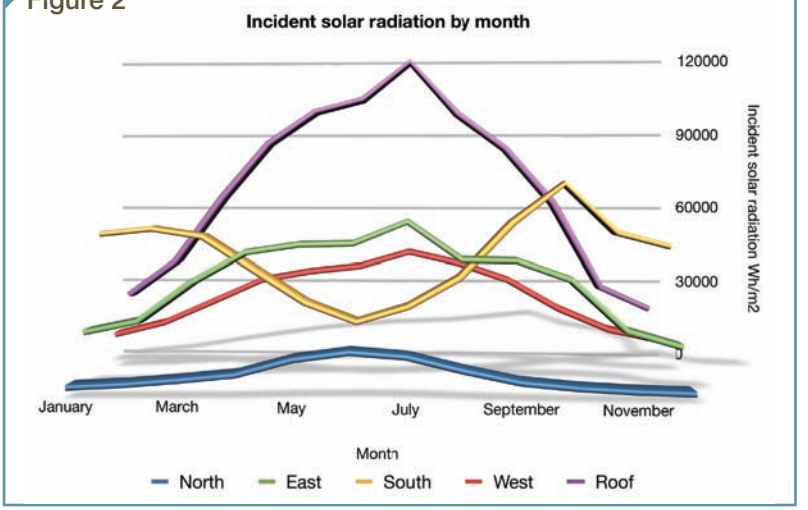
In Miami, the sun angle is about 86 degrees, and almost vertical in the sky, at 12:00 p.m. on June 21. In Anchorage, the sun has a peak altitude angle of approximately 51 degrees, which is not much greater than the highest winter sun angle in Miami of 41 degrees. The sun also sets much further to the south in Anchorage during the winter compared to Miami.

Given the differences in sun movement, the optimal shading strategies will be different. In Miami, fixed projections will be effective; while in Anchorage, retractable and adjustable systems offer much more flexibility in controlling solar gain.

The glazing's orientation will also have a significant impact on system choice. The graph in Figure 2 shows the incidental solar radiation on different orientations of glazing for a building in Indianapolis, Indiana. As expected, the solar radiation on the north elevation is the lowest as there is no direct sun. However, the background radiation is still reasonably significant, particularly in the summer.

The solar radiation on the east and west elevations is similar, with the maximum values occurring in the summer. Interestingly, the maximum solar radiation on the south elevation occurs during the colder months. In the middle of the summer, the high sun angles mean the incident radiation falls. The maximum exposure to solar radiation, however, occurs at the roof. Therefore, any skylights will potentially cause significant solar issues.

Figure 2



The orientation of the glazing has a significant impact on what solution works best. Shown above is the impact of orientation on incident solar radiation for a building in Indianapolis, Indiana.

Given the variations by façade, fixed systems might work on the south elevation, but operable ones will be better east and west. Although vertical louvers might work on the east and west elevations, horizontal ones are generally better for controlling the solar gain and allowing views to the exterior.

7. How do exterior shading systems cope with adverse weather conditions?

As previously highlighted, fixed louver systems are designed to take account of the maximum applied loads. With brise-soleil systems, the loads at the attachment points might be significant, particularly if projections are substantial. If this is the case, diagonal brace rods might be incorporated into the design to allow the load to be shared between two attachment points. With fixed systems, ice buildup and the risk of falling ice must also be considered. Therefore, the brise-soleil assemblies might be

This installation in Holland features solid-screen, 'zip' system installation.

Photo © AVZ. Photo courtesy Draper Inc.

inappropriate for tall buildings in urban areas.

Retractable systems such as exterior roller shades and venetian blinds are more lightweight than fixed systems and are designed to retract when the wind speeds are high. Standard roller shades need to be retracted at relatively low wind speeds (up to a maximum of about 32 km/h [20 mph]) and will not be appropriate for windy locations or on tall buildings. There is, however, a generic version known as a 'zip system,' which allows the fabric to be locked into side tracks. This type can operate in wind speeds of up to 144 km/h (90 mph) and is suitable for tall buildings.

Ice is also a potential issue, but should not be a problem if the systems are protected in the raised position. Automated controls will ensure the systems are only deployed when there is sun. Temperature and humidity sensors can also be used to stop the blinds or shades from being operated when there is a risk of icing. In locations with a cold winter climate, buildings generally require heating in the winter months. It may be appropriate to leave the exterior shading systems in the retracted position during these periods and allow the solar gain into the building as a free source of heating.

8. What maintenance is required?

Most exterior shading systems require little or no maintenance. Fixed louver systems need to be cleaned periodically to maintain the warranty on the paint finish, but no other maintenance work is required.

Adjustable and retractable systems also require little or no maintenance. Nevertheless, it is recommended they be inspected on a periodic basis to check the systems are correctly operating, guide cables (where used) are adequately tensioned, and there is no evidence of damage or general wear and tear to components.

9. How can exterior shading contribute toward achieving LEED certification?

There are numerous areas where the use of exterior shading system can help achieve credits for Leadership in Energy and Environmental Design (LEED) certification. These include:

- minimum energy performance: use of exterior shading systems can assist in achieving a five percent reduction in building performance compared with the baseline building (in many cases, the reduction achieved is substantially more);
- optimize building performance: using exterior shading systems can help in achieving reductions beyond the minimum requirement;
- thermal comfort: exterior shading systems can potentially assist in achieving the requirements of American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) 55-2010, *Thermal Comfort for Human Occupancy*; and
- daylight: to achieve this credit it is necessary to provide manual or automatic (with manual override) glare-control devices for all regularly occupied spaces (exterior shading systems—possibly in combination with interior ones—allow this to be achieved).

10. Do exterior shading systems make sense in terms of costs and benefits?

To justify using exterior shading systems, it needs to be demonstrated it makes economic sense to do so. Determining the cost of an exterior shading system is a straightforward exercise, but measuring the benefits can be more difficult. It is therefore important the shading system be considered in the context of the building as a whole, rather than as an isolated system, as it can impact several areas of building performance—notably lighting and the HVAC system.

In the past, it has often been the case the shading system's performance was not taken into account when sizing the HVAC system. In this case, it is difficult to justify the use of exterior shading since the potential cost savings from reducing the size of the HVAC system will not be achieved. However, the mechanical consultants who deal with the heating and ventilation systems are now much more aware of the impact of effective shading, and are generally able to take this into account in their calculations.

This building in Erbendorf, Germany features an exterior venetian blind system.

Photo © Faltenbacher. Photo courtesy Draper Inc.

Conclusion

The traditional approach to windows has been to use interior shading systems to control light and glare, and to address solar heat gain through the HVAC system. Increases in the energy costs, requirements for improved façade performance, and greater environmental awareness are leading architects to look for alternative solutions.

Exterior shading systems will not be appropriate for all buildings; where they are used, however, they can make a significant contribution to the building's performance as well as the building aesthetic. There is no question more architects are considering exterior shading, and, as understanding grows, exterior shading systems will become an important element in the design of high-performance buildings. **CS**

INFORMATION

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Richard Wilson, B.Sc., is a consultant to Draper Inc., and has been working with the company to introduce a range of exterior and specialty shading systems. He has been involved in the solar shading industry for more than 20 years. Wilson can be contacted by e-mail at rwilson@draperinc.com.

Abstract

Over the last decade, exterior shading has become more popular in the United States. However, many architects and building owners still have limited knowledge about these systems and why they should be considered part of the building design. This article explores 10 frequently asked questions about exterior shading, while providing insight into available systems and how they can be an important part of the building's environmental control.

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