

EXTERIOR VENETIAN BLINDS: THE MOST EFFECTIVE WAY OF PROVIDING SOLAR CONTROL?



Exterior Venetian Blinds provide the most effective available solar control solution.



Venetian Blinds can be opened to allow in natural light, or closed for maximum heat and light reduction.

- It is generally acknowledged that the best way to provide solar control is to use an exterior shading system.

When considering solar control, most people think of reducing heat gain. There is no question that this is a significant part of what an effective exterior shading system should achieve. Energy from the sun, however, also includes the visible spectrum, so the control of natural daylight is also very important. An effective solar control system is therefore one that appropriately deals with heat gain, while allowing as much natural daylight into the building as possible in a way that doesn't cause glare issues for the building occupants.

By controlling heat gain, reductions in the size and running costs of the HVAC system can be achieved. Making good use of natural daylight also allows artificial lighting requirements to be reduced, resulting in further cost savings over the life of the building. Effective solar control through exterior shading is therefore an approach that should be actively considered as part of the design process.

Controlling heat gain doesn't necessarily mean preventing it from getting into the building throughout the year. During the summer months, there is no question that the key aim will be to minimize heat gain. As a result, the shading system will need to prevent direct sun from passing through

the glazing and into the building. Depending on the building location and the building design, it might also be appropriate to minimize heat during the winter months. In buildings that require heating during the winter, however, it may be better to allow solar energy into the building as it's a free source of heating. It will still be necessary to include an interior shading system to control natural daylight and prevent glare, which can be a particular problem with low winter sun angles.

A high-performing shading system should be capable of addressing a number of key requirements:

1. **Effective shading:** Provide complete shading when there is sun on the façade.
2. **Adjustability:** Be capable of dealing with the varying sun angles over the course of the day and the year.
3. **Light control:** Allow as much controllable light into the building as possible.
4. **Flexibility:** Allow heat gain into the building during the winter months, if required.

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System

Effective Shading

Adjustability

Light Control

Flexibility



Brise Soleil

Projection of the system and the spacing of the louvers can be designed to provide effective shading during the summer months.

System offers no adjustability.

System is designed to shade high sun angles but is not adjustable and, accordingly, doesn't provide any real light control.

Projection can be adjusted to provide shading during summer while allowing sun penetration during the winter months.



Horizontal Louvers

Size of the louvers, the spacing between them and the angle at which they are set can be adjusted to achieve optimum shading.

Fixed: no adjustment possible. Operable: louver angle can be changed as required to address the sun position.

Fixed systems don't really provide light control. Operable systems are much more effective.

In winter, it may be possible to adjust the louver angle to allow sun penetration. Systems can't be retracted, however, when there is no sun on the facade.



Vertical Louvers

Size of the louvers, the spacing between them and the angle at which they are set can be adjusted to achieve optimum shading.

Fixed: no adjustment possible. Operable: louver angle can be changed as required to address the sun position.

Fixed systems don't really provide light control. Operable systems are much more effective.

In winter, it may be possible to adjust the louver angle to allow sun penetration. Systems can't be retracted, however, when there is no sun on the facade.



Exterior Roller Shade

Ability to deploy and retract the system in response to sun conditions, as well as the range of available fabrics means that the system provides good shading.

Roller shades can be deployed and retracted and set to intermediate positions depending on sun angle.

Range of fabrics in terms of color and openness factor means that effective light and glare control can be achieved.

Systems can be retracted in winter to allow sun penetration into the building, if required. Systems can also be retracted when there is no sun on the facade.



Exterior Venetian Blind

Ability to deploy and retract the system in response to sun conditions, as well as ability to adjust slat angle, means that the system provides very effective shading.

Ability to adjust the angle of the slats between a number of preset positions means that the system can be very responsive to the sun conditions.

Adjustability of the slat angles means that sun control can be achieved while allowing ambient light into the building.

Systems can be retracted in winter to allow sun penetration into the building, if required. Systems can also be retracted when there is no sun on the facade.

Figure 1: Performance of exterior shading systems

A number of different exterior shading devices are available including brise soleil systems, fixed vertical and horizontal louvers and operable systems, such as roller shades. So, which system, amongst all the different options that are available, is the most effective? In Figure 1, the performance of a number of different shading options is assessed by reference to these criteria. As can be seen, operable systems allow the shading to be adjusted to address the changing sun conditions. Exterior roller shades and venetian blinds can also be retracted when there is no sun on the façade or when it would be beneficial to allow solar gain into the building. The additional adjustability of venetian blind slats means that they can provide even more responsive shading than is the case with roller shades.

The relative effectiveness of different exterior shading systems can be easily demonstrated by using software such as Ecotect™. A west facing office in Indianapolis was modelled and the sun exposure of the glazing was analysed by means of a sun exposure graphs. These graphs show the time of the day on the vertical axis and the months of the year on the horizontal one. Areas on the graphs that are blue indicate that there is no sun on the glazing, either because there is no sun on the elevation or because the glazing is fully shaded. Areas that are yellow indicate full sun (i.e. no shading) and the scale on the right-hand side of each graph shows the extent of shading between these two extremes.

Because the model has a west facing elevation, all of the sun exposure is in the afternoon. The sun sets earlier in the winter than in the summer, so the sun exposure is much greater during the summer months. Incorporating a range of exterior shading devices results in significantly different shading performance being achieved as considered below.

Using a **brise soleil system**, Figure 3, only limited shading is achieved. When sun first comes onto the façade, it is high to the south and passes between the first louver and the glazing. Because of the angle of the sun to the glazing, the impact of this is not significant. As the sun starts to move to the west, but is still relatively high in the sky, almost complete shading is achieved. As the sun moves further west and the sun angle reduces, it passes underneath the brise soleil system and the amount of sun on the glazing increases.

Using **horizontal louvers**, Figure 4, the amount of shading achieved increases noticeably. The extent of the shading can be modified (resulting in more or less shading) by changing the size of the louvers, the spacing between them, the angle at which they are set or a combination of all three.

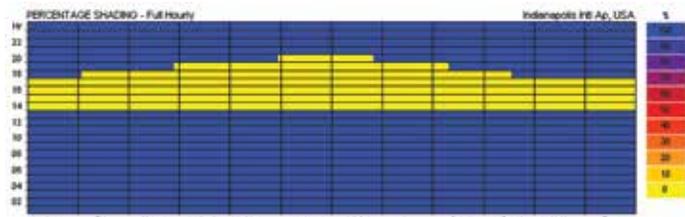


Figure 2: No shading

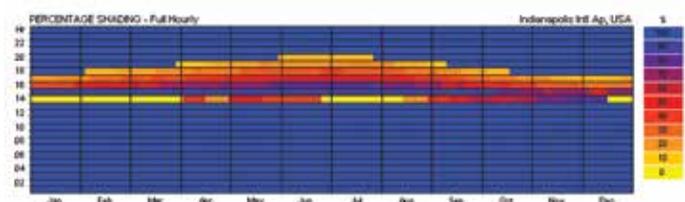
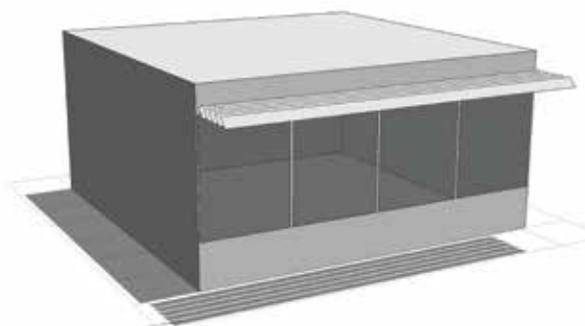


Figure 3: Brise Soleil

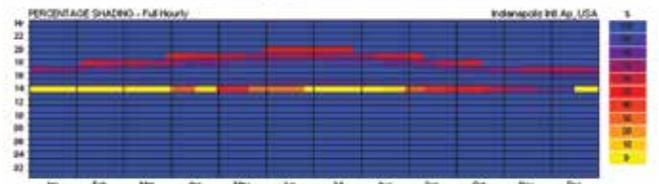
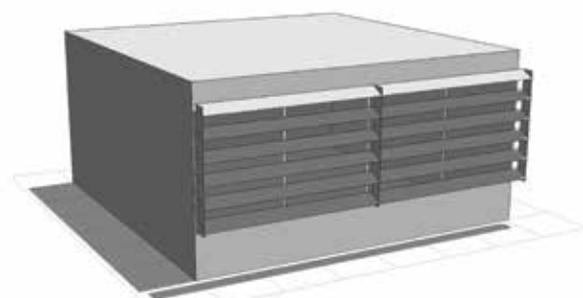


Figure 4: Horizontal Louvers

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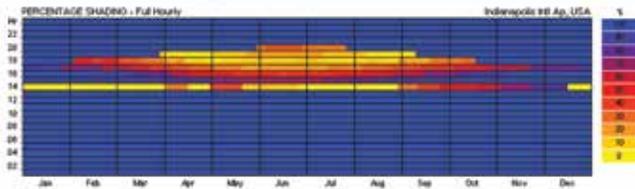
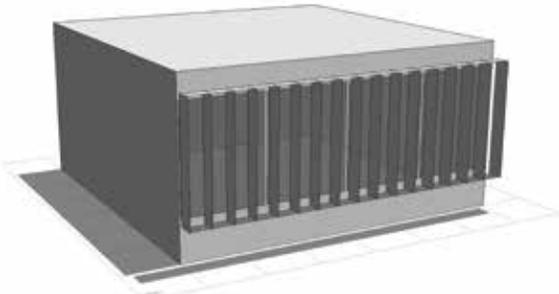


Figure 5: Vertical Louvers

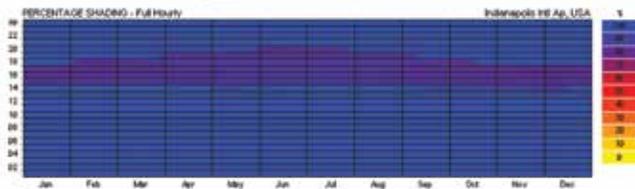
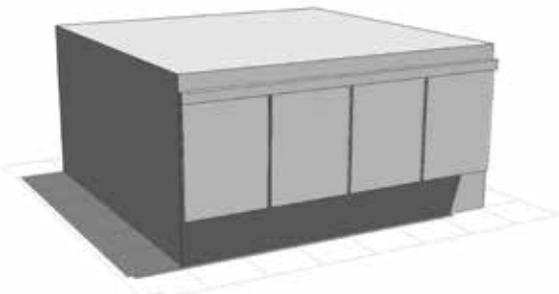


Figure 6: Exterior Roller Shades

General architectural thinking is that **vertical louvers**, Figure 5, should be used on east and west elevations. As can be seen, they are not very effective, particularly during the summer months, whether they are perpendicular to the façade (as analysed) or set at an angle to the glazing. The systems will prevent solar gains from entering the building in the winter (when it might be beneficial to allow them in), but not during the summer when solar control will certainly be required.

The performance of **exterior roller shades**, Figure 6, is primarily dependent on the fabric selected. This will influence the amount of light passing through the fabric, the view through it and the solar performance. The shading achieved will broadly be consistent over the year. Given that there is some thickness to the fabric, shading will be slightly greater at high sun angles than at lower ones.

The graphs in Figure 7, (opposite page), clearly demonstrate the effectiveness of **exterior venetian blinds**. The slats can be tilted from horizontal through approximately 70° to the closed position. When closed there is horizontal cut off, i.e. no sun penetration, even if the sun is on the horizon. If an automated control system is used to operate the blinds, a number of intermediate slat angles can be set up to provide optimal solar control, while allowing ambient light into the building. As can be seen, when the blind is deployed and the slats are horizontal, full shading is achieved for a large part of the afternoon. Later in the day, when the sun is lower in the sky, the slats can be tilted to continue to provide effective shading. During the summer months, they probably don't need to be fully closed during the normal working day as they will provide full shading until 6.00pm or later when still partially open.

Not only do exterior systems provide shade, they also significantly reduce the heat gain in the building. Using the data generated by Ecotect™ to determine the indicative direct solar gains in the building gives the results shown in Figure 8.

The lowest solar gains occur when exterior venetian blinds are used. The analysis is based on the slats being set at a partially closed position. If an automated sun tracking control system was used and the slat position was automatically adjusted to prevent any direct sun penetration, even better performance would be achieved.

The analysis clearly shows that exterior venetian blinds will provide the most effective and responsive solar control, particularly if combined with a sun tracking control system. The systems are specifically designed for exterior use

and can operate effectively for many years with minimum maintenance. Will they be an appropriate choice for a project? In assessing this, a number of items need to be considered.

BUILDING AESTHETICS

Exterior venetian blinds will have an impact on a building's appearance, especially when the blinds are deployed, but also when retracted, however. If side guide extrusions are used the vertical lines of the facade will be accentuated. The facade design might incorporate pockets into which the blinds retract. Alternatively, formed or extruded aluminium head boxes can create a strong horizontal feature.

A range of slat options is available with sizes ranging from 2" to 6" (50 mm to 150 mm). Moving to the larger end of the range means a greater spacing between adjacent slats and greater transparency when the slats are in the open position.

WEATHER CONDITIONS

With all exterior shading systems, it's necessary to consider the prevailing weather conditions and their impact on system performance. Venetian blinds need to be retracted if the wind speed is too high. A control strategy that is sometimes used is to move the slats to the open (horizontal) at a certain wind velocity and then retract them at a second, higher, wind speed. Moving slats to the open position allows the wind to pass through them and for the wind pressure to quickly equalise on both sides of the blind. If this is the case, the blinds will remain stable in windy conditions and will not act as a distraction to building occupants.

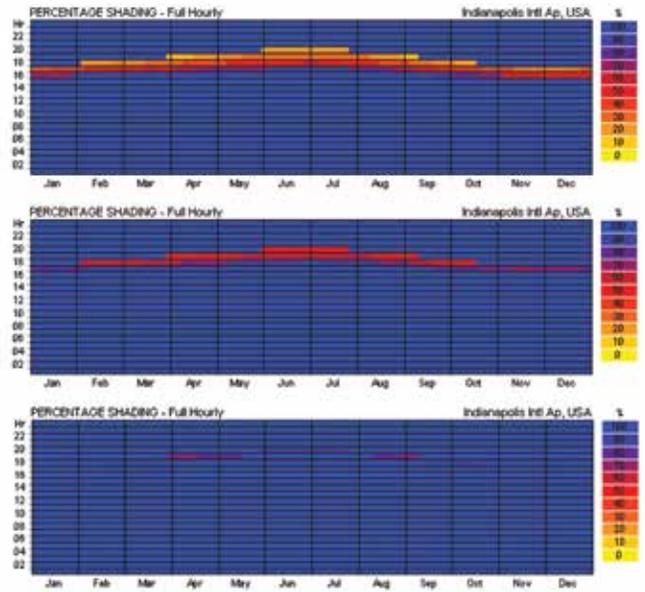
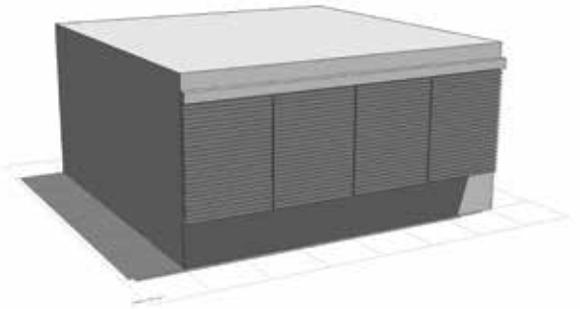


Figure 7: Horizontal Exterior Blinds

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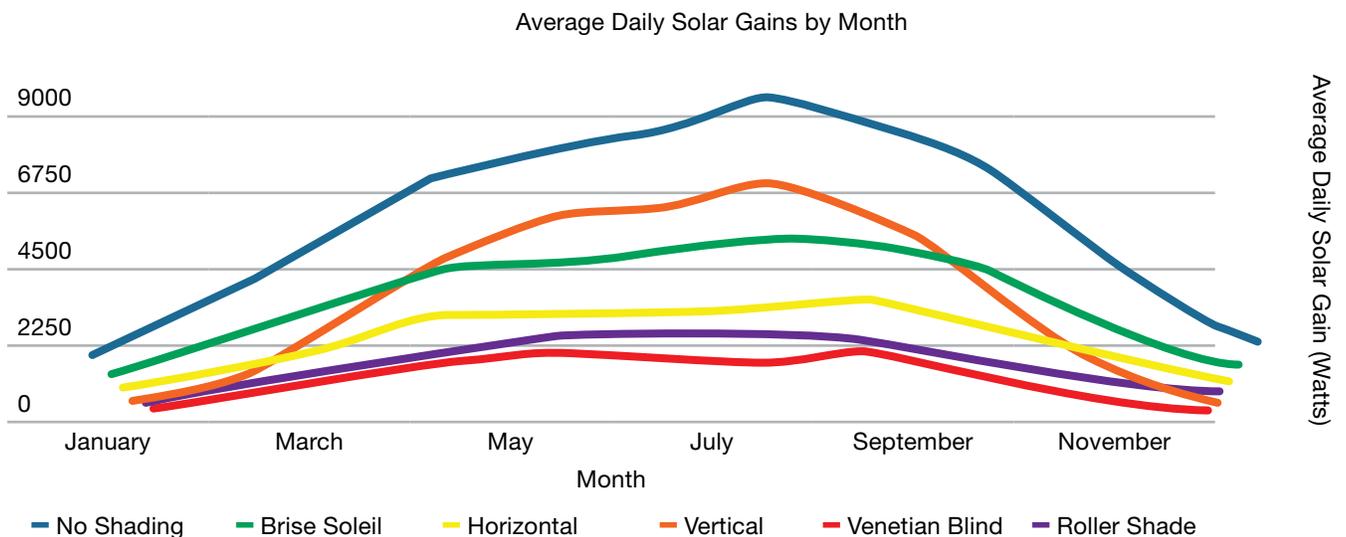


Figure 8: Solar Heat Gain



Visual impact of horizontal blinds.

The maximum acceptable wind speed will be influenced by a number of factors, including:

- a. Local wind conditions. Unusual wind patterns can potentially reduce the maximum wind speeds at which the blinds can be used.
- b. Distance of the blind from the glazing. If the blind is set some distance away from the glazing, it will be more affected by the wind and will need to be retracted at a lower wind speed.

- c. Height of the blind. Taller blinds take longer to retract and are therefore more prone to gusting. As a result, they will need to be retracted at a lower wind speed than would be the case with standard sized systems.

The impact of wind also means that exterior venetian blinds cannot be installed on the upper floors of high rise buildings due to the increasing wind speeds at the higher levels. As a result, exterior venetian blinds tend to be used on buildings with up to 10 or 12 floors. With taller buildings, the blinds will be installed on the interior or inside a double façade.



Moving slats to the open position during wind allows pressure to equalize.



Headboxes or other custom enclosures house the blinds when retracted, providing protection from high winds and other severe conditions.



There are many slat options and sizes available.

In addition to wind, it's also important to consider the impact of snow and ice. If the venetian blinds are automated and are only deployed when there is sun on the glazing, snow and ice should not be an issue as they will be retracted when there is risk of these occurring. Providing that the blind pockets or head boxes are watertight, the blinds will be protected from rain, snow and ice, and can be deployed when there is sun on the façade, even when temperatures are near or below freezing.

As previously highlighted, if a building requires heating during the winter months, it might be appropriate to leave the blinds retracted during this period and allow solar gains into the building. If this is the case, interior roller shades will generally be installed to provide light and glare control, as required.

INTEGRATION WITH THE FAÇADE

As with all exterior shading systems, it's important to look at the integration of the blinds with the façade at an early stage during the design process. If the head boxes and guide wire brackets are going to be attached to the curtain wall, the connections methods and applied loads need to be discussed with the curtain wall contractor to ensure that no problems arise. This is also the case if the systems are going to be connected to a cladding system. It will be necessary to look at the routing of electrical cables to ensure that the proposed approach is in accordance with the National Electrical Code, as well as local code requirements.

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Motorized Venetian Blinds, Private residence Vancouver Island, BC Canada

CONTROL METHODOLOGY

Using exterior venetian blinds to minimize the solar heat gain inside the building means that the size of the HVAC system can be reduced. This is only possible if the blinds are deployed when there is a risk of excessive solar gain. Given that this is the case, the use of a fully-automated control system should be carefully considered. This will ensure that the shading system is as effective as possible. It also means that building occupants have no control of the blinds. This is generally not a problem if people understand the reasons for the blinds and how they respond to the sun conditions. If required, some manual control can be given, but this should be set up in a way that doesn't compromise building performance.

Possible control options include:

- i. Manual override to tilt the slats, but not retract the blinds.
- ii. Full manual override, but the blinds revert to automatic operation at set times, possibly at the end of the morning and the end of the working day.
- iii. A limit to the number of times that the blinds can be manually overridden during the working day with a reset to automatic during the evening.

MAINTENANCE AND CLEANING

There are often concerns about the reliability of operable systems on the exterior of a building and the need for regular maintenance. The requirements are actually limited although it is always recommended that exterior venetian blinds are inspected on an annual basis. It is also recommended that slats are cleaned as part of the window washing procedures

Motors are installed inside the venetian blind head rail and do not require lubrication. The blinds should be operated to ensure they are running correctly and to verify that there are no signs of wear or damage to the system. Side guide wires (if used rather than side guide extrusions) should also be checked and re-tensioned, if required.

Exterior venetian blinds are the most effective system available for the shading of vertical glazing. They may not be appropriate for all projects, but they provide a level of flexibility, control of heat gain, and control of natural daylight that is unsurpassed by any other shading system. Although exterior venetian blinds are relatively new to the North American market, they have been used in Europe for more than 50 years. This experience has demonstrated the durability and reliability of these systems, and their on-going use on new projects shows that they continue to be seen as a very effective way of achieving solar control.

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