FLORIDA SOLAR ENERGY CENTER®

Techniques for Shading Residential Walls and Windows

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Techniques for shading residential walls and windows

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Solar radiation is a major heat source in buildings — welcome in cold weather but a summertime problem. Florida's long cooling season and short heating season increase the importance of protecting windows, walls and sliding glass doors during hot weather, while still permitting solar heat to enter a building during cold weather. cooling and heating energy savings of 10% - 20% are possible through good shading strategies.

Properly designed roof overhangs can provide adequate sun protection, especially for south-facing surfaces. Vertical shading devices such as trees, trellises, trellised vines, shutters, shading screens awnings and exterior roll blinds are also effective. These options are recommended for east- and west-facing windows and walls. Because there is a large amount of diffuse radiation in Florida, large overhangs are effective for all orientations.

Roof overhangs for south-facing surfaces

The sun's path changes from season to season. This fact means that properly designed roof overhangs can protect south windows and other surfaces from the high summer sun, while allowing heat from the lower winter sun to reach them. See Figure 1.

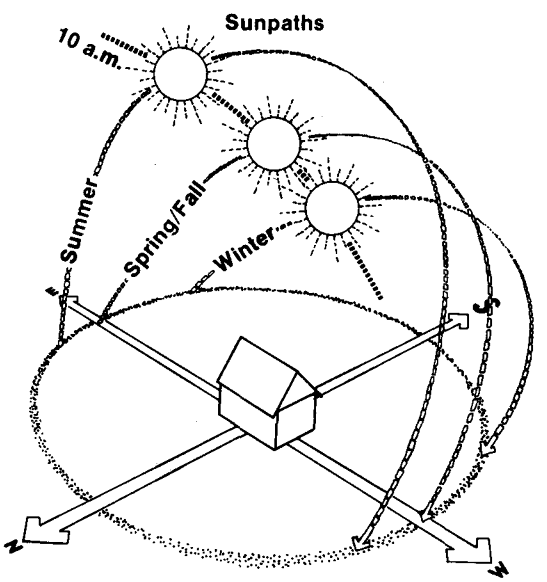


Figure 1. Diagram of the sun's seasonal path.

Effective design of roof overhangs depends on two factors: (1) the building's site latitude (the further north, the lower the sun's path) and (2) the length of the cooling season.

South-facing roof overhang calculation

The required shading period from roof overhangs is determined by observing the average monthly temperature and degree-day heating demand. Table 1 provides sample climate data and shade requirements for Orlando, Florida. After the shading period is determined, solar altitude angles for the site's latitude and simple trigonometric functions are used to calculate the required overhang length. A correlation between overhang length and the sun's natural yearly path ensures proper shading during the cooling season and solar heat gain during the heating season.

Table 1.

Orlando Climate Data			Shade Needed										
Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Average monthly temp. - °F	60.3°	61.5°	65.9°	71.3°	76.4°	80.2°	81.4°	81.8°	80.1°	74.3°	66.6°	61.5°	71.8°
Heating degree days (Base = 65°F)	197	184	94	13	0	0	0	0	0	0	75	170	733
Solar altitude (21st of month at solar noon)	42.0°	52.0°	62.0°	73.6°	82.0°	85.5°	82.6°	74.3°	62.0°	51.5°	42.2°	38.6°	

The Florida Solar Energy Center has compiled climatic data for various Florida locations and determined multi plication factors that appear best for the state's various latitudes. See Figure 2 and Table 2. These functions, when multiplied by the distance from the window sill to the soffit, provide overhang lengths that will adequately protect southern windows and upper wall surfaces from solar radiation during the cooling season. An example cal-

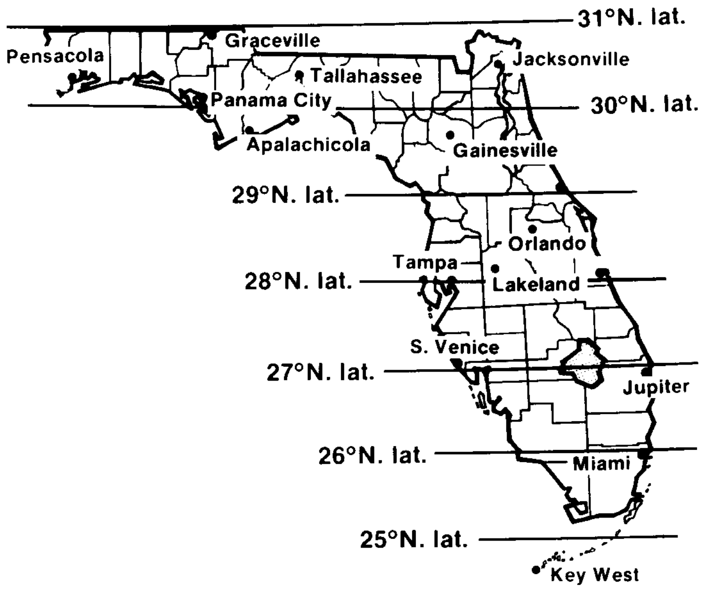


Figure 2. Latitudes for various Florida cities.

culation for a building located in Panama City, Florida (approximate latitude = 30 degrees, with south-facing windows and a sill-to-soffit distance of 4 ft. 6 in.) is as follows:

L = D x F

Where:

L = length of overhang

D = distance from window sill to soffit

F = multiplication factor from Table 2

In this case then,

L = 4.5 ft x .58 = 2.61 ft = 2 ft 7 in.

Therefore, the correct overhang length in this example is 2 ft 7 in. Figure 3 provides overhang calculations for an Orlando roof.

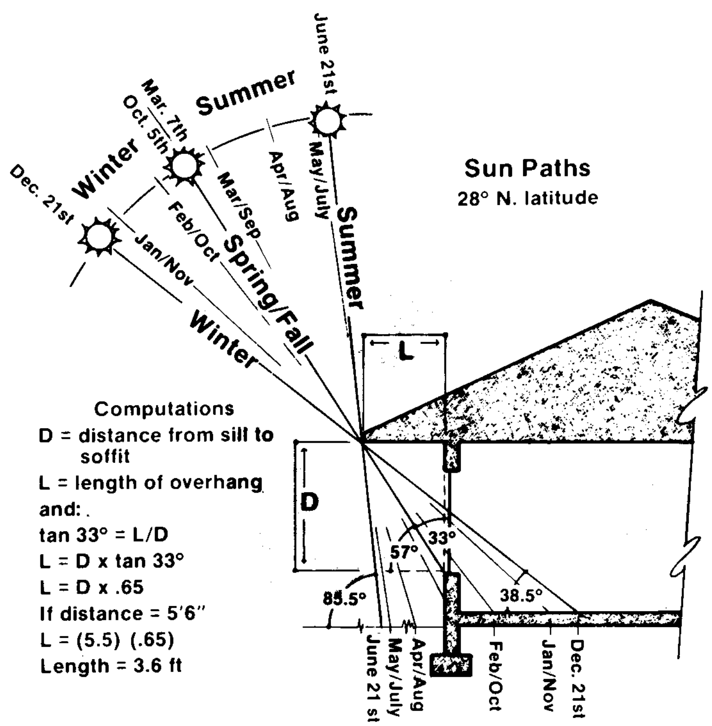


Figure 3. Overhang calculations for an Orlando roof.

Roof overhang design for north, east, and west surfaces

The overhang calculations presented here are valid for south-facing surfaces only. However, overhangs can be effective for all orientations. Nearly 50% of the solar radiation in Florida on east and west walls is diffuse rather than direct-beam, and overhangs are effective in blocking diffuse radiation for all orientations. Therefore, we recommend an overhang length on north, east and west walls equal to or greater than that for the south wall. Of course, on east and west walls 10- to 12-foot-wide overhangs would be necessary to protect against early morn-

Table 2. City latitudes, multiplication factors and angles.

Latitude		Factor	Dec. 21 12:00 noon **Angle α**	Date of Year varies with latitude **Angle β**	June 21 12:00 noon **Angle θ**
25°	Keys	.77	41.5°	52.5°	88.5°
26°	Miami	.73	40.5°	54.0°	87.5°
27°	Jupiter	.69	39.5°	55.5°	86.5°
28°	Tampa	.65	38.5°	57.0°	85.5°
29°	New Symrna Beach	.61	37.5°	58.5°	84.5°
30°	Panama City	.58	36.5°	60.0°	83.5°
31°	Graceville	.54	35.5°	61.5°	82.5°

ing or late afternoon sun. This size of overhang can be reasonably provided only by a porch or patio roof. Wide overhangs on all orientations have an additional benefit; the roof provides good rain protection for windows that are open for natural ventilation.

Overhang design for south-facing clerestory windows

Actual sun angles are sometimes more appropriate than are multiplication factors for use in overhang design. For example, on a south-facing clerestory, the roof that shades the clerestory is often angled upward and multiplication factors (calculated for horizontal soffits) are less appropriate. Sun angles, α, β and θ are shown in Table 2 along with multiplication factors for each Florida latitude. The best location for all south-facing overhang extensions is the point at which angle α crosses angle β. See Figure 4. However, angle β is the dominant angle where practicality does not allow full window use.

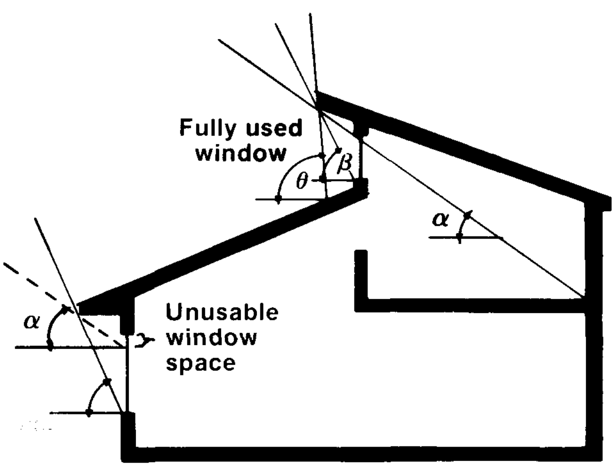
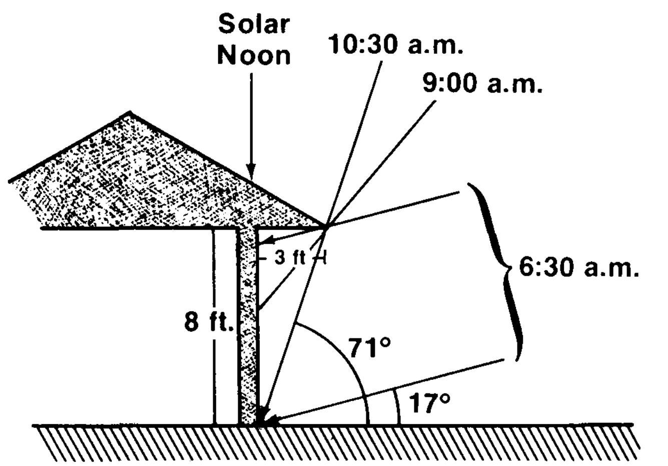


Figure 4. Clerestory vs. soffit design.

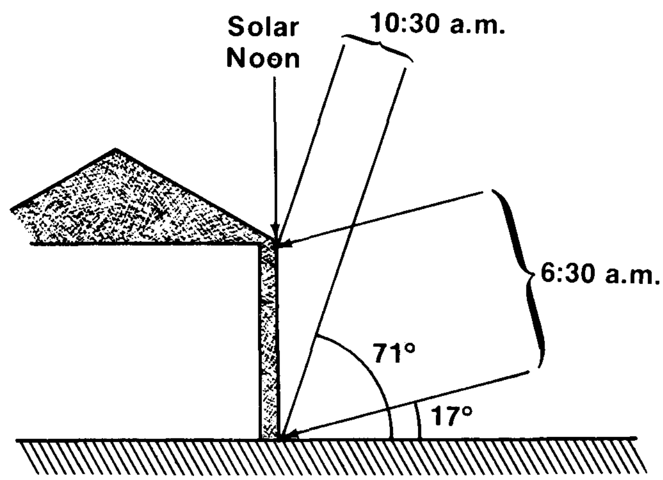
The most effective way to use the sun angle data given in Table 2 is to use a building section drawn to scale and a protractor for the angles. Angle β originates at the bottom of the window glass and angle α originates at the top of the window glass. The intersection of the lines is the optimum point for the end of the overhang. If the optimum point cannot be used because of roof slope, then use the point at which angle β intersects the roof plane as the end point of the overhang.

Vertical shading devices

Vertical shading devices such as trees, trellises, trellised vines, shutters, shading screens and exterior roll blinds can be very effective in reducing summer heat gains. They are particularly useful where east and west roof overhangs are not large enough to provide shade when the sun is at low elevations, or where overhangs are not cost effective. See Figures 5a and 5b.



a. Three-foot roof overhang.



b. No roof overhang.

Figure 5. Solar incidence variations on an east wall in June at 28° N. latitude.

Table 3. Solar heat gains through vertical, east and west-facing single-glazed windows on a clear day at 28° N. latitude.

June 21	6 6	7 5	8 4	9 3	10 2	11 1	12 —	am - East facing pm - West facing
Heat gain	106	188	205	187	142	80	43	**Btu/ft²**
Solar elevation angle	11	23	36	49	63	76	85	**Degree**
December 21	6 6	7 5	8 4	9 3	10 2	11 1	12 —	am - East facing pm - West facing
Heat gain	0	1	157	173	133	67	25	**Btu/ft²**
Solar elevation angle	—	1	13	23	31	37	39	**Degree**

Window films, interior shades, curtains and interior insulating shutters also help, but exterior devices save more energy because the heat that they absorb remains outside the building.

In Florida, significant solar heat gains occur between 6:30 a.m. and 10:00 a.m. on east walls, and between 2:00 p.m. and 5:30 p.m. on west walls when the sun is lower in the sky. See Table 3.

To be effective, vertical shading devices must block solar radiation when the sun is 10-55 degrees above the horizon. Also, properly designed shading devices should allow skylight and ground-reflected light to enter a building's windows for good interior illumination.

Note: Solar time is used in this discussion, and local times vary from solar times, depending on location. Daylight savings time must also be considered before using the listed solar elevation angles for design purposes. Local standard time is usually within on-half hour of solar time.

For more information

The Florida Solar Energy Center distributes several free publications that offer more information on building shading techniques. They include:

- **Window Treatment for Energy Conservation,** by Ross McCluney, order no. EN-4.
- **Sun Postion in Florida,** by Ross McCluney, order no. DN-4.
- **A Checklist for Building an Energy Efficient Home in Florida,** by Michael Houston and Subrato Chandra, order no. EN-10.
- **Landscaping for Energy Conservation,** by Magdy Girgis, order no. EN-12.