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GREENHOUSES NEED TO BE ABLE TO WITHSTAND FORCES OF WIND

Dealing with greenhouse wind loads

IN MOST PARTS OF THE UNITED STATES, wind load is the greatest force a greenhouse will be subject to. This can occur from hurricanes or tornadoes or the sudden squall from a passing weather front.

Wind forces that act on the greenhouse are influenced by numerous factors including the basic wind speed, building orientation and exposure, height and shape and doors or vents that may be open.

The wind passing over a greenhouse creates a positive pressure on the windward side and a negative pressure on the leeward side. These can combine to create a force that wants to collapse or overturn the structure. It can also create a force similar to an aircraft wing that wants to lift it off the ground.

Wind speed

The basis for wind load design is the wind speed map developed by the American Society of Civil Engineer (ASCE-7) and based on National Weather Bureau data. It is made up of wind speed measurements at 33 feet above the ground in open terrain based on a probability of recurrence every 50 years.

Basic wind speed varies from 85 mph in the western part of the country to as much as 150 mph along the Gulf Coast and Southern Florida. Each state develops its own wind speed chart, by municipality, that is appended to the building code. Either the International Building Code (IBC) or the National Fire Protection Association 5000 Building Code is the basis of structural design in all states. National Greenhouse Manufacturers Association (www.ngma.com) has developed standards and recommendations that are used in conjunction with the above codes.

Velocity pressure

In greenhouse design, the basic wind speed is converted to a velocity pressure in pounds per square foot (psf). The velocity pressure varies as the square of the velocity. This value is modified to take into account that the wind speed is reduced for buildings less than 33 feet high and for areas where obstructions such as trees or hilly terrain reduce exposure. It is also modified by an importance factor (I) that takes into account the hazard to human life. Except for greenhouses in hurricane areas, this factor is 0.87 for production greenhouses and 1.0 for retail sales greenhouses.

To illustrate: the velocity pressure for a production greenhouse with a 12-foot effective building height located in a suburban setting in a non-hurricane area with potential 90 mph wind would be about 14.4 psf.

Force coefficients

The full velocity pressure does not normally occur on all surfaces of the greenhouse because of shape and orientation. The wind generally hits the surfaces at some angle, such as a roof, depending on the building profile. This creates an aerodynamic effect.

Force coefficients have been developed for these different surfaces and affect the loading. These are also increased by a factor that accounts for wind gusts.

A structure has to withstand various loads depending on the direction of the wind and the shape and size of the structure. When the area of the different surfaces is multiplied by the loading, the total force that the surface has to withstand can be determined. In many parts of the United States, the magnitude of the largest forces is comparable to the snow load.

The forces on gutter-connected houses are calculated the same way. They are the greatest on windward sections and less in subsequent sections. With taller gutter-connected greenhouses being built today, the forces can be very large.

Other load considerations

The loads on individual structural members and the greenhouse glazing also have to be calculated. This is done during the design process by the structural engineer.

The loading can become even more critical if a large opening, such as a door or vent, is left open on the windward side of the building during high winds. If this happens, a positive pressure builds up inside the greenhouse so that not only is there an uplift suction force on the outside due to the aerodynamic effect, there is also pressure on the inside, equal in magnitude, acting in the same direction.

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