Reducing Storm Damage to Your Greenhouses

39 pounds per square foot – That’s the weight of snow I had in my yard in Ashford after the January 2011 snow and rain storms. The Connecticut Building Code calls for a design load of 30 pounds per square foot (psf) and many greenhouses are designed for significantly less as the code assumes that the greenhouse will be heated to a minimum 50˚ F during a storm. There are many reasons for structural failure but let’s review the type of loading that greenhouses are subject to first. Loads are commonly classified as dead loads, live loads, wind load, snow load and in some locations, earthquake loads.

Dead loads – are gravity loads that are constant and include the weight of the structure, equipment, and long term crops such as tomatoes. Values for wind uplift must not exceed the dead load of the structure otherwise the greenhouse could be lifted out of the ground. Hoophouses, for instance, are very light structures and have little weight.

Live loads– Short term hanging baskets are considered live loads which could add 3 to 5 psf. A maintenance crew working on the roof or hanging trolley conveyor is also a live load.

Wind loads – Loading from the wind can come in any direction. Basic wind speeds for design are 90 miles per hour (mph) in the northern part of Connecticut to 120 mph on the immediate coast. These are usually considered to act in horizontal direction against the walls. They are adjusted for such factors as site exposure, height and shape of the structure, roof slope and a use factor. For example, a 10’x 100’ polycarbonate wall subjected to a 60 mph wind would have to withstand a force of about 10,000 pounds. The wind tries to overturn the greenhouse.

Greenhouses are also subject to uplifting due to the wind blowing over the roof. The shape of the roof gives it an airplane wing effect. A 60 mph wind will create a lifting force of about 18,000 pounds on a 25’ wide hoophouse house and each post will have to withstand an uplift force of about 350 pounds. This is reduced somewhat in air inflated roofs as the plastic deflects and temporarily relieves the pressure.

Snow loads – Snow can be light and fluffy with a water equivalent of 12” equal to 1” of rain. It can also be wet and heavy with 3” – 4” equal to 1” of rain. Snow having a one inch rainwater equivalent will load a structure with 5.2 psf. This amounts to amount 6.5 tons on a 25’ x 96’ greenhouse. Temporary 2 x 4’s placed under the ridge every 16’ – 20’ carry considerable load and make a good safety measure. Locate them under a hoop or major frame member and secure them with a strap or wire.

Causes of greenhouse failure
The following are some of the failures I observed from my inspections after the storm and things to consider when a snowstorm is predicted.
**Drifting snow** – In Nor’easter storms, adjacent greenhouses or bays of a gutter-connected house that have a north-south ridge orientation tended to collect more snow on the leeward side. Snow that was lifted over the ridge of the first house can be dumped on the windward side of the second house. This creates an off-center load on the roof.

**Greenhouses too close together** – This is a common cause of failure especially on overwintering structures that are only 4’ to 6’ apart. When the snow slides off the roof, it fills the space and crushes the sidewall frame. There is inadequate space to get in with a bucker loader to remove it. Some growers cut the plastic to allow the snow to flow into the greenhouse and relive the pressure. Others install 2 x 4’s to brace the side frame.

**Shape of the greenhouse frame** - The gothic shape was developed to eliminate the flat spot that can collect snow on the top of hoop shape structures. For instance, since 1994 when the nursery industry changed from the hoop design to a gothic design for overwintering structures, there have been very few failures.

**Poor frame connectors** – First check and tighten all the bolts and tek screws before the winter season. These tend to loosen up over time. Second, brace bands and u-clamps can slip if they are not held in place with a tek screw. The screw should be at the side of the frame member, not the bottom. Several greenhouses failed at the point where a tek screw was paced at the bottom of the hoop tubing. This created a weak spot.

**Racking of the greenhouse frame** - Many manufactures do not include bracing with the greenhouse kit. All greenhouses should have diagonal braces from near the peak at the endwall to the baseboard about 16’ to 20’ from the endwall on all four corners. This gives stability and keeps the frame vertical. The frame loses considerable strength when they are not vertical. Install tubing or a 1” x 4” and secure with a “U” bolt at each hoop.

**Poor welds** – Welds that are not continuous or that have burned through the metal are weak spots. Areas that should be checked include truss braces, welds between sections of gutters and tubing sections that are welded together without an insert. Although expensive, professional inspection and x-ray testing may be worth the added expense.

**Inadequate air inflation** – Heavy wind can create rippling of the plastic causing failure at the attachments. Increase air inflation slightly by opening the blower’s intake valve. Make sure any holes are taped. Check to see that the inflation fan intake cannot be blocked by the snow.

**No heat or inadequate heat** - Most of the greenhouses that failed did not have heat or were heated to 40 °F or less. When heavy snow is predicted, the greenhouse heating system should be turned on and thermostat stet at 70° F or higher. Energy screens should be left open. The few extra gallons or oil used are less expensive than replacing a collapsed greenhouse.
Open vents, doors or louvers – The effective force of the wind is doubled when it is allowed inside the greenhouse. Latch doors and tape vents and shutters so that they cannot open.

Plugged gutters and downspouts – Once the snow has accumulated, it is important to have provisions for its removal. Raking the snow from the roof will let some light in warming the inside. This will create some melting which helps to reduce the load. Once the snow is melted. It is important to keep the gutters and downspouts free of ice. Ice socks filled with calcium chloride placed in the gutter and downspout will melt the ice. If available, magnesium chloride or sodium acetate is more environmentally friendly and reduces corrosion.

To shovel or not – It can be very expensive to remove the snow. You also have to have space for it. If the snow is light, there is not much danger of collapse. If it is heavy, some growers found that as it settled, melted and refroze, it formed a cocoon next to the plastic and didn’t put a lot of pressure on the greenhouse. Removing it may cause more damage. Most storm damage can be eliminated or at least reduced by proper preparation before a storm. With weather forecasts frequently inaccurate, it pays to plan ahead.

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