CALHOUN

Engineering Bulletin 033

RE: Snow Shadow Impact on Fabric Structure Design and Siting

When planning a fabric structure for your operations, you've likely considered the basics: building size, intended use, budget, and local snow loads. But there's another critical factor that must be considered to ensure the reliability of the structure: the snow shadow effect

What is a Snow Shadow?

A snow shadow occurs when wind-driven snow encounters an obstacle. Whether that's a hill, a building, or a tree line, this obstacle creates zones of altered snow deposition on the downwind side.

Here's what happens: as wind carries snow across the landscape, it flows up and over obstacles in its path. On the upwind side of an obstacle, snow deposition is often reduced as wind speeds increase. But on the downwind side, the air current slows down and becomes turbulent, causing snow to fall out of the air stream and accumulate in concentrated drifts. This sheltered zone is the snow shadow.

This phenomenon is particularly critical for structural design of buildings. Structures located in snow shadows can experience snow accumulations two to three times higher than the baseline design snow load for the region—a substantial margin that must be considered to ensure the building has the required capacity.

Site Assessment: Identifying Snow Shadow Risks

Before you break ground or even finalize your building specifications, conduct a thorough site assessment focused on snow shadow risks. This evaluation should include several key factors.

Terrain features play a primary role in snow shadow formation. Hills, ridges, valleys, and even dense tree lines can all create zones of enhanced snow deposition. A fabric structure positioned 50 to 200 feet downwind from a ridge line, for instance, sits in a prime snow shadow zone.

Similarly, a building placed at the base of a gradual slope may experience heavier snow loads than one on level ground.

Nearby Structures matter just as much as natural terrain. Existing buildings, grain silos, storage tanks, and even other fabric structures can generate significant snow shadows. The size and shape of these obstacles determine how far downwind the snow shadow extends, with taller obstacles creating effects that reach further downwind. Wind speed, storm intensity, and local terrain all influence the extent of the affected zone.

Prevailing wind direction during winter months is crucial information. While your region may have dominant winds from the west during most of the year, winter storm systems might consistently arrive from the northwest or northeast. These seasonal patterns determine where snow shadows will form relative to existing obstacles. Don't rely on annual wind data alone; consult local weather records specifically for the winter months when snow events occur.

Distance and placement evaluation helps determine if your proposed site falls within a snow shadow zone. The extent of snow shadow effects depends on multiple factors including obstacle height, wind patterns, and terrain. A fabric structure positioned relatively close downwind from a tall obstacle faces greater risk than one positioned at a substantial distance. The relationship between obstacle height and affected distance is significant—taller obstacles create snow shadow zones that extend considerably further downwind.

For sites with complex terrain or multiple nearby structures, consulting with a structural engineer experienced in fabric buildings or even a meteorological expert can provide valuable guidance.

Design Considerations for Snow Shadow Environments

Once you've identified snow shadow risks at your site, the next step is incorporating that information into your structure's design. Several engineering decisions can mitigate the impact of enhanced snow loads.

Increasing the design snow load rating is the most direct approach. Calhoun's engineering team can calculate appropriate load increases based on your specific site conditions, taking into account obstacle geometry, distances, and local climate data.

Frame geometry significantly affects how well a structure sheds snow. Steeper roof profiles naturally shed snow more effectively than lower-slope designs, reducing the peak loads your frame needs to support. However, steeper profiles also increase overall building height and material costs. The optimal balance depends on your snow shadow exposure: sites with severe snow shadow risks may justify the use of steeper geometry, while sites with minimal exposure can use more economical profiles.

Strategic Siting to Minimize Snow Shadow Impact

Sometimes the best way to address snow shadow risks is to avoid them entirely through strategic site placement. When you have flexibility in where to position your fabric structure, even 50 feet of difference can dramatically reduce or eliminate a snow shadow.

Position structures upwind of obstacles whenever possible. Placing your building suitably far west of an existing structure in a region with prevailing winter winds from the west eliminates the snow shadow concern entirely. While this isn't always feasible due to site constraints, access requirements, or utility locations, it's worth considering during the planning phase.

Site preparation can sometimes reduce snow shadow effects. Removing tree lines, grading slopes, or relocating movable obstacles can change the wind patterns and snow deposition zones on your site.

Planning for Long-Term Success

Snow shadow effects are another factor to consider in the planning process, much like soil conditions, drainage, or access roads. The key is recognizing snow shadows proactively during the planning and design phase rather than reactively after installation. Calhoun's engineering team has decades of experience designing fabric structures for challenging winter climates and can work with you to evaluate your specific site conditions, recommend appropriate design specifications, and help you make informed decisions about placement and structural requirements.

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