Modern Snow Retention Products & Installation Methods

AIA Continuing Education Provider

This Online Learning Seminar is available through a professional courtesy provided by:

SnoBlox
671 Willow Street
Lemoyne, PA 17043
Tel: 717-737-3125
Fax: 717-697-2452
Toll-Free: 800-SNOJAX-1
Email: sales@snoblox.com
Web: http://www.snoblox.com/

START

powered by www.aecdaily.com @AECDAILY

Modern Snow Retention Products & Installation Methods

To ensure the current status of this course, including relevant association approvals, please view the course details here.

AIA Continuing Education Provider

The American Institute of Architects
Course No. AEC655-01
This program qualifies for 1.5 LU/HSW Hours
Course Expiry Date: 06/03/2024

AEC Daily Corporation is a registered provider of AIA-approved continuing education under Provider Number J624. All registered AIA CES Providers must comply with the AIA Standards for Continuing Education Programs. Any questions or concerns about this provider or this learning program may be sent to AIA CES (cessupport@aia.org or (800) AIA 3837, Option 3).

This learning program is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

AIA continuing education credit has been reviewed and approved by AIA CES. Learners must complete the entire learning program to receive continuing education credit. AIA continuing education Learning Units earned upon completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon completion of the test.

AEC Daily Corporation has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

How to Use This Online Learning Course

To **view** this course, use the **arrows** at the bottom of each slide or the up and down arrow keys on your keyboard.

To **print or exit** the course at any time, press the **ESC** key on your keyboard. This will minimize the full-screen presentation and display the menu bar.

Within this course is a ★ **test password** that you will be required to enter in order to proceed with the online test. Please be sure to remember or write down this test password so that you have it available for the test.

To receive a **certificate** indicating course completion, refer to the instructions at the end of the course.

For **additional information** and postseminar assistance, click on any of the logos and icons within a page or any of the links at the top of each page.

Purpose and Learning Objectives

Purpose:

Today's modern metal roof panel coatings are designed to be low friction in order to self-clean. However, when snow and ice accumulate on the roof, their rapid release causes countless personal injuries, millions of dollars in property damage and liability claims, and business disruptions worldwide. This course provides an overview of snow retention systems that protect against these dangers. Information about components of both pad and bar styles, features, installation, and layout are presented.

Learning Objectives:

At the end of this program, participants will be able to:

- restate the dangers to people and property from snow and ice on roofs
- describe pad-style snow guards and their features, including strength, shape, and attachment methods
- describe bar-style snow guards and their features, including finishes, components, and attachment methods
- explain the common installation and layout mistakes in snow guard applications that can result in danger and damage, and
- discuss snow guard layout theory and the most important topics to consider when designing a snow guard system.

Contents

Introduction to Snow Retention

History of Snow Retention

Snow guards of various materials and methods can be dated back centuries to Europe. From stones to logs, these primitive systems protected the roofs from snow and ice slides. The main reason for snow retention was to insulate the structures from extreme weather by holding snow on the roof. These methods and materials added both tremendous weight to the roof structure, and a threat of falling rocks.

There were two primitive methods for holding snow on roofs. One was with rocks that were staggered on the roof creating a “field.” Today’s pad-style guards use this method to hold the snow and ice in place by using multiple, staggered rows. This method locks the snow in place until it melts. The other method was with logs that created a “fence.” Today’s bar systems use the fence method to create a barrier to hold snow and ice.

Field Method

Notice that the rocks are arranged in multiple, staggered rows up the entire roof surface, creating a field-type layout that holds snow and ice where it lands until it is completely melted.

Today’s pad-style snow guards should use this type of field method. The original snow retention design concepts remain the same to this day, but modern snow guards are very different in appearance.

Fence Method

Multiple rows of logs shown at right protect this roof and pedestrians. This style of system, known as a fence, was effective at keeping snow and ice from sliding. Today's bar systems should be designed with this type of fence method.

Below, a crossed log fence protects the roof.

Why Do Modern Metal Roofs Need Snow Guards?

Today’s modern metal roof panel coatings are designed to be low friction in order to self-clean. However, this creates a huge problem when snow and ice accumulates on the roof. As the temperature increases, a layer of water forms between the roof panel and the snow, which allows the snow to rapidly release and slide down the roof. This causes countless personal injuries, millions of dollars in property damage, liability claims, and business disruptions worldwide.

Most metal roofs in areas that get snow should be protected against these slides by utilizing a properly designed snow retention system. In terms of overall cost versus the damage prevented, snow guard systems are a tremendous value and one of the most important safety considerations for a metal roof.

Dangers of Snow and Ice

Just a few inches of snow and ice can cause thousands of dollars in property damage or kill a pedestrian without warning. The majority of metal roofs in snow load areas are not adequately equipped to prevent these disasters. Fortunately, today's snow guard systems can be designed for new construction or retrofit.

Dangers of Snow and Ice

Although this eave is only a few feet high, it can still avalanche hundreds of pounds of snow and ice in seconds on a vehicle or an unsuspecting pedestrian. The building owner and the insurance company that underwrite this property have a responsibility to provide protection for pedestrians and employees.

The cost of one lawsuit or emergency room visit for a major injury could easily exceed the cost of a properly designed and installed snow guard system. However, the potential liability exposure could be in the millions if someone were to be seriously injured or killed.

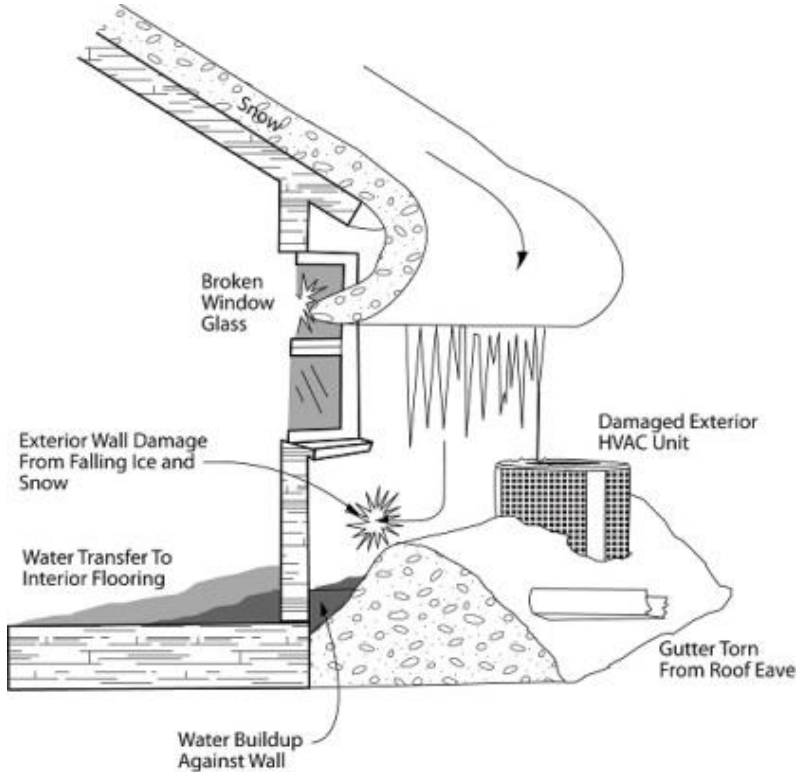
Dangers of Snow and Ice

The extra overhang of this roof design helps minimize the danger to the windows from the curling snow. However, the light fixtures on the roof and the landscaping below are still at risk.

Snow retention is sometimes overlooked in the building specification and sales process. Unfortunately, there are very few areas that mandate snow retention for metal roofs. It's imperative that design professionals, property owners, insurance companies, and contractors be informed about how metal roofs shed snow and ice.

How Metal Roofs Shed Snow

Curling snow develops from slow sliding snow on metal roofs. This dangerous occurrence can be avoided by holding the snow and ice on the roof until it can safely melt off.



Building Damage

The building in the upper image has sustained major damage from sliding snow and ice. A small investment in a properly designed snow retention system would have prevented thousands of dollars in damage.

The gutter damage in the lower image was a result of improper use of seam-mounted snow guards. We will discuss this common mistake later in the course.

Unprotected roofs can experience snow and ice avalanches. This dangerous situation can result in gutter damage, ruined landscaping, vehicle damage, or worse, pedestrian injury or death.

Vehicle Damage and Injury Risk

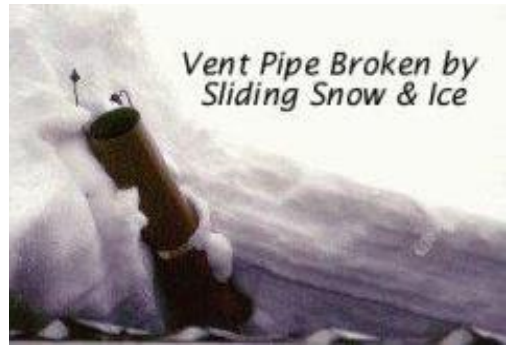
How many vehicles have been slammed by a chunk of snow or ice at this drive-through over the years? In terms of liability exposure for the restaurant owner, a properly specified snow guard system is the most logical solution to this problem.

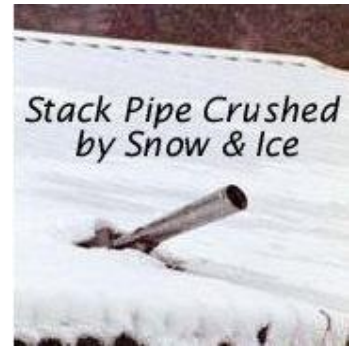
In the right-hand photo, the same restaurant is shown from the opposite side of the building. The sidewalk is closed off during business hours while an employee hangs off the side of the roof to manually remove snow from the panels. This is another disaster waiting to happen.

Pipe and Chimney Damage

Vent pipes and chimneys are the most common victims of sliding snow and ice. Thousands are replaced annually; however, the best solution is to fix the cause of the problem.

A broken vent pipe from snow and ice slides is shown in the lower photo. Notice that there was some kind of snow guard upslope of the broken vent. Vent-saving devices specifically designed for this application, or a full snow guard system, are the best solutions to keep this from happening again.

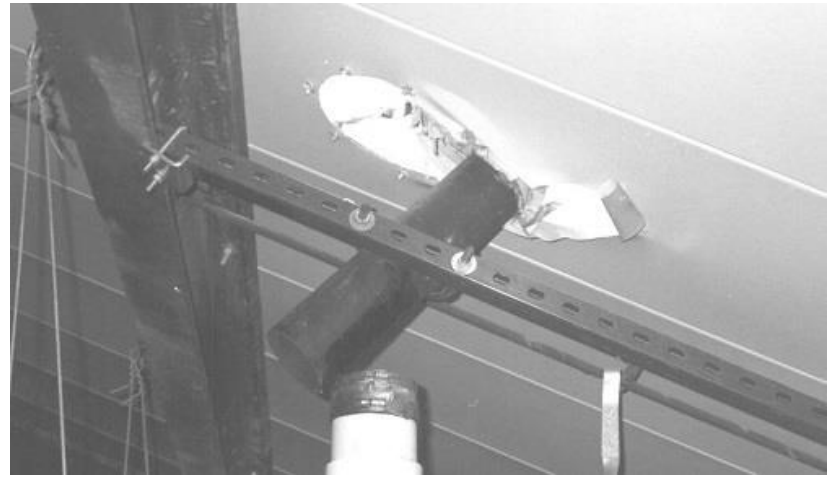




Roof Damage

The US military documented this torn roof panel in the upper photo—a worst-case scenario resulting from a plumbing stack failure from sliding snow and ice.

Shown in the lower photo are metal roof panels ripped open by sliding snow and ice. Imagine the cost difference between a snow guard system and replacing this entire roof area.



Snow Guard Developments

Specially designed, standalone vent and chimney protection devices are a great option to prevent damage to this chimney.

Snow retention has evolved greatly over the years, emerging from decades of limited attachment options. In just the last 35 years, we have seen the introduction of injection molded polycarbonate snow guards, nonpenetrating seam clamps, and adhesives designed to bond plastics to metals with incredible strength. Just as the metal roofing industry has grown and become a more financially viable option, so have snow retention products. Snow retention is still an afterthought to many, although its function is crucial. No other roofing component provides such huge benefits at such a small cost.

Let’s study some of today’s snow guard products and methods in the next sections.

Review Question

Which fixtures are the most common victims of sliding snow and ice?

Answer

Vent pipes and chimneys are the most common victims of sliding snow and ice. Thousands are replaced annually; however, the best solution is to fix the cause of the problem.

Pad-Style Snow Guards

Pad-Style Snow Guards

There are two main methods of modern snow retention. Pad-style guards are used to create field-type layouts, and bar systems are used to create fence-type layouts. We'll begin with pad-style snow guards.

The oldest and most popular snow guard design is the pad-style snow guard. Multiple staggered rows of guards mounted in the flat part of the roof panel work together as a complete system to protect the roof from snow slides. Pad-style guards are most commonly made from UV stabilized polycarbonate, stainless steel, or cast metal. Some other materials used to make pad-style snow guards are bronze, copper, aluminum, and mild steel.

Most pad-style failures result from improper layout. They should always be used in staggered rows that create a field, not in a straight line that creates a fence.

Pad-Style Snow Guards

Take notice of how the staggered pattern effectively holds the snow and ice in place, protecting pedestrian traffic and the cars below.

Pad-style snow guards historically have been the most widely used product of the snow retention industry. When designed properly in a field pattern, they are very effective at holding snow and ice.

Polycarbonate vs. Metal

The most popular pad-style snow guards are made of polycarbonate. Prior to 1976, snow guards were made of metal and sometimes led to serious corrosion problems on steel roofs. This was due to a dissimilar metal reaction that can occur between two different metal alloys exposed to the outside environment.

Besides eliminating dissimilar metal reactions on metal roofing, clear polycarbonate snow guards have other advantages. Once installed, they are practically invisible and do not detract from the building's appearance. The clear snow guards enable the UV rays to transmit through the guard to assist in the curing of the adhesive and/or sealants. They will never rot, rust, or corrode and will usually outlast the life of the roof.

Polycarbonate vs. Metal

Not all polycarbonate snow guards are created equal. There are many different grades of polycarbonate used to make snow guards. Prices can fluctuate based on the grade of polycarbonate and where they are made. Products that are not lab tested with published test results are usually cheaper and are unpredictable in the field. This is because cheaper grades of polycarbonate are used to keep the cost down and the profit margin up. Reputable manufacturers use a UV stabilized, virgin grade, Lexan® or equal quality of polycarbonate to ensure the product will last the life of the roof.

Snow guards that are made of stainless steel do not get brittle like cast aluminum guards and are one of the strongest pad-style snow guards in the metal category. Independent lab testing shows that they still are not as strong as polycarbonate because they tend to bend permanently when overloaded. Testing proves that most UV stable polycarbonate snow guards are semiflexible and will return to their original shape after being overloaded.

Architectural Testing, Inc. (ATI) lab testing shows that properly designed and mounted stainless steel guards withstand loads around 4,000 lb. Some polycarbonate guards have been tested to withstand over 6,000 lb of shear force in the testing lab.

Pad-Style Models

Pad-style snow guards are available in many shapes, sizes, styles, and colors. Some models are designed to hold the snow and ice on the roof until it safely melts. Other models minimize dangers by breaking up the snow and ice as it slides. Certain models are a universal fit, while others are designed for specific panel applications.

Decorative metal snow guards are a good choice cosmetically and can be powder coated to color match the roof; however, these guards are limited to screw-down attachment and should only be used on nonfloating, mechanically fastened metal roofs. Polycarbonate snow guards are universal in nature and are generally stronger, are less expensive, may be glued or screwed, can straddle minor ribs, and are available in many stock colors.

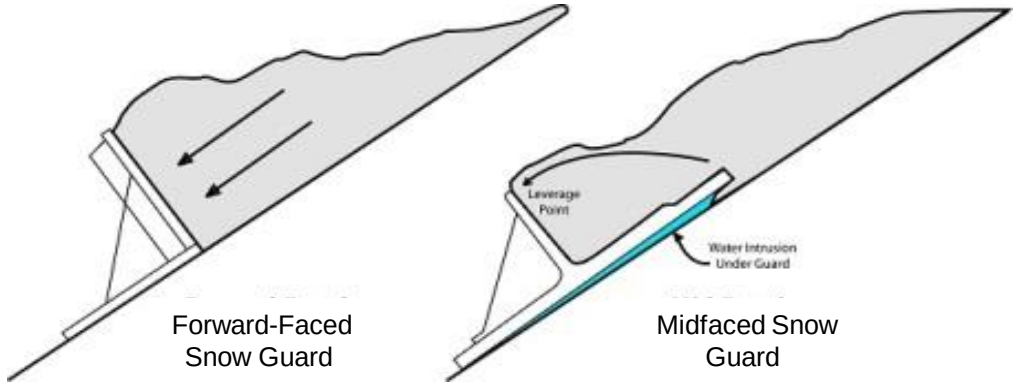
Features to Consider: Strength, Shape

Strength

A snow guard should never be used on a project unless it has been professionally tested by an unbiased third-party testing facility. Any reputable snow guard manufacturer should willingly provide and/or publish those test results. Without testing, there is no way to determine if the guard being considered for the project will be appropriate for a specification with a load-based safety factor.

Shape

Guards with flat, forward-mounted faces tend to have better leverage against heavy, sustained snow loads. The faces should be perpendicular to the roof panel for maximum holding strength. Midfaced snow guard designs tend to allow the load to leverage the front of the base up and away from the attachment point.



Forward-Faced Snow Guard

Midfaced Snow Guard

Features to Consider: Shape, Attachment Method

Shape, cont'd

Faces that are pointed, angled, or sloped tend to "slice" the snow and ice into smaller pieces and usually don't retain it on the roof very long.

Guards are most effective when mounted down in the center of the roof panel, where the snow and ice actually moves. For maximum holding strength, many models are designed to mount on a flat surface or straddle over a minor rib to stay centered in the flat portion of the panel. Verify with the manufacturer that the guard specified is the best choice for the particular roof panels being installed.

Attachment Method: Adhesive

The development of modern construction adhesives has paved the way for the polycarbonate snow guards to become one of the fastest growing snow retention segments in the world. Adhesive mounting is considered by many experts to be the safest mounting solution to avoid panel damage. If the guard becomes overloaded, generally, the worst that can happen is that the guard will release from the panel harmlessly. The snow guard can then be reattached in the same spot without adverse effects to the roof or the guard.

Features to Consider: Attachment Method

Attachment Method: Adhesive, cont'd

The best performing are construction sealants/adhesives that are high strength, waterproof, and weatherproof. Some have 2,000 lb/in^2 tensile strength and 500% elongation. The adhesive can create a chemical bond as it cures to the polycarbonate and is safe to use on most factory painted roof panels.

Clear polycarbonate pad-style guards can be attached with adhesive on just about every panel manufactured today, except round corrugated panels, EPDM-style membranes, slate, or shingle-style panels. Glue-down guard systems are just as strong and effective as any other type of snow retention if they are properly designed and installed using a professional layout. Although adhesive attachment may require several more staggered rows, it is often the safest and least expensive option.

Architectural Testing, Inc. (ATI) tested this adhesive-mounted polycarbonate snow guard to 1,561 lb.

Features to Consider: Attachment Method

Attachment Method: Mechanical

Pad-style guards can also be mechanically fastened with a noncorrosive #14 neoprene washered screw. A silicone sealant or a foam pad must be applied to the underside of the guard to create a weathertight seal. A screw-down snow guard system is a great choice for exposed fastener roof panels such as the popular 9-inch and 12-inch R-panels.

This type of attachment is as old as metal roofing itself; however, there are some things to consider. Screws must be driven into at least 1.5 inches of solid structural wood, a metal purlin, or at least 1.5 inches of wood blocking. The metal panels alone will not hold the screws, and the guard will eventually pull out, leaving holes that could be a catalyst for roof leaks.

Use an exterior grade, all-weather silicone sealant that can be applied at low temperatures on the underside to keep water from forming under the guards. If water would be allowed to form under the guards, it could potentially freeze and pop the guards off the roof.

Features to Consider: Attachment Method

Attachment Method: Mechanical, cont'd.

According to independent Architectural Testing, Inc. lab tests, screw-down guards are able to hold 300%–400% more snow load than adhesive-mounted guards, so fewer rows may be necessary with this system design. On longer roof slopes, multiple rows should be equally spaced up the roof. This is the most effective way to hold snow and ice until it can safely melt.

Silicone sealant is important to prevent water from getting under the guards and causing leaks or unsightly mold spots. Notice at right that the rows are spaced to ensure that the mounting screws hit the structural purlins.

Typical screw-down installation using #14 galvanized screws with neoprene washers

Features to Consider: Attachment Method

Attachment Method: Tape Plus Sealant/Adhesive

Another type of adhesive attachment is two-sided, acrylic, pressure sensitive tape that is used in conjunction with construction sealant/adhesive to seal around the perimeter. The adhesive adds additional shear strength, and the tape holds the guard securely in place while the adhesive fully cures. This attachment method is highly recommended for all tape installations but should only be used on pointed snow-breaker-style guards that break up snow and ice. Snow guards with flat faces are designed to hold the snow load for longer periods; therefore, they need a much stronger adhesive.

While this type of attachment seems attractive and simple, it is considered a light-duty adhesive application but is a viable option for colder weather installations. It is better than just using tape by itself, but not as strong as using construction adhesive on the entire underside.

Features to Consider: Attachment Method

Attachment Method: Seam Mounted

Individual seam-mounted snow guards are sometimes a popular choice due to the ease of installation. However, individual guards are mounted on the seam above the flat panel area where the snow and ice actually moves. They are not as effective at stopping the movement of snow and ice as snow guards mounted in the center of the panel.

As snow melts, it is pulled into the lowest part of the panel by gravity, where it can slide under or beside a high seam-mounted snow guard. The wider the standing seam panel, the less effective this style of snow guard is at holding snow. Since the snow and ice can actually twist these guards as it slides by, seam damage is more likely to occur. The most effective type of seam-mounted snow guard system uses a series of bars with ice stoppers that extends down to the panel to block the snow and ice from sliding.

Multiple rows of seam-mounted snow guards still can't prevent snow and ice from sliding dangerously into the parking lot. Adding a series of pad-style guards mounted in the center of the flat part of the panel could help prevent this problem in the future.

Features to Consider: Layout

Snow Guard Layout

The best time to request a layout is when the project is in the planning phase. Once the layout is calculated, the architect can include the proper information in the specifications prior to the job going out for bid. This mandates a standard for the installer to uphold.

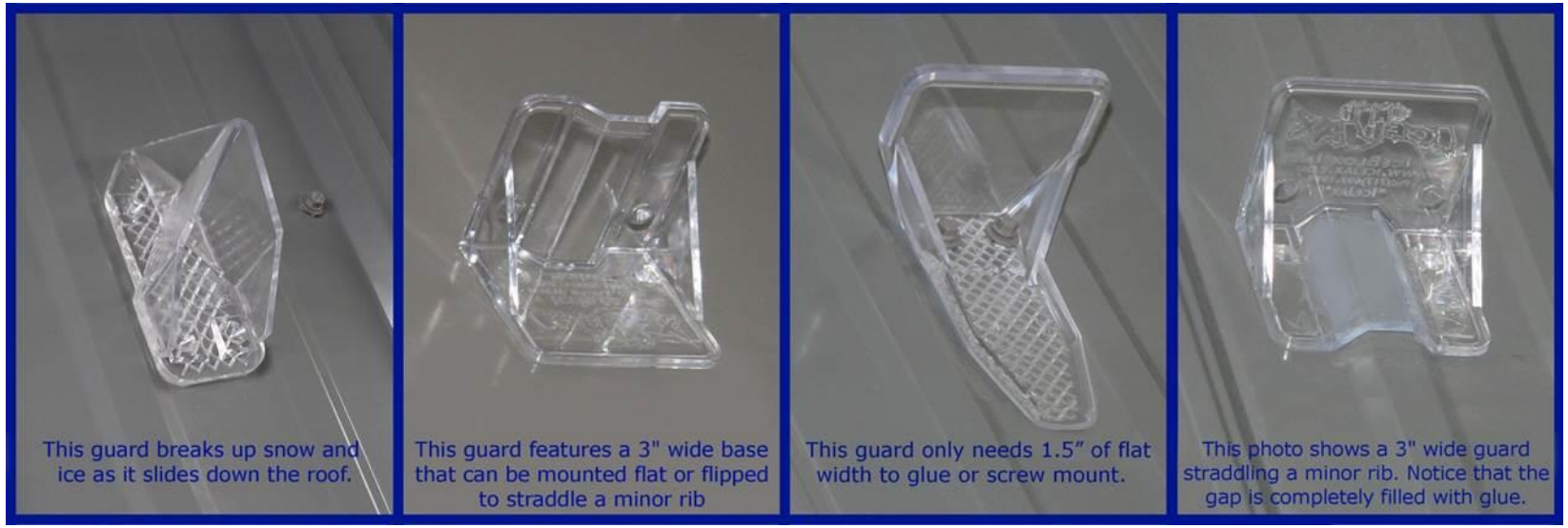
A specification that calls for snow guards without a project-specific layout can become a liability for the building owner in the future. Snow retention is a safety item, and without a professional layout and proper installation, there is an increased risk factor to pedestrians, gutters, cars, landscaping, and equipment below.

Most snow guard manufacturers are happy to consult with architects, contractors, and homeowners free of charge to be sure the project is designed properly. Reputable manufacturers will provide free design services, such as online estimators.

Model Selection

Depending on the panel being used, snow guards should be properly matched to be sure that the guards fit flush on the panel. Keeping the guards centered on the panel will provide the most efficient holding strength. Matching the correct guard to the specific project is the first step in designing a quality snow guard system. Keep in mind, all snow guards don’t fit all roof panels.

Polycarbonate guards are very versatile and can be used on just about all metal panels.



Model Selection

There are instances when it’s necessary to break up the snow and ice while still allowing it to come off the roof in a controlled manner. The solution to this is a wedge-shaped, snow-breaker-style guard. This product can be mounted with screws, adhesive, or a combination of tape and adhesive.

This design is contrary to the conventional snow retention systems of today that are designed to hold snow and ice on the roof, usually by creating a holding field with a staggered pattern. The design allows the snow and ice to slowly shed itself from the panel while the guard slices it into safer, smaller pieces before reaching the roof’s edge. This can be most beneficial in areas where winter weather conditions can sometimes exceed the roof snow load design. Other uses are light snow load roof systems, isolated placement, and controlling snow avalanching on solar panels.

Specialty Products

Specially designed products will protect vent pipes, chimneys, antennas, and masts from damage. They can be very effective as standalone products or as part of a full snow guard system. These vent-saving devices work by splitting and diverting the snow around the pipes. They also stabilize the roof stacks with steel cable that wraps around the pipes to prevent them from being broken.

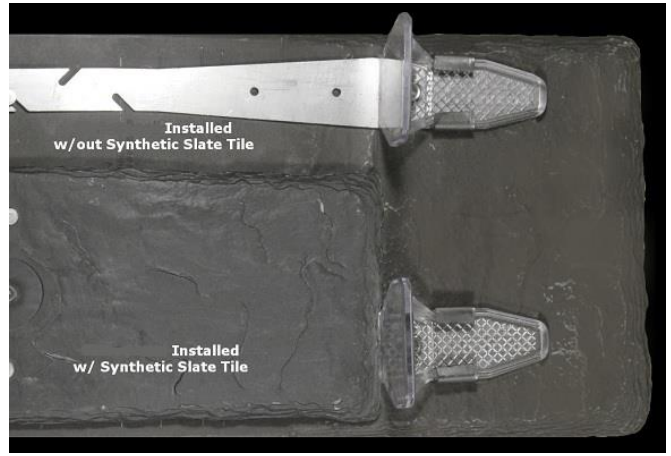
Here is an example of a very simple vent-saving device. It is mechanically fastened upslope of the vent pipe, and a stabilizer fin is used to secure the stack. This product is very effective at diverting snow and ice around roof vents, chimneys, and masts.

Specialty Attachments

Slate, asphalt shingle, and composite shingle roof systems have always posed a problem when it comes to controlling the snow load. Adhesives are not very effective on these roofing materials, and mechanical fastening of brackets or guards is extremely difficult.

Specially designed brackets have been developed to solve this challenge. These stainless steel straps can be used for new or retrofit projects and can be sourced in various colors. They can be attached with nails or can be hooked onto existing roofing nails already in place.

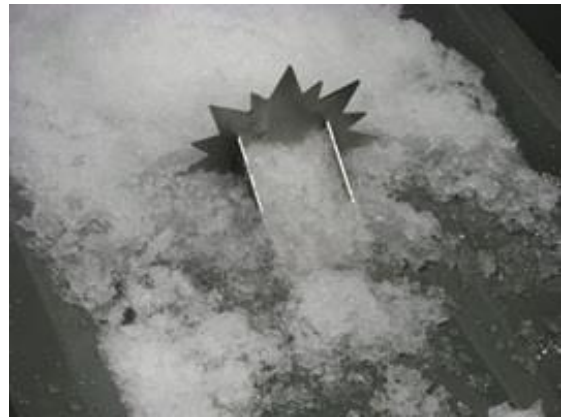
Installation and layout of this style guard should closely follow the manufacturer's recommendations based on the project-specific data.



Specialty Attachments

The pad-style guard at right is attached to a 304 stainless steel strap that allows a composite tile roof to have an effective snow guard system without screws or adhesive.

A nice feature of metal snow guards is the ability to use them for cosmetic appeal as well as for snow retention. There are various decorative designs available today, the most common being made of 304 stainless steel. These can be powder-coated to match the roof and must be mechanically fastened. Although they can be used as decoration, they must still be installed with a professional layout to avoid overloading.



Review Question

What is the best stage of a project at which to request a snow guard layout?

Answer

The best time to request a layout is when the project is in the planning phase. Once the layout is calculated, the architect can include the proper information in the specifications prior to the job going out for bid. This mandates a standard for the installer to uphold.

Bar-Style Snow Guards

History of Bar-Style Snow Guards

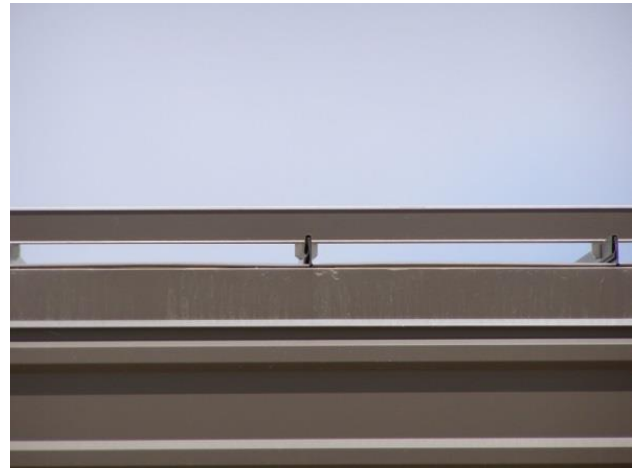
Modern bar and clamping systems have evolved since primitive log “fences.” Kunz Construction in Wheat Ridge, Colorado developed a system for snow retention on standing seam metal roofing in 1980. Installed on an office plaza in Inverness, Colorado, it utilized common bar joist clamps and a threaded rod, bent to match the profile of the roof panel. It was the first nonpenetrating rod system that retained snow and ice on a metal roof, developed 12 years prior to the first patented system (upper image).

In 1987, a bar system using nonpenetrating clamps was requested for the standing seam metal roof on the Chipeta Elementary School in Colorado Springs, Colorado, to protect the school’s doorways. The roofing installer welded two bar joist clamps together and mechanically attached a bar to the tops of the clamps. Even 30+ years later, this system (lower image) has yet to fail, and the integrity of the painted roof surface remains intact. This was five years prior to the first bar patent application.

History of Bar-Style Snow Guards

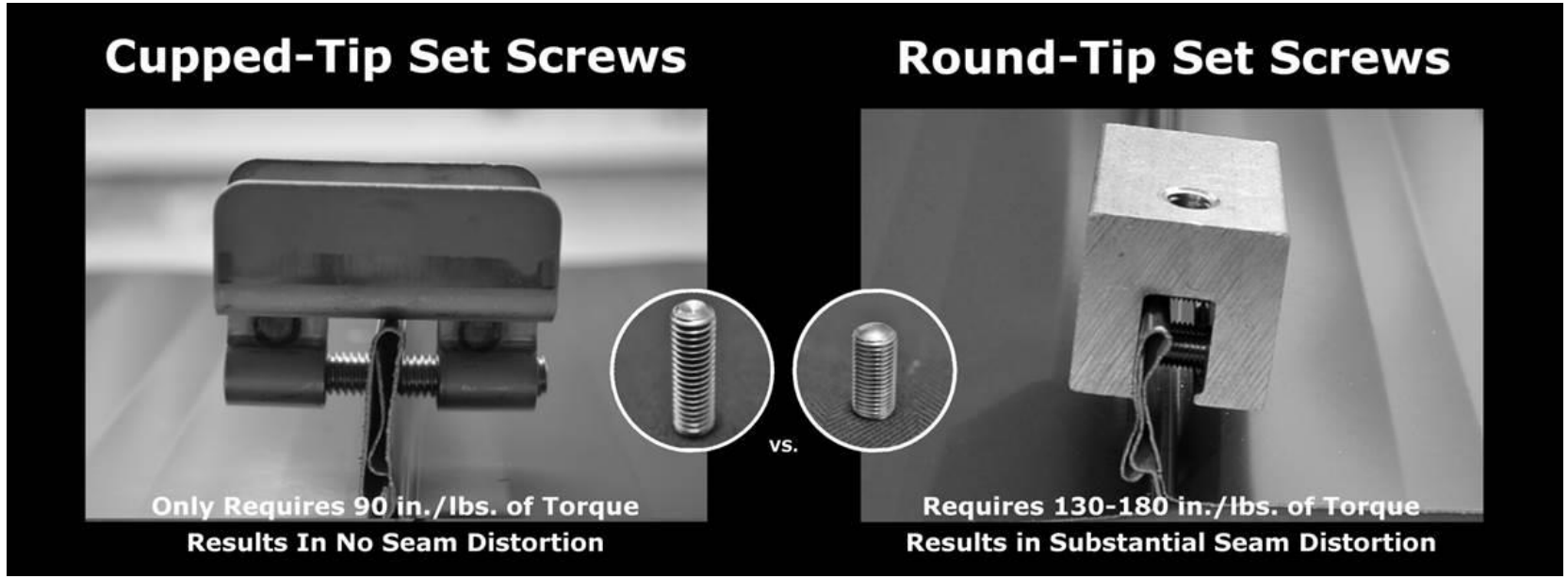
In 1990, Jim Huff, a metal roof installer, was the first to design a bar system that could accept 2-inch color strips for an easy color match to the roof panel, modeled after the name plates often used in offices. This was two years prior to the first patent application for this type of clamp and bar. The system (upper image) was installed in 1992 on the Toll Plaza at the Denver International Airport and is still in service today. Since this pioneering concept hit the market, there have been several improvements made.

Donald Drew developed a one-piece clamp (lower image) that allowed for a bar to be dropped in during installation. This allowed the system to be used without predrilling or welding. This evolution made the bar system easy and fast to install. Mr. Drew filed for a patent on this product on June 9, 1992.



Seam Clamps

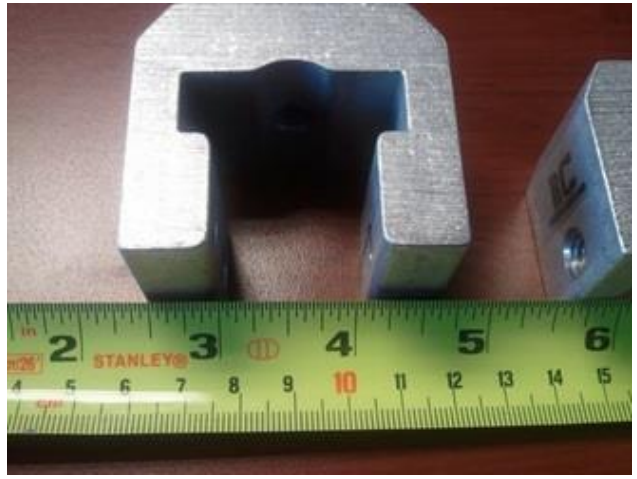
The greatest improvement to the roof clamp technology has been the shift towards more universal fit designs, as opposed to the old-style clamps that only fit certain seams. Another improvement is the use of coarse threaded set screws and all-stainless steel clamps that top load for faster installations. Set screw technology has also improved, so there is no longer a need to use high torque set screws that deform the seam. Cupped tip set screws can mount bar systems securely with only 90 in/lb of torque, resulting in less seam distortion and a permanent attachment to the seam for the life of the roof.

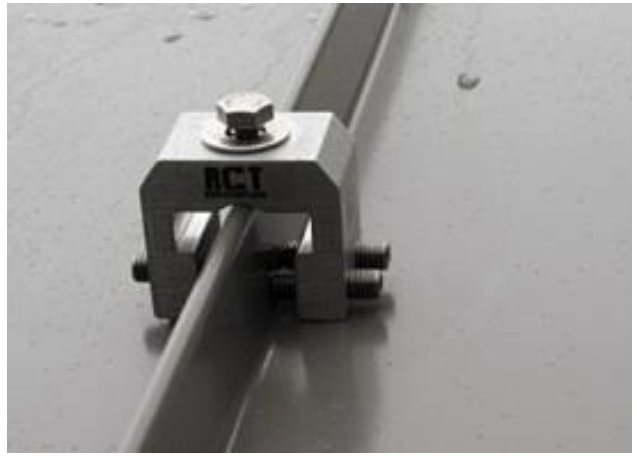


Seam Clamps

Bar systems with seam clamps are a year-round snow retention attachment solution and are available in various strengths and materials. They can be attached with screws or nonpenetrating seam clamps. Specialty mounting brackets are available for shingle, membrane, and slate applications.

The most effective method of holding snow and ice is with a flat-faced bar, mounted perpendicular to the panels. Ice stoppers should be mounted on the bar, in the center of the panel, to keep snow from sliding under the bar.





Bar System Examples

Mechanically fastened bar system holding about two feet of snow.

Bar system protecting very expensive HVAC equipment on the landing below.

Bar system on a barrel roof, with multiple rows of bar effectively holding the snow and ice until it can safely melt.

Bar system with a unique radius installation around the entry roof.

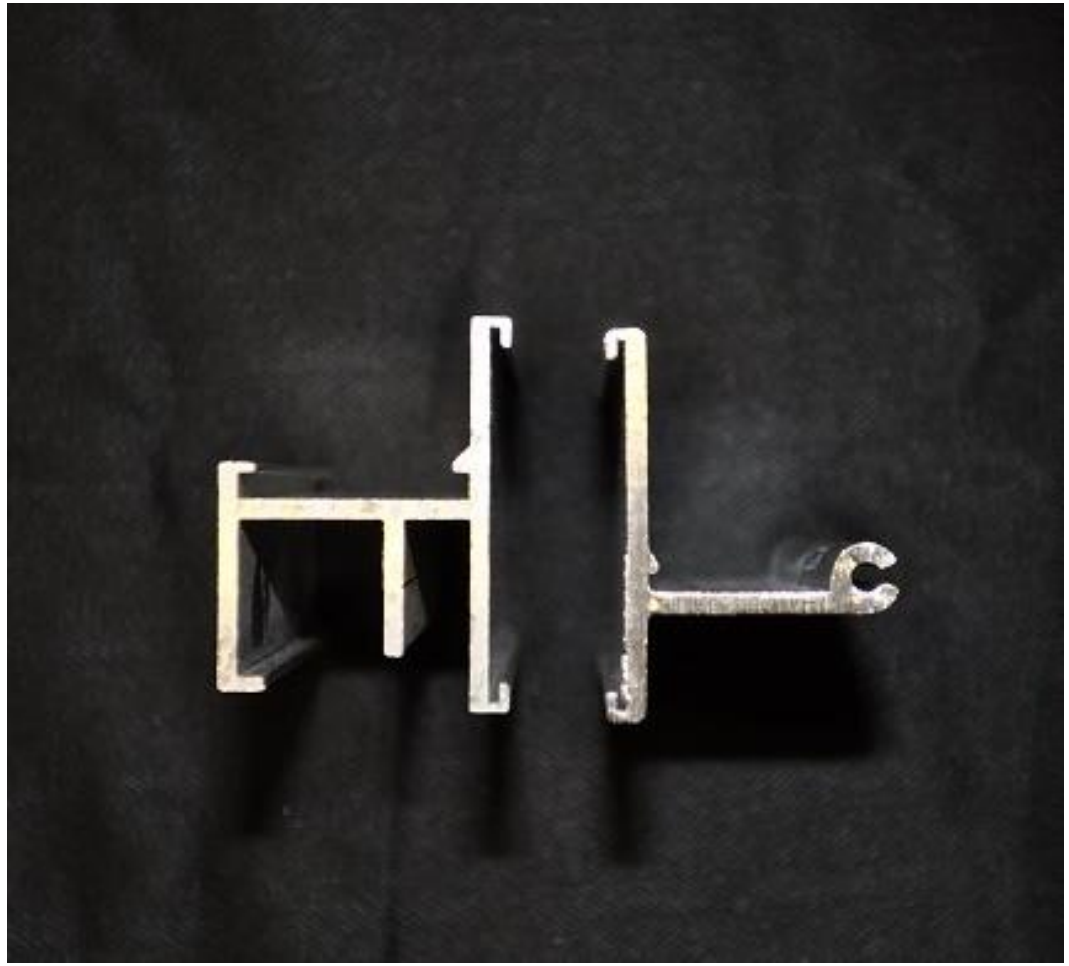
Bar System Example

There are several styles of bar, some with multiple bars and high fences. Here is an example of how a simple single bar can effectively and safely hold back thousands of pounds of snow and ice.

Bar Finishes

You can find bar systems in mill finish, or they can be custom powder coated to match the roof panels. There are also several manufacturers who make extruded aluminum bars that accept a 2-inch strip of metal in the face to match the roof panels. This works well with brand new roofs, but it is sometimes hard to match the color of a roof that has been faded in the sun for several years.

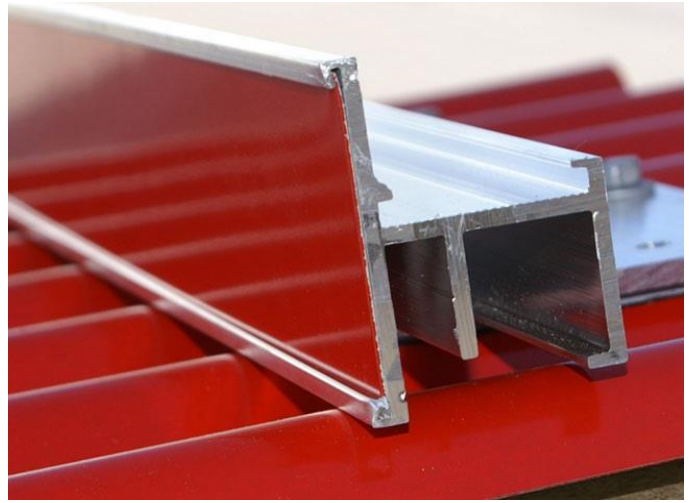
Here are two commercially available extruded aluminum bar samples; both accept color strips in the face, but the heavier bar on the left has extra struts to allow ice stoppers to mount perpendicular to the roof panels. The heavier bar has less deflection properties so it can span up to 42 inches. It is highly recommended to obtain samples from various bar manufacturers so the components can be examined up close.



Color Match

The upper photo shows a picture of the extruded aluminum bar with a slide-in, 2-inch color strip. Notice the edges of the bar and mounting components are not color matched to the roof.

The lower photo is a powder coated bar system with color matched ice stoppers. Powder coating provides a finished look since the components and ice stoppers also match.



Ice Stoppers

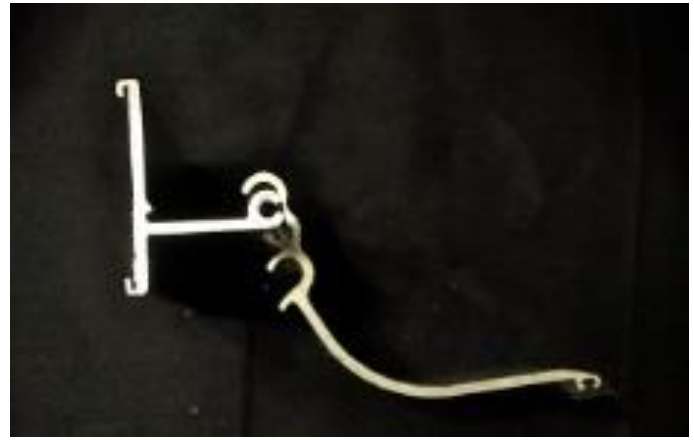
Bar systems must use some type of ice stopper between seams to protect the roof from snow and ice that can slide under the bar. The most effective ice stoppers are mounted perpendicular to the roof panels to prevent snow and ice from ramping up and over the bar. They should be mechanically fastened to the bar itself with a foot to keep them from being flipped under or over the bar.

Perpendicularly mounted ice stoppers are the only product that can effectively hold the center of the panel down during high winds. This significantly increases the wind uplift performance and can eliminate the noise from rumbling roof panels. This patented style of perpendicularly mounted ice stopper has been tested under the ASTM E1592 guidelines to improve wind uplift performance up to 300% when designed for snow and wind protection.

Ice Stoppers

The upper photo shows a perpendicularly mounted ice stopper. This view is from the upslope side of the bar. It is very simple in its design but performs several functions. It protects the roof from snow and ice sliding under or ramping over the bar. It can also significantly increase wind uplift performance. The mechanically mounted foot design prevents the panel from lifting or rattling during extreme winds.

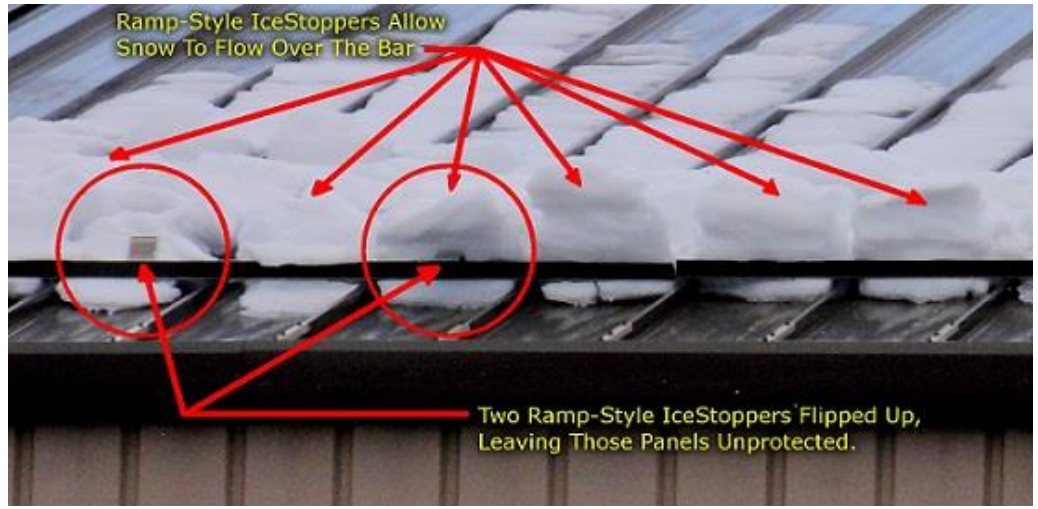
A nonmechanically attached ice stopper, as shown in the lower photo, can blow or flip up and over the bar, leaving the panel unprotected. This style of ice stopper also does not provide any wind uplift improvement and can slide off-center after installation. This leaves the center of the panel unprotected. The best option is a mechanically fastened, perpendicular ice stopper with a foot that adds wind uplift improvement.



Improper Ice Stopper Design

The upper photo is an example of a nonmechanically attached ice stopper. As you can see, the design allows snow and ice to ramp up and over the bar. This is the wrong way to hold snow and ice on a roof.

Below is another example of a bar system with nonmechanically attached ice stoppers. Notice that the snow is ramping up and over the bar instead of being held until it can safely melt.



Proper Ice Stopper Design

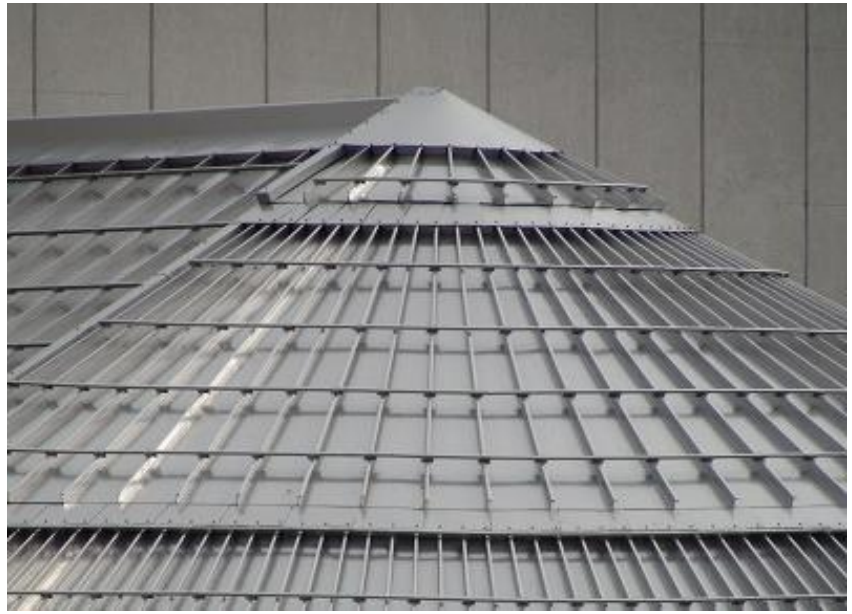
At right is an example of an excellent bar system using two perpendicular ice stoppers per panel for maximum hold time of snow and ice.

Below left is a well-designed example of a bar system on a huge metal roof. Three evenly spaced rows on the main roof hold the snow and ice until it can safely melt away. Trying to catch this much snow down at the eave would be detrimental to the roof panels and cause unbalanced loading on the roof surface.

Below right is a two-bar system. It is important to use flat-faced bar and clamps at every seam for this type of design.

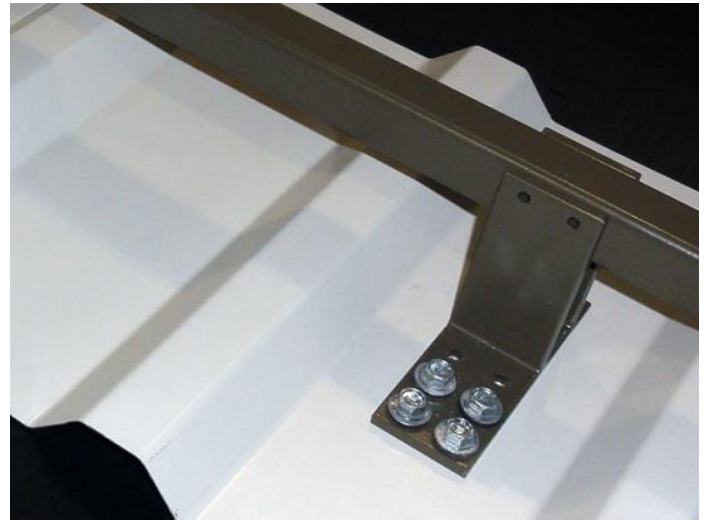
Functional and Aesthetic Ice Stopper Design

Design professionals often choose to use bar for aesthetics as well as for snow retention. Featured on the left is the Alaska Center for the Performing Arts. This bar system has a unique architectural look while providing maximum protection against falling snow and ice. Several round roof areas of this project also use a radius bar design for a distinctive look. The Alaska Railroad terminal at Ted Stevens International Airport is shown at right. Both Anchorage projects were featured in *Metal Construction News* in January 2011 (accessed March 2021).



Bar Attachment Options

Depending on the project, a bar system can be installed with either nonpenetrating seam clamps for standing seam roofs or with mounting brackets for exposed fastener roofs, shingles, membranes, or tile roofs.



Shown at right is a top-loading bracket for exposed fastener roofs; the screws must be fastened into a steel purlin or structural wood. This bracket is powder coated along with the bar.

Here are several brackets for mounting bar systems to a variety of roofing materials. Membrane/TPO, round corrugated, exposed fastener, shingle, and tile roofs can now utilize this attachment method.

Bar Attachment Examples

Mill-finished bar and mounting bracket system using color strips. An advantage of using the screw-down brackets on this roof is that they also perform as ice stoppers.

Specialty bracket for mechanically mounting a bar system to a round, corrugated roof panel.

Excellent example of a bracket-mounted bar system with color strips holding about two feet of snow.

Roof utilizing a specialty corrugated roof bracket for mechanically mounting a bar system to a round, corrugated panel.

Seam-Mounted Clamps

Most bar systems on standing seam roofs are installed using nonpenetrating seam clamps. There are several styles available; the most popular are made of stainless steel or aluminum.

Top-loading clamps such as this one are the fastest and easiest to install. A one-piece design made of stainless steel allows the bar to simply drop into the clamp. This eliminates the need for clips or having to feed the bars through the clamps.

Seam-Mounted Clamps

Clamp materials can vary from diecast zinc zamak, to aluminum, to the preferred stainless steel. The most popular clamps use multiple set screws for direct attachment to the seams as opposed to just using a two-piece clamp that squeezes the seam at a single point. Many clamps are stronger than the seams they are mounted on, so proper layout and clamp loading distribution is of utmost importance. Improper use of clamps can cause severe panel damage and system failure. Always consult the bar system manufacturer for a project-specific layout before specifying a bar system.

Shown here is a stack of test panels during clamp testing on a bulb seam. Extensive Architectural Testing, Inc. tests show that the seams are the weakest link and are always the point of failure.

Seam-Mounted Clamps

Some clamps are designed to fit specific panels, and some are designed for universal fit on multiple seams without panel feeding. From an installation standpoint, the easiest to install are the universal-style, one-piece clamps that have a wider throat opening so they can drop over the various seams without having to be assembled or panel fed up from the bottom of the seam. Most roof clamps must be used on at least 24-gauge panels to avoid damaging the seams. Here are some basic design considerations for choosing the correct clamp-on bar system.

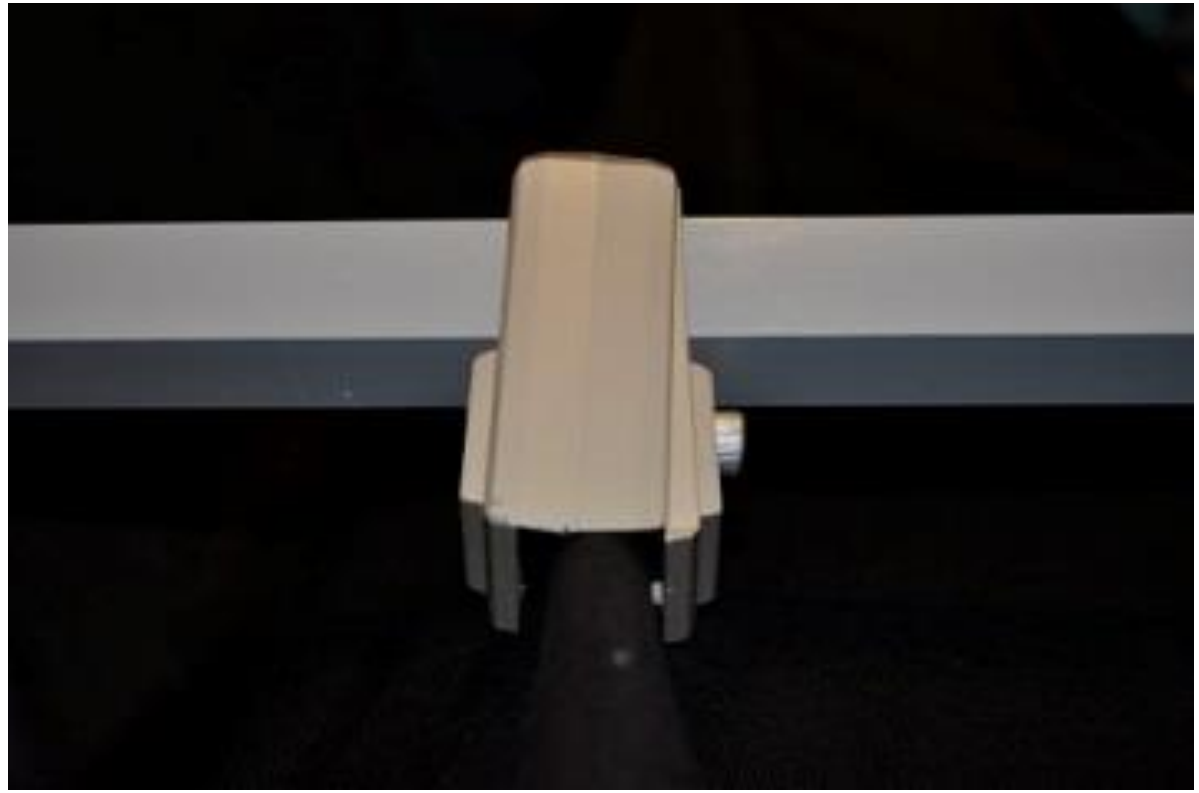
Cupped tip set screws only require 90 in/lb of torque for a lifetime attachment. Round tip set screws can require up to 180 in/lb of torque to keep the clamp from sliding down/off the seams. High torque can cause seam distortion and can penetrate and damage the seam.

Testing has proven that fine threaded set screws used in aluminum clamps often lock up, preventing them from being retorqued or removed. Despite being properly installed, the aluminum shavings can get caught in the fine threads of the set screws due to the high torque requirements. Only coarse threaded, low torque set screws are recommended for use in aluminum clamps.

Seam-Mounted Clamps

Choose a one-piece clamp that does not require the bar to be fed through the clamp during installation; it can scratch the finish of the bar and take longer to install.

Warranties vary on bar systems—be sure to analyze the restrictions. Many companies do not warranty the performance of the system, only the parts. Some companies advertise lifetime warranties, but they charge thousands of dollars in extra fees to add a performance warranty. There are “lifetime warranties” that actually expire in 30 years. According to the Metal Roofing Alliance, the life cycle of a metal roof is 50+ years! Always specify systems that include a full lifetime warranty for parts and performance. This ultimately protects the client, the roof components, and the pedestrians below for the life of the roof.



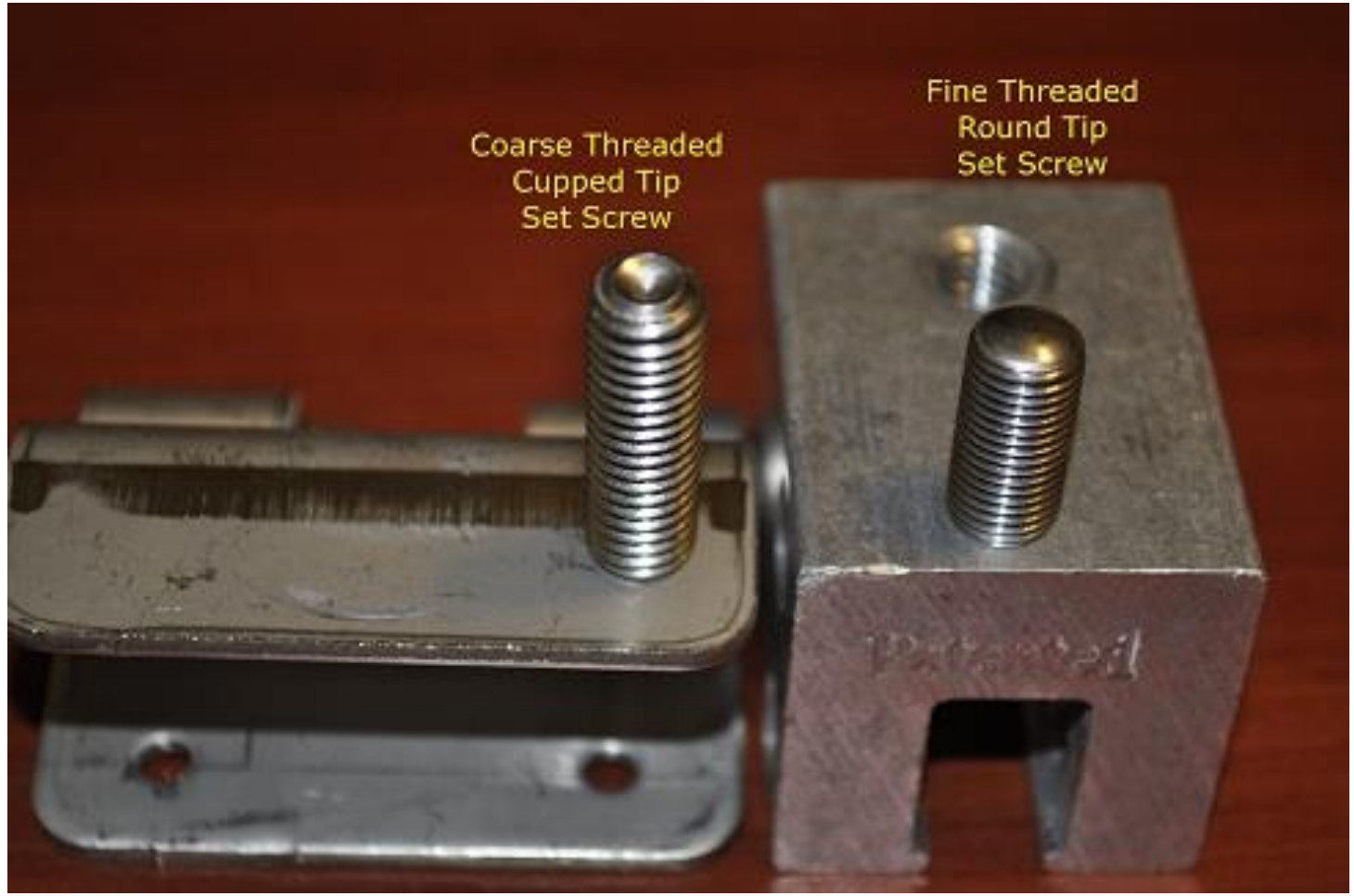
Two-piece clamp made of diecast zinc zamak that requires the bar to be fed through the clamps and relies on compression to stay in place on the seam. Notice that the aluminum bar is turned 45 degrees. A bar mounted at this angle will not hold snow and ice as long as a flat-faced bar mounted perpendicular to the panels.

Set Screws

Round Tip vs. Cupped Tip

There is a lot of controversy regarding metal roof clamp set screws and how they attach to standing seam metal roofs, primarily over fine threaded round tip set screws vs. coarse threaded cupped tip set screws.

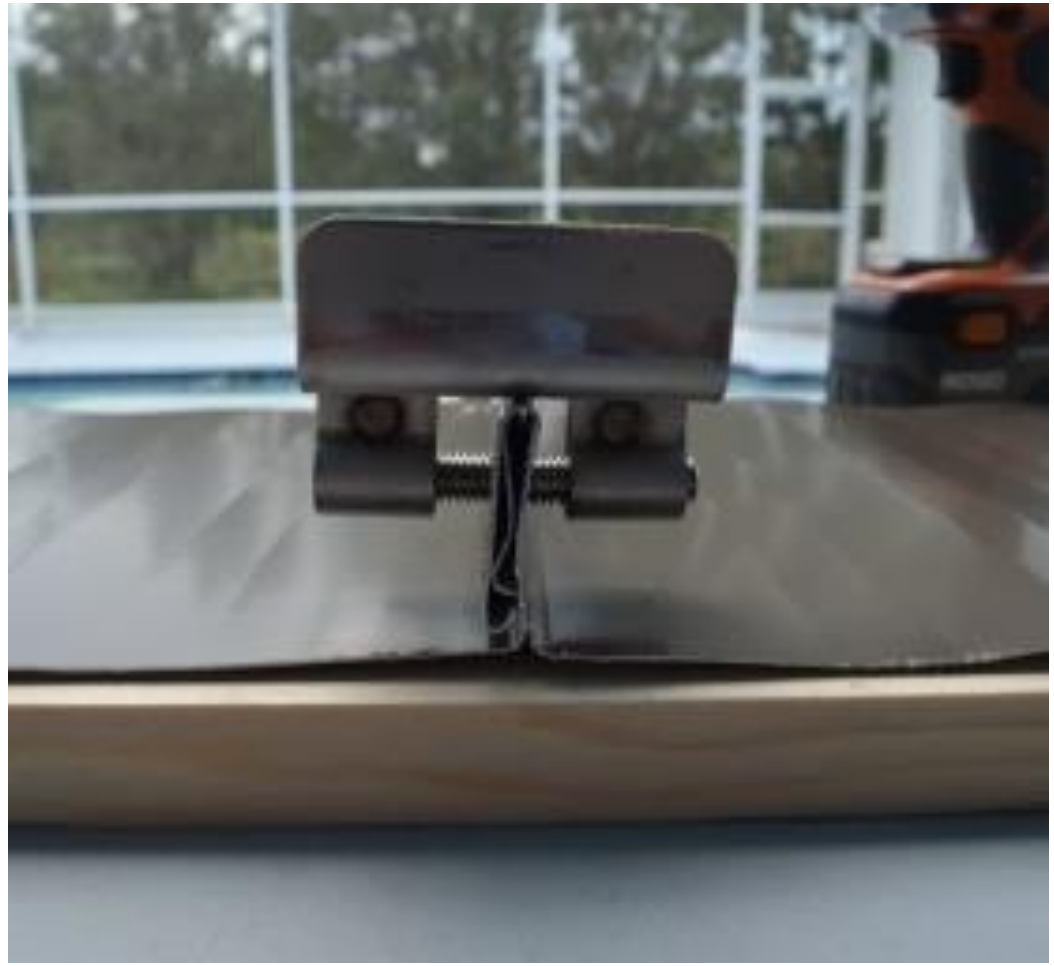
The bottom line is simple: All clamps and all set screws can damage the seams and panel finish if used improperly. There are no special patented set screws that don’t scratch or chip the paint.



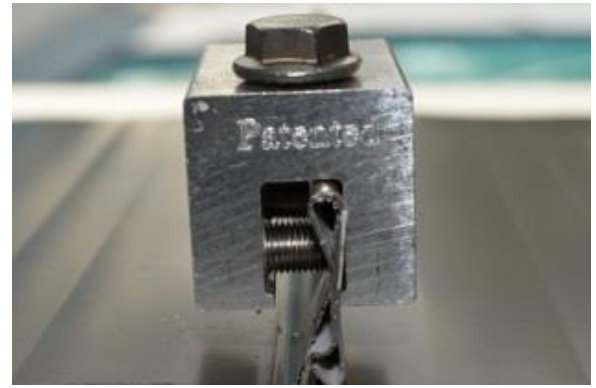
Set Screws

Clamps with cupped tip set screws and round tip set screws actually attach to the seams in very different ways. The cupped tip screws create a positive anchor point when properly torqued to 90 in/lb, while round tip set screws rely on high torque and panel compression or deformation to stay in place. In order for the clamps that utilize round tip set screws to stay in place under load, they must be torqued to 130–150 in/lb, or even as high as 160–180 in/lb, for 22-gauge panels.

Cupped tip fasteners do not overly distort the seam, nor do they ever gouge, destroy the finish, or cause premature corrosion when installed properly. This image illustrates a properly installed stainless steel clamp utilizing cupped tip set screws, mounted near the end of a seam, to show that there is very little seam distortion at 90 in/lb torque.



Set Screws



Here (upper photo) is an aluminum clamp using fine thread, round tip set screws where the factory recommended torque setting is between 130 in/lb and up to 180 in/lb for heavier panels. This type of clamp was placed at the end of the seam to demonstrate the seam distortion that occurs when torqued to the recommended setting.

Parts that attach with clamping mechanisms should be carefully scrutinized. This test (middle photo) shows that a round tip set screw, torqued to the factory recommended setting, can in fact scratch and deform the metal panel during installation.

This picture (lower photo) shows the permanent seam deformation and paint scratches left behind from using high torque set screws.

Bar Component Testing and Sustainability

ASTM B117 Accelerated Salt Spray Corrosion testing was conducted on several aluminum and galvanized steel bar samples with various finishes, along with clamps utilizing cupped tip and round tip set screws. According to the testing lab, the 1,006 hours of salt spray testing is extreme and probably beyond the natural life of a metal roof. This test was so severe that the paint was actually peeling off the panel surface.

After the test, all attachment point locations of the cupped tip set screws were free of corrosion and rust. This test shows that cupped tip set screws self-seal at the attachment point and do not contribute to premature corrosion.

The lower photo is an example of an aluminum clamp utilizing round tip set screws. This clamp could not be removed for seam inspection because the screws seized inside the clamp.

Bar Component Testing and Sustainability

A site inspection was performed in July 2013 on a standing seam roof in Pennsylvania. The bar system was installed in 1996 with cupped tip set screws and stainless steel clamps. The inspection was to determine if the panel had experienced any premature corrosion or other issues related to the clamp installation.

The upper photo was taken after removing the bar for inspection of the set screw attachment points. Low torque set screws protect the panel from deformation and stress cracks to the paint.

After 17 years of service, the lower photo shows the cupped tip set screw attachment point. The cupped tip set screw self-seals the attachment point, thereby protecting it from premature corrosion and rust. This system was inspected and reassembled and is expected to outperform the metal roof system.

Bar Component Testing and Sustainability

This test picture at right illustrates a few important facts:

- Roof clamps are exceptionally strong and will destroy seams if not properly used.
- A safety factor of three is highly recommended when designing anything to be mounted with seam clamps.
- The weakest part of a clamp system is always the seam.

Professional clamp testing at ATI

Bar Component Testing and Sustainability

In summary, tests showed that coarse threaded, cupped tip set screws are far more efficient at staying in place on the seam by only requiring 90 in/lb of torque. By design, round tip set screws are far less efficient at staying in place and therefore must be highly torqued from 130 in/lb to 180 in/lb depending on the gauge of the panel. High torque leads to panel deformation.

The salt spray test also proves that neither type of screw causes premature paint corrosion at the attachment point, and neither screw should void any paint or panel warranty since they both perform in a similar manner.

Pull-off test with a universal fit aluminum clamp using three stainless steel, cupped tip set screws on a Morin bulb seam. This clamp far exceeds the strength of the super strong panel joint.

Review Question

What is the difference between using cupped tip vs. round tip set screws in a snow guard system?

Answer

Cupped tip screws create a positive anchor point when properly torqued to 90 in/lb, while round tip set screws rely on high torque and panel compression or deformation to stay in place. In order for the clamps that utilize round tip set screws to stay in place under load, they must be torqued to 130–150 in/lb or even as high as 160–180 in/lb for 22-gauge panels.

Avoiding Common Mistakes

Common Mistakes to Avoid

Snow retention systems are just that: They only work as a system. The sum of several simple parts makes a very effective solution to prevent property damage and personal injury. The strongest and best design is useless if improperly installed. Snow bar system tests should include two clamps and bar, not just clamp test data. Designing snow retention systems based on clamp test data alone is very misleading because it does not properly establish the system strength. Weaker bar makes for weaker system strength; stiffer bar makes for stronger bar systems.

Guards should only be installed based on the manufacturer's recommended layout. Layouts should be designed using the field or fence method. Avoid concentrating multiple rows down by the eave; they should be equally spaced up the roof slope. A safety factor of three or higher should normally be used for snow retention products. This will help protect the components and roof from possible damage.

Common Mistakes to Avoid

All upper roof areas that dump onto lower roof areas also require designed snow retention. Snow drifting areas may require additional protection. Local knowledge of prevailing winds should be taken into consideration and discussed with the system designer.

Avoid snow guard products that do not have published independent test data. Working loads cannot be determined for something that has not been lab tested. All equipment can fail; however, engineered systems are far less likely to fail if properly designed and installed.

Use Proper Installation

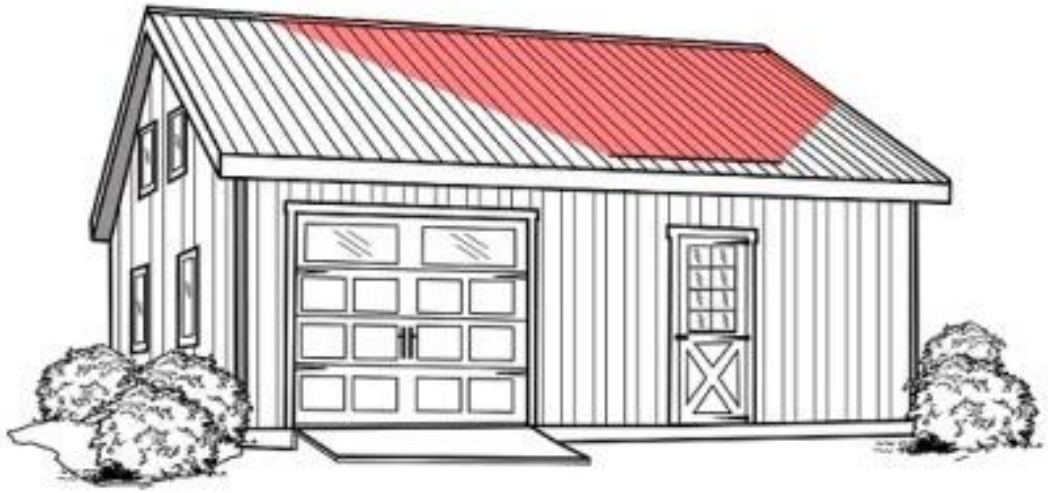
Polycarbonate guards should be glued whenever possible to avoid additional holes in metal panels. Attachment locations should be cleaned with alcohol wipes prior to glue attachment for best results. Peel-and-stick methods are an alternative for colder weather installation and should only be used with pointed guards designed to break the snow and ice.

Screw-mounted guards should always be screwed into at least 1.5 inches of solid wood or into steel purlins. The layout must be modified based on the purlin spacing. Noncorrosive #14 screws with neoprene washers and a high-quality silicone sealant should also be used with this type of attachment. Avoid using mechanically fastened guards on floating standing seam roof systems. Use nonpenetrating roof clamp bar systems or adhesive-mounted, pad-style guard systems for this application.

Be sure the snow guard design is an appropriate match for the project panel. The guard should be able to fit in the center of the panel for maximum efficiency. For example: 9-inch R-panels normally have two minor ribs; therefore, a guard with a 1.5-inch-wide base will fit perfectly between the two minor ribs. For bar systems, be sure that the clamp specified is an appropriate fit for the panels being used.

Use Proper Placement

Avoid isolated placement of snow guards; they have a high failure rate. Any snow guard product installed in an isolated fashion must be able to hold the dynamic load of the area above, PLUS the areas out at a 45-degree angle, as in the illustration below.



This graphic shows an example of isolated placement of a short section of bar over a doorway. These types of installations have a high rate of failure due to dynamic overloading. The safest and most proven method to protect this building is to design a snow guard system to cover the entire roof area.

Use Professional Fabrication and Design

Some roofing companies fabricate angle bars in their shops to install with their roofing jobs. These are also untested and likely to fail, causing severe panel damage, as seen in the photos below. This entire roof had to be replaced with new panels due to the failure of the homemade bars.

This contractor-fabricated system was made of 1.5-inch aluminum angle on 9-inch R-panel. The bar was predrilled, and roofing screws were used to mechanically fasten through the major ribs and down into the subroofing.

The roof has a 6/12 pitch. Only one row was used on this 50 psf ground snow load project. The system lasted three years before failure.

Use Professional Fabrication and Design

The upper photo shows an installer-fabricated angle that has been screwed through the watertight seam. This compromises the watertightness of the roof and can possibly void the roof warranty. A bar system with nonpenetrating clamps should be used, and the rows should be evenly spaced up the panels.

Anything mounted on a roof will hold snow. It should be designed to withstand the snow load, or snow retention should be specified. Notice the single staggered row of snow guards below the sign in the lower photo. A professionally designed layout would have had multiple staggered rows of guards spaced up the entire roof area. Also notice that the snow guards were screwed down on this concealed fastener roof.

Follow Instructions

Rule #1: Follow the instructions. These snow guards in the upper photo were mounted sideways in a straight line across the roof, allowing this light snow load to dislodge them.

In the lower photo, a failure of a compression-style clamp system is shown. Notice the two rows of bar mounted at the eave. The extreme pitch and distance that snow is allowed to slide before reaching the second row of bar is exceeding the bar's capability. Improper spacing contributed to the failure of this system. This failure could have been avoided by equally spacing the bar up the roof.

Use Proper Spacing

This image shows the opposite side of the same roof from the prior slide. Notice that the top row slid down due to overloading from improper spacing. It then forced the next row to also slide. The rows should have been equally spaced up the roof in order to avoid this type of failure.

Concentrating most of the protection down by the eave caused this bar system to fail. This system used compression-style clamps, which do not use set screws that permanently lock onto the seams.

Use Proper Spacing

This photo shows a failure of a bar system in Colorado. Notice that three rows of bar are concentrated close to the eave. Snow retention should be equally spaced up the roof area to control the dynamic loads of sliding snow and ice.

Two-thirds of the snow load on this roof was being held by just the upper bar. The lower two bars only held one-third of the snow. In addition, this system failed because it used isolated placement and extended the bars too far across the panel at the end of the run. These clamps were also installed over batten strips, which is not a good idea. This failure could have been avoided by equally spacing the rows up the roof, by extending the runs the entire length of the roof, and by using clamps that would have attached under the batten strip, not on it.

Use Proper Bar Lengths

Terminating the bar before the end of a run is a recipe for disaster. The damage to the seams and bar shown in the upper photo could have been avoided by equally spacing the rows up the roof and by extending the rows the entire length of the roof.

In the illustration of seam-mounted snow guards in the lower photo, notice the middle guard has been twisted to the side from uneven loading. Unfortunately, the seam is damaged as well.

Use Proper Number of Bars

This is what it looks like when clamps, installed with round tip set screws, fail and have to be reattached. This view is from the down slope side looking up. The original snow retention application crushed the seam as the bar was overloaded.

This project was quoted by one manufacturer for four rows and by another for two rows. The clamps of the two-row system cantilevered up, causing the highly torqued round tip set screws to rip the seam open. Four equally spaced rows with a clamp mounted on every seam would have reduced the clamp loads considerably and probably avoided this type of failure.

Insisting on conservative safety factors is far more important than choosing the least expensive system with the fewest rows.

Use Proper Bar Size

Pencil-thin round bar is extremely ineffective at holding back snow and ice. The most effective method is flat-faced bar, mounted perpendicular to the panels. Notice the snow and ice ramping over and sliding under the bar.

Review Question

Which common mistake has caused the situation in the photo at right?

Answer

Improper spacing. Note that the top row slid down due to overloading from improper spacing. It then forced the next row to also slide. The rows should have been equally spaced up the roof in order to avoid this type of failure.

Concentrating most of the protection down by the eave caused this bar system to fail. This system used compression-style clamps, which do not use set screws that permanently lock onto the seams.

Understanding the Snow Guard Layout Theory

Evolution of Modern Snow Guard Methods

As the metal roofing industry has improved its technology, so has the snow guard industry. Stones and logs have been replaced with polycarbonate, stainless steel, and aluminum. One of the first studies of snow guard methods on modern metal roofing was done by the US Army Corp of Engineers. They had to develop methods to protect military buildings and property from the damage they had been sustaining from sliding snow and ice. They learned that to properly calculate the safest and strongest methods, they had to assume that the friction between roof and snow is zero. They determined that snow guards could be mechanically fastened or glued down in rows in order to effectively protect the roofs from further damage.

Modern systems should be designed to hold the snow and ice in place with multiple rows up the roof. Concentrating the protection near the eave is ineffective and dangerous. Trying to stop the dynamic force of sliding snow and ice can cause serious damage to the roof components and pedestrians. The idea is to hold it, not attempt to catch it before it flies off the roof. Once it begins to slide down the roof, the snow load increases dramatically and can quickly exceed the design loads. It is also possible to experience a snow guard failure without the equipment actually coming off the roof. This happens when snow and ice are allowed to generate enough velocity to slam into the lower rows of guards, allowing the snow and ice to fly right over them and down to the ground.

Snow Guard Layout Theory

This design theory is the basis of modern snow retention layouts and has been conceded in studies by both the Army Corp of Engineers and the American Society of Civil Engineers (see References slide at end of course).

Layouts should be based on these design considerations:

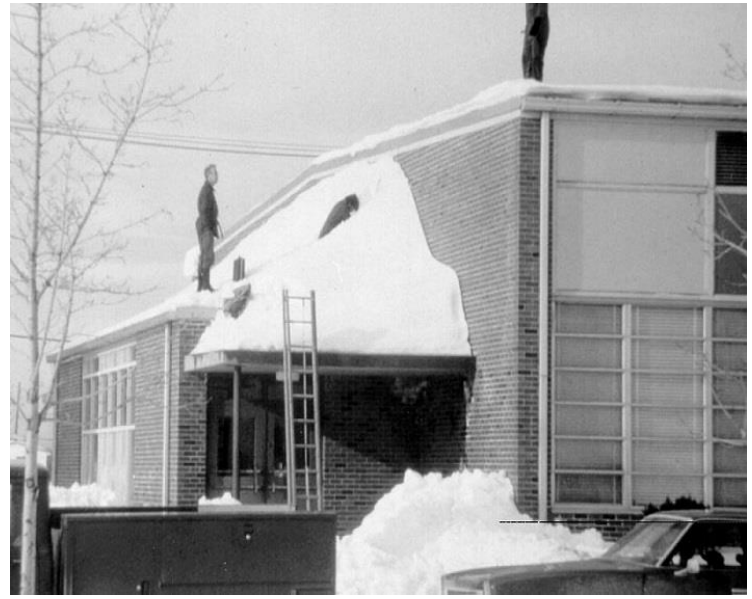
- “the rows should be spaced uniformly...multiple rows of reasonably strong snow guards are preferred over one very strong last line of defense placed near the eaves.”[1]
- “Multiple rows of snow guards spaced well apart up the roof...are better at holding snow in place (i.e., avoiding the large dynamic loads created by sliding snow) than one row of last-resort snow guards placed near the eaves.”[2]
- “A short snow guard on a long roof without other snow guards must be able to resist all the snow located within outward 45° angles up slope of its location. The loads at the ends of such a snow guard are about twice the average load on it.”[3]

The type of vehicle damage shown here prompted the US Army Corp of Engineers to develop effective methods of snow retention.

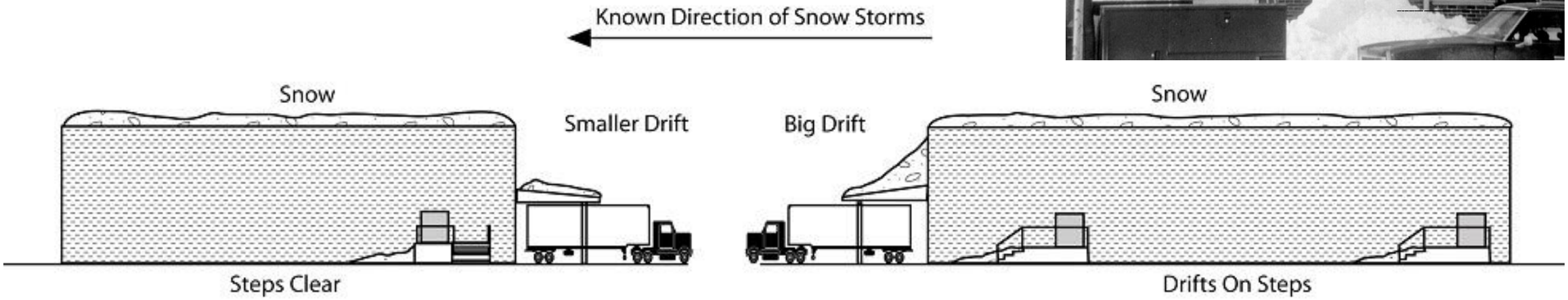
[1]Tobiasson, W., J. Buska and A. Greatorex. “Snow Guards for Metal Roofs.” American Society of Civil Engineers, August 1996.
[2,3]US Army Corps of Engineers. “Technical Instructions: Commentary on Snow Loads.” TI 809-52. Directorate of Military Programs, 3 August 1998.

Snow Drifts

This 130 psf snow drift occurred on a roof with a light 20 psf design snow load. Snow drifts must be considered when calculating snow retention systems. They can far exceed the design snow loads and cause failures and severe panel damage.



Having local knowledge of prevailing winds and using conservative safety factors when designing the snow retention system will help mitigate these issues.



Snow Guard Layouts

A properly designed, tested, and installed snow guard system should last the life of the roof. Here is a brief overview of the most important topics to consider when designing a snow guard system.

1. Start by writing down the following for each roof area on your building:
    a. Roof area overall width (eave length)
    b. Panel run (panel length from peak of roof down to the eave)
    c. Panel type (standing seam, R-panel, etc.)
    d. Panel dimensions (width between seams or on-center width between major and minor ribs)
    e. Local ground snow load
    f. Determine your roof pitch
    g. Special design considerations such as drifting areas

Without a proper snow guard layout, the strongest snow guard in the world is worthless. Today, anyone can input roof dimensions, pitch, and ground snow load into an online software program. The system will offer the option of three attachment methods including adhesive, screws, or a seam clamp-mounted bar system. After all the options are selected, the best layout is calculated, and a line drawing is created that shows the recommended quantities, optimal row spacing, and project costs.

Snow Guard Layouts

2. The idea is to hold the snow and ice in place (where it originally landed), not just try to catch it before it avalanches over the eave. No snow guard system will hold 100% of the snow and ice. Nearly all failed snow guard layouts have just one or two rows, and they are usually installed only down at the eave. This typical amateur type of layout has a high failure rate because it attempts to catch sliding snow and ice, instead of holding it where it landed on the roof. By the time the snow and ice start to slide, it's game over.

3. Rows of pad-style snow guards in the field method are to be installed in a staggered pattern, never in straight lines. Pad-style snow guards that are installed in staggered rows have a significantly lower chance of failure. The staggered pattern helps the snow and ice field coagulate to eliminate the possibility of movement.

4. On longer runs, evenly distribute the load across the roof structure with multiple rows. Roofs are designed to hold the snow load but are not designed to withstand uneven loads concentrated at the eaves.

Please remember the **test password LAYOUT**. You will be required to enter it in order to proceed with the online test.

Snow Guard Layouts

Here is an excellent example of an evenly spaced bar system in a fence method. The four rows are spaced evenly up the roof to prevent the snow and ice from building dynamic loads that exceed the design. Remember that the weakest link in a clamp system is the seam, so using a clamp on every seam combined with a conservative safety factor and evenly spaced rows will help protect the seams from damage.

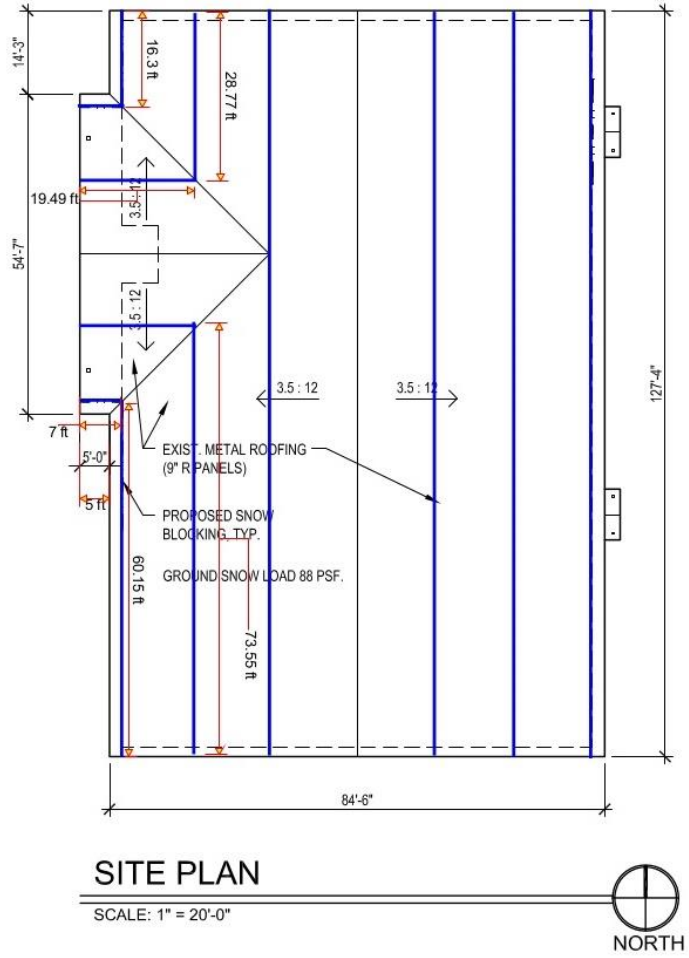
The lower photo shows standing seam panel damage due to converging snow in a valley. This is a good reason to use multiple rows going up the roof. If all the rows are down at the eave, there is nothing to prevent this type of damage: “Flow of snow down valleys can bend the standing seams of metal roofing...reducing their strength and violating their waterproofing integrity.”[1]

[1]US Army Corps of Engineers. “Technical Instructions: Commentary on Snow Loads.” TI 809-52. Directorate of Military Programs, 3 August 1998.

Snow Guard Layouts

Bar system layouts should look similar to this roof plan.

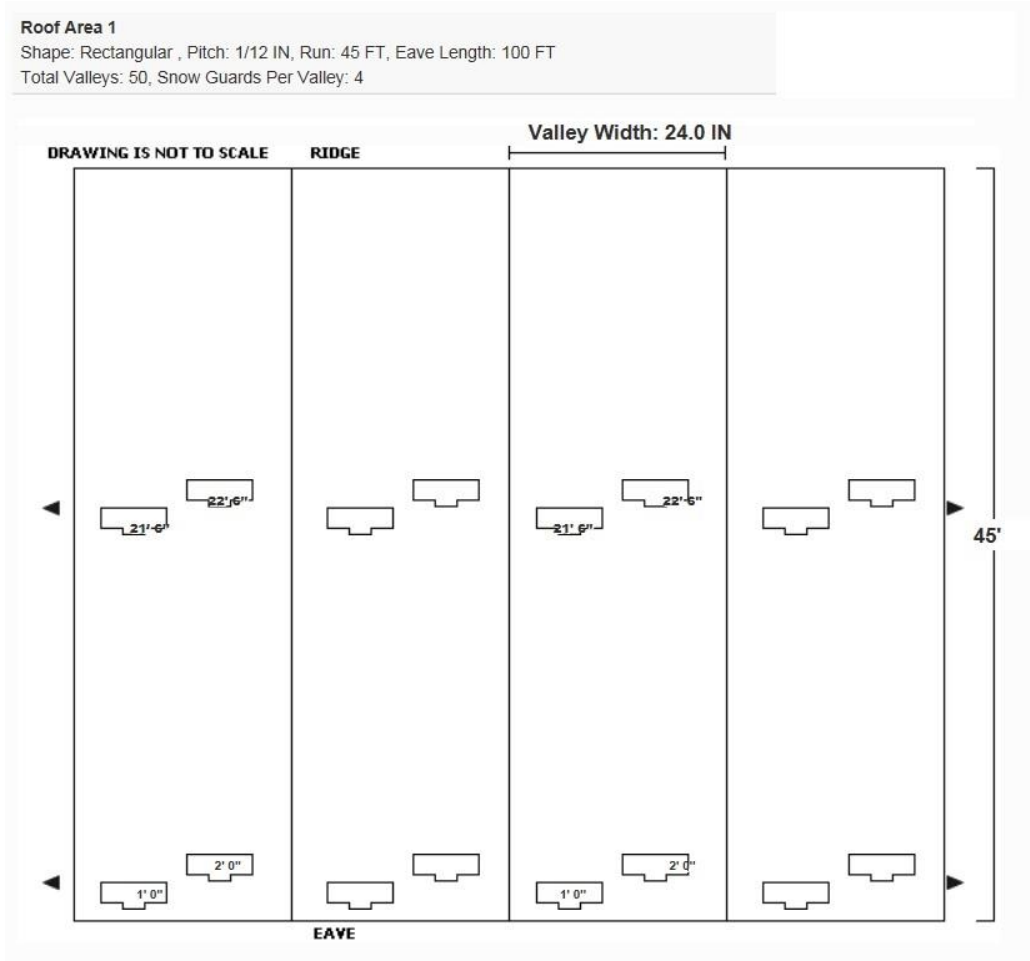
The project-specific layout calls for three, evenly spaced rows of bar with mechanically fastened brackets every 18 inches with a 3.5/12 pitch, 88 lb ground snow load, with 42-foot runs on each roof area. This layout will contain the snow and ice every 14 feet going up the roof. Concentrating rows down by the eave would leave a potential 30-foot run exposed. This could cause severe panel damage because of the dynamic loads exceeding the design load. Evenly spaced rows distribute the weight proportionately on the roof structure.



Snow Guard Layouts

This is an example of a popular snow guard layout created by an online estimator.

This layout shows a 24-inch-wide panel that requires two staggered snow guards per row, per panel. This is a 45-foot run from ridge to eave with a 1/12 roof pitch and a 20 psf snow load. Notice that the rows are staggered, spaced evenly up the roof area, and not just concentrated down by the eave. Some manufacturers offer a lifetime breakage warranty if the layout is followed.



References

"Raising the Bar: Snow Guards Work as Architectural Feature." *Metal Construction News.* Modern Trade Communications Inc., Jan. 2011, http://www.metalconstructionnews.com/articles/magazine-features/snow-retention-jan-2011.aspx. Accessed Mar. 2021.

Tobiasson, Wayne, James Buska, and Alan Greatorex. "Snow Guards for Metal Roofs." American Society of Civil Engineers, August 1996, https://www.poa.usace.army.mil/Portals/34/docs/engineering/MP-05-6443,%20Snow%20Guards%20for%20Metal%20Roofs.pdf. Accessed Mar. 2021.

US Army Corps of Engineers. "Technical Instructions: Commentary on Snow Loads." TI 809-52. Directorate of Military Programs, 3 August 1998, https://www.scribd.com/document/421045688/US-Snow-Loads. Accessed Mar. 2021.

Conclusion

If you desire AIA/CES, state licensing, or CE credits for another organization, please click on the button to commence your online test. A score of 80% or better will allow you to print your Certificate of Completion; you may also go to your AEC Daily Transcript to see your completed courses and certificates.

For additional knowledge and postseminar assistance, click on the Ask an Expert link.

If you have colleagues who might benefit from this seminar, please let them know. Feel free to revisit the AEC Daily website to download additional programs.

MORE ›

Questions? Ask an Expert – click here

Click Here to Take the Test

Exit