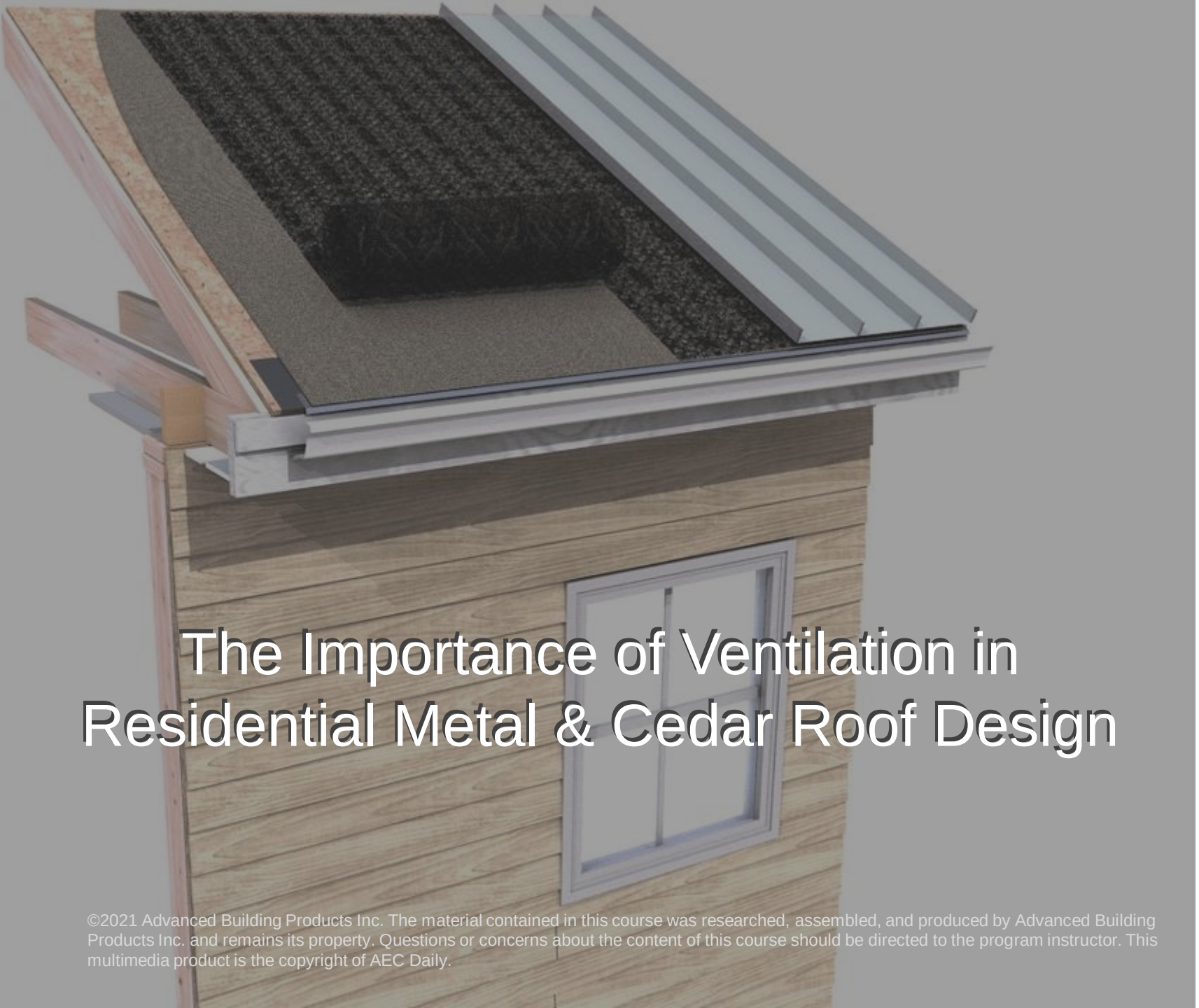

The Importance of Ventilation in Residential Metal & Cedar Roof Design

AIA Continuing Education Provider

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The Importance of Ventilation in Residential Metal & Cedar Roof Design

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Purpose and Learning Objectives

Purpose:

The primary purpose of a roof is to provide shelter and protection; to do so effectively over the long term, proper drainage and ventilation are required. Presented here are the categories of metal roofing, the moisture- and noise-related issues associated with architectural metal roofs, the use of a three-dimensional drainage and ventilation mat as a solution to these issues, and best practices for incorporating a mat in metal and cedar roof assemblies.

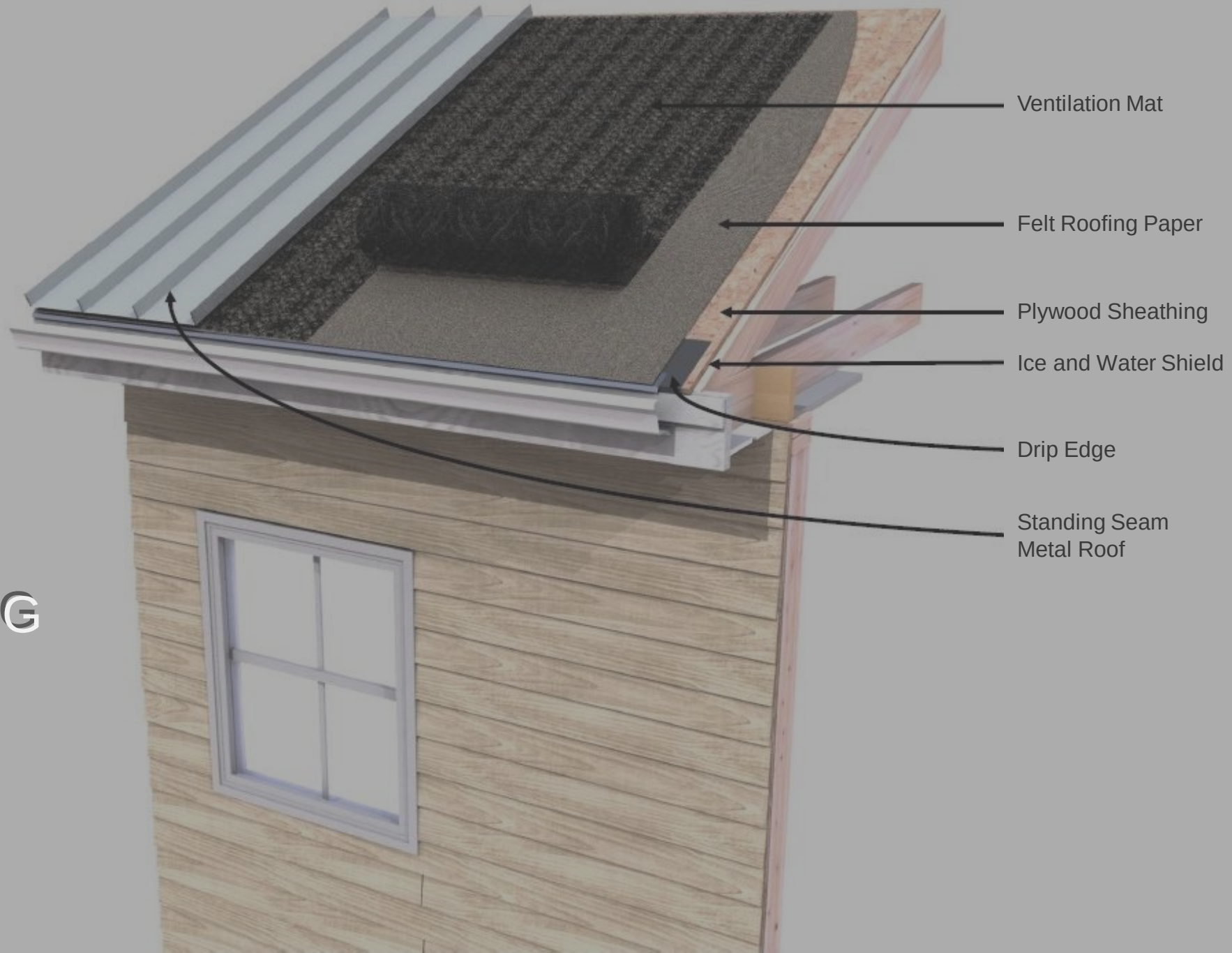
Learning Objectives:

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

- define hydrokinetic and hydrostatic metal roofing and describe their construction, how they manage water, and their suitable applications
- summarize the moisture- and noise-related issues associated with architectural metal roofs and their impact on the performance and longevity of the roof and the comfort and well-being of building occupants
- explain how a three-dimensional drainage and ventilation mat that utilizes entangled-net technology promotes airflow, provides a path for drainage, and mitigates noise in metal roof assemblies, and
- recall best practices for incorporating roof ventilation mats in metal and cedar roofs to ensure high-performing, energy-efficient installations.

Contents

OVERVIEW OF METAL ROOFING



Benefits of a Metal Roof

Metal roofing is experiencing a steady gain in popularity; the reason why is evident when you consider the characteristics of metal roofs.

Durable

- Sustain high winds
- High strength
- Impact and crack resistant
- Low maintenance

Long Lasting

- Service life of 50–70 years compared to 15–30 years for asphalt shingles

Energy Efficient

- Reflect solar heat to reduce cooling costs

Safe

- Will not spark or promote flames from wildfire or lightning

Ecofriendly

- 25–95% recycled content
- 100% recycled at the end of life

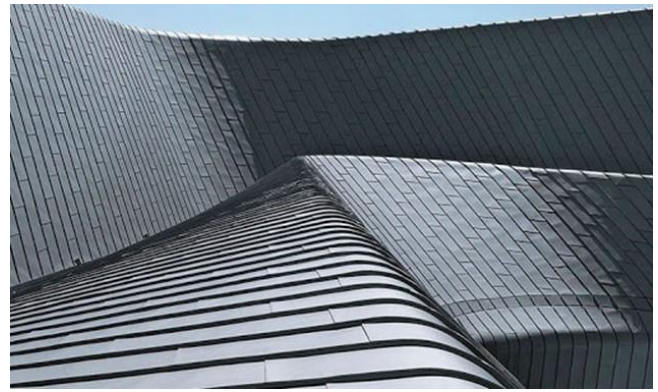
Aesthetically Appealing

- Consumers like the look
- Market share is growing

Metal Roofing Materials

Metal roofing is available in various materials:

- Copper
- Stainless steel
- Painted steel
- Painted aluminum
- Galvanized steel
- Zinc
- Titanium



Metal Roofing Categories

Metal roofing panels are divided into two categories based on the seams between the roofing panels: hydrokinetic or hydrostatic. The slope of the roof determines panel selection.

Hydrokinetic metal roofing, referred to as architectural roofing, is designed to move water. The panels are not watertight and depend on gravity to shed rainwater, and they are therefore suitable for steep-slope applications.

Hydrostatic metal roofing, referred to as structural roofing, is watertight and employs a sealant along the seams/joints to protect against water intrusion. It is suitable for low-slope applications subject to standing water.

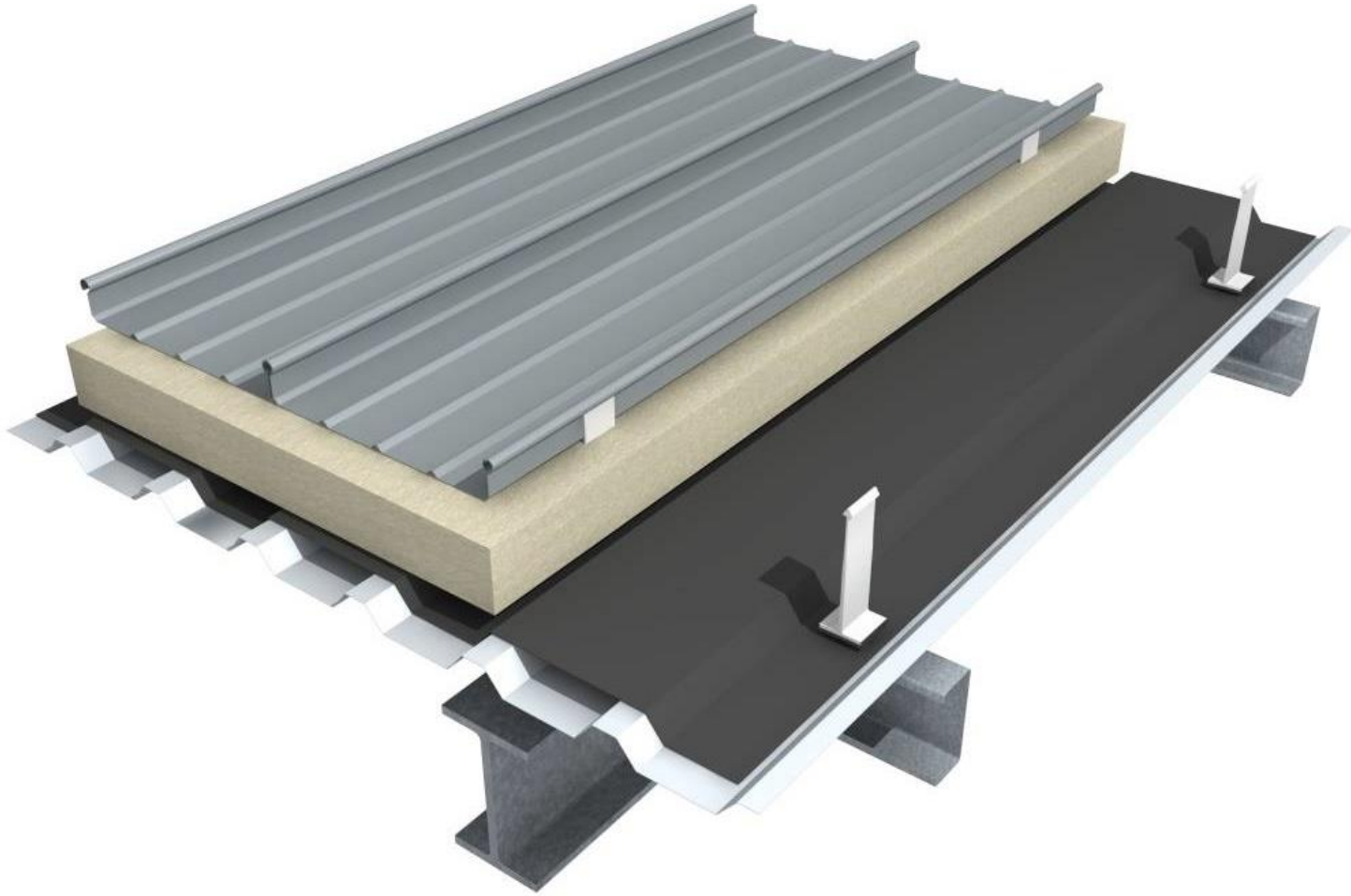
Image by PublicDomainPictures from Pixabay

Hydrokinetic/Architectural Roofing

Hydrokinetic roofing is usually suitable for a pitch of 3:12 or greater. A solid substrate and a water-resistant barrier are required. The metal roofing must attach to the structural sheathing that spans between the roof joists. This means that the roof clips are connected to plywood, oriented strand board (OSB), or a proprietary board provided by several manufacturers in the industry today.

Hydrokinetic/Architectural Roofing

A hydrokinetic metal roof is sometimes used for commercial applications. It is attached to a corrugated metal roof deck with a layer of rigid insulation, typically between the metal deck and the metal roof.

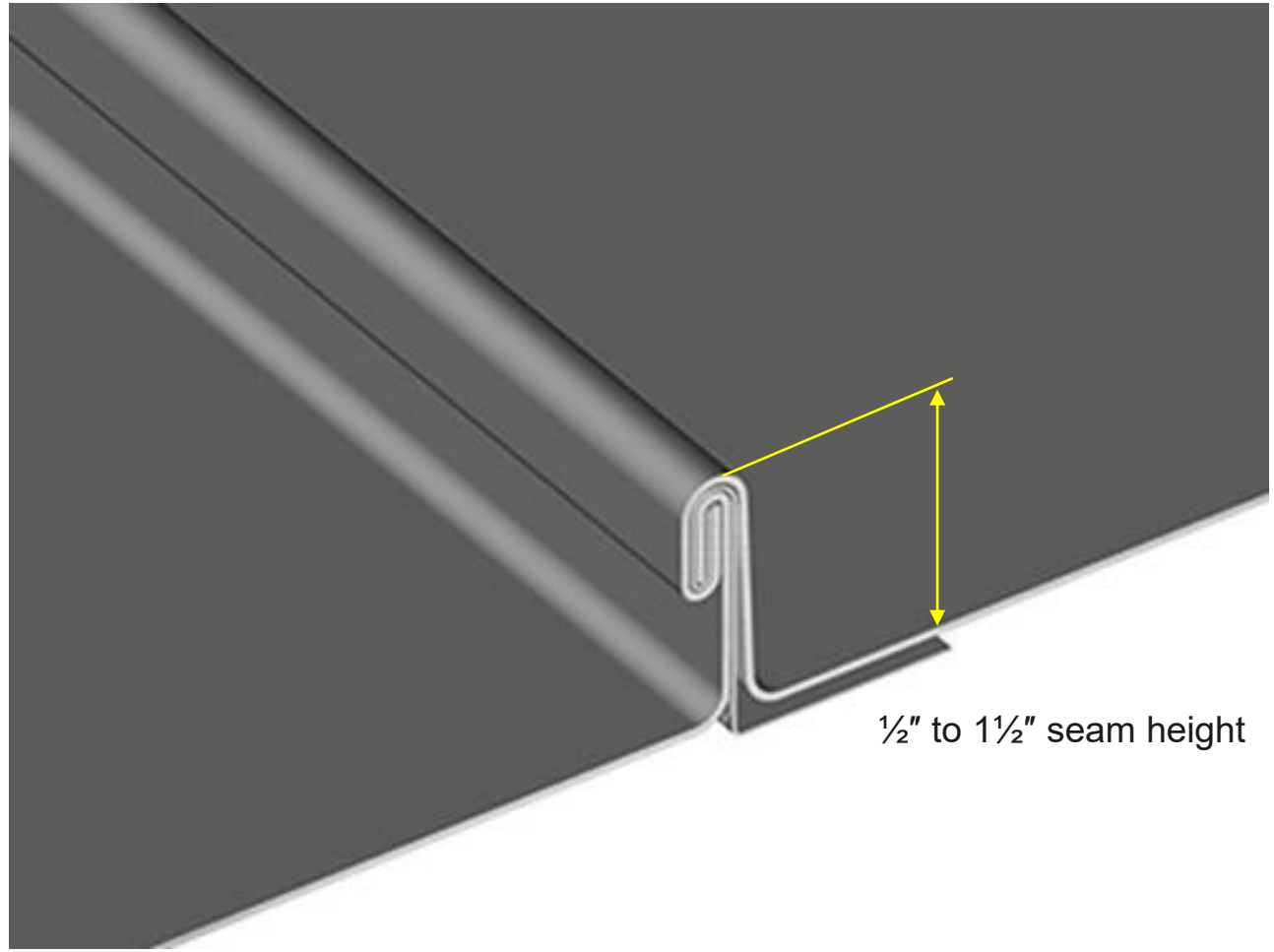


Hydrokinetic/Architectural Roofing

Seams are usually ½″ or 1½″ in height. Some continuous standing seam metal roofing products use an integral seam; each panel snaps into place over the previous panel and is fastened with clips.

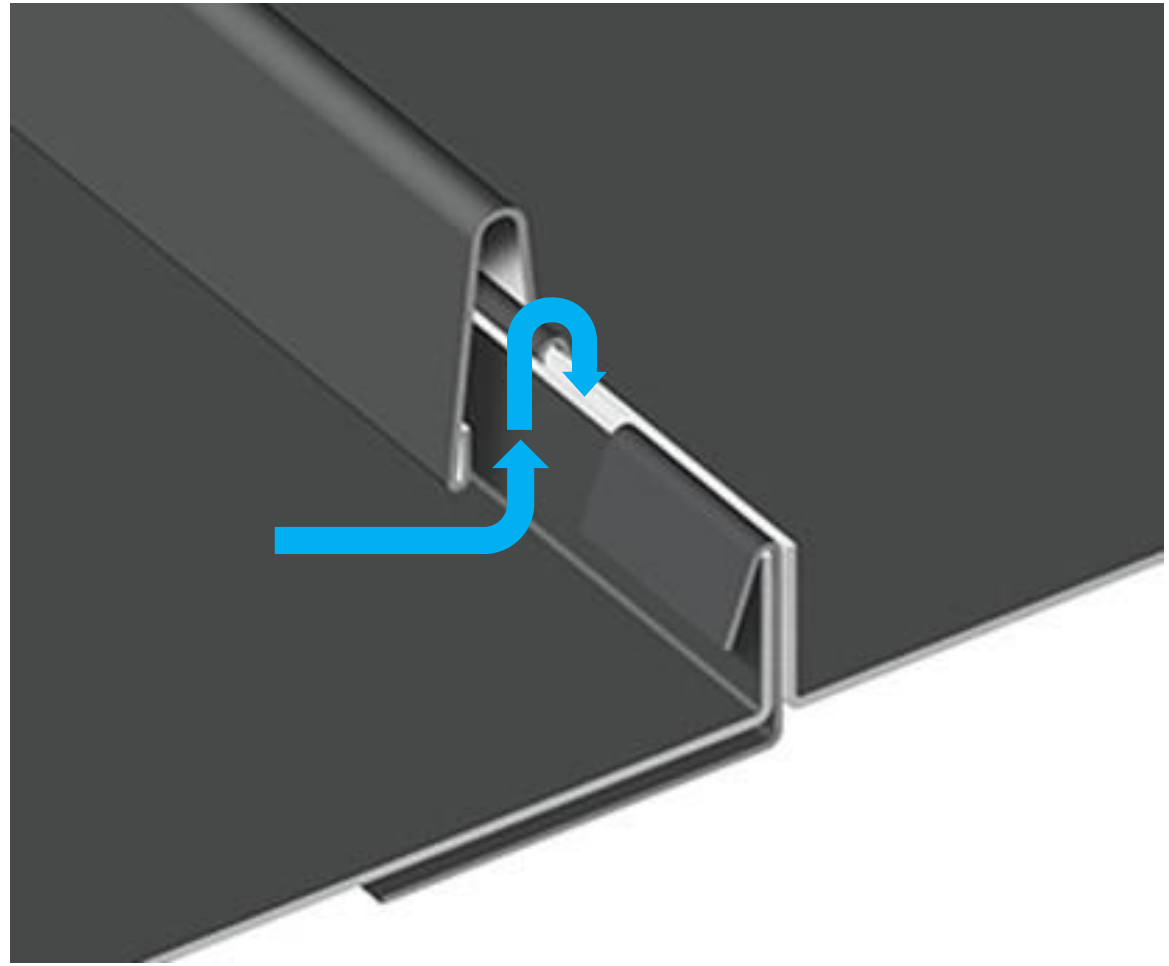
An architectural metal roofing system can also be mechanically seamed in the field during installation. These types of systems can be fabricated with many different seam heights. Field-fabricated panels are ordinarily installed with a fixed or sliding clip system.

To reiterate, hydrokinetic metal roofing is dependent on the proper sloping of the roof because it is not watertight.



Hydrokinetic/Architectural Roofing

Some metal roofing panels have gaps that allow water to seep into the roofing sheathing if rainwater backs up or is driven by the wind. Also, poor workmanship, especially at the seams, creates the potential for water intrusion.



Hydrokinetic/Architectural Roofing

Some hydrokinetic roofing is roll formed, including standing seam, batten seam, and flat seam roofing. Hydrokinetic roofing can also be fabricated on the jobsite from coils of metal.

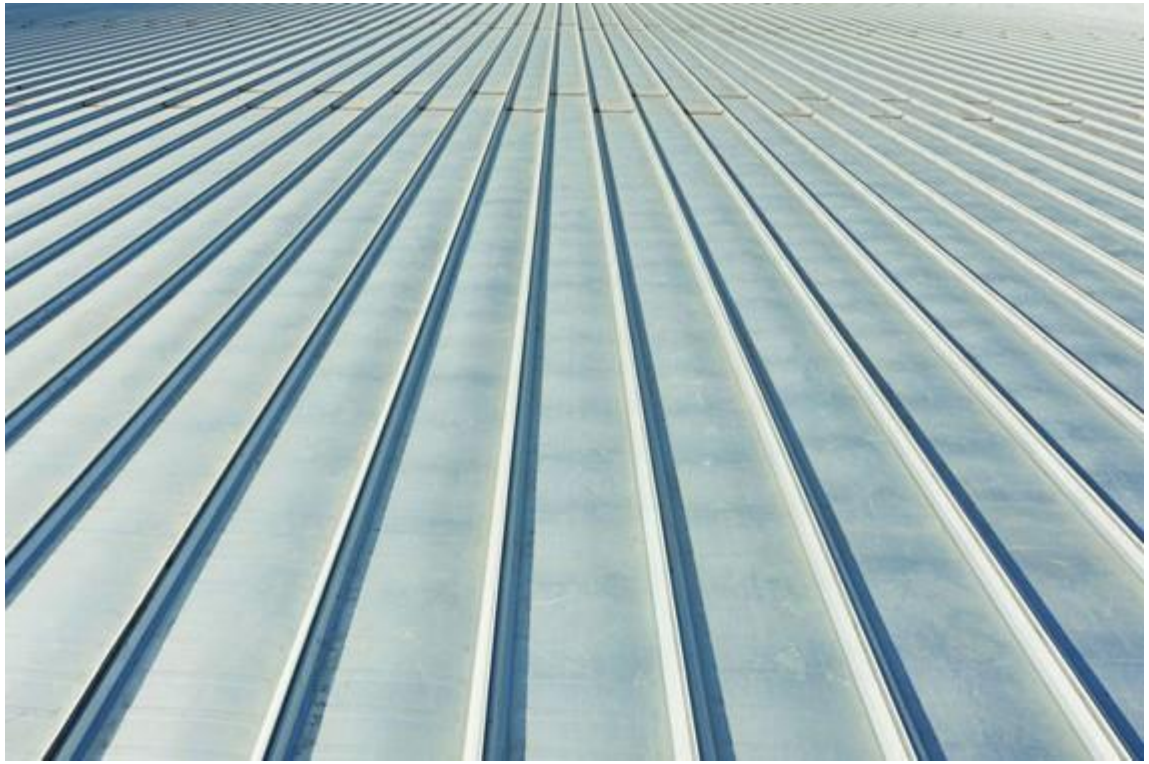
Hydrokinetic roofing can be stamped to simulate factory-made tiles or cedar shakes. These panels are typically attached at the top of the ridge and allowed to move at the bottom. This type of metal roofing is often used on residential buildings, churches, and other small to midsize commercial buildings.

Hydrostatic/Structural Roofing

Hydrostatic metal roofing is typically suited for applications with a slope of 2:12 or lower. This system does not require a substrate or water-resistant barrier. The panels must attach directly to the purlins that span between the roof joists. The seams are typically 1½″ to 3″ in height. The roofing panels are sealed with sealant or tape and mechanically at the joints to resist ponding water.

Hydrostatic/Structural Roofing

Hydrostatic metal roofing systems are used predominantly on warehouses and other large industrial and commercial buildings. The roofing panels are typically attached at the base of the slope and allowed to move at the top—the opposite of hydrokinetic roofing.



Review Question

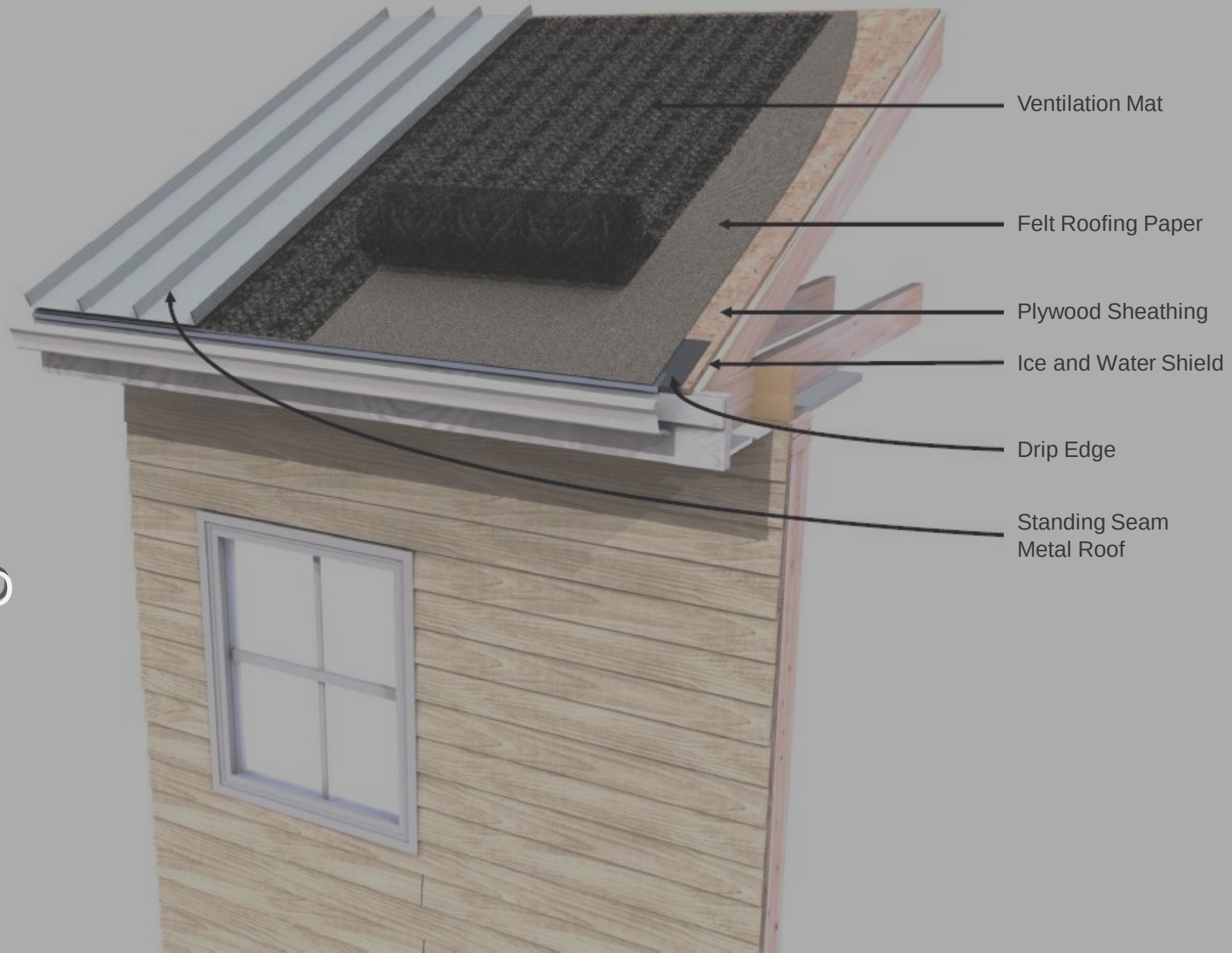
Explain what hydrokinetic and hydrostatic metal roofing are.

Answer

Hydrokinetic metal roofing, referred to as architectural roofing, is designed to move water. The panels are not watertight and depend on gravity to shed rainwater, and they are therefore suitable for steep-slope applications.

Hydrostatic metal roofing, referred to as structural roofing, is watertight and employs a sealant along the seams/joints to protect against water intrusion. It is suitable for low-slope applications subject to standing water.

METAL ROOFS: MOISTURE AND NOISE ISSUES

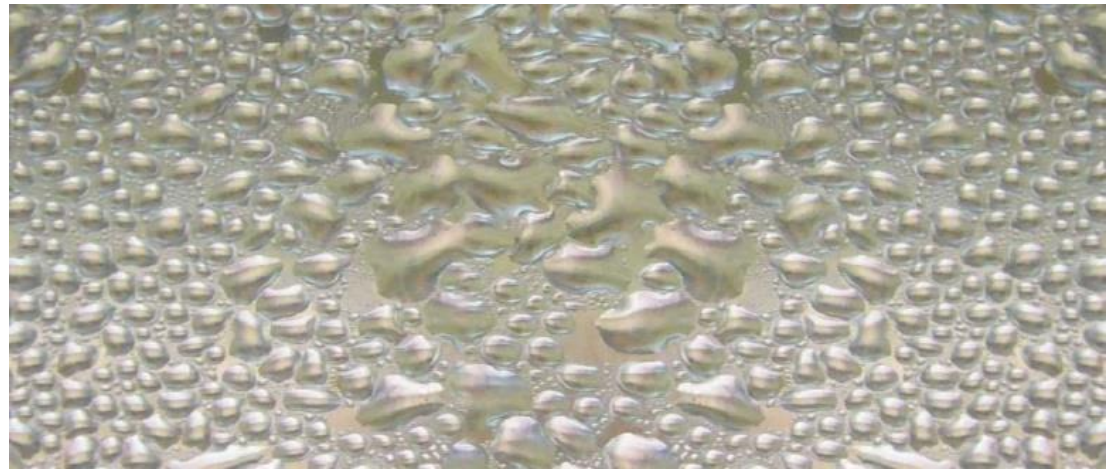


Metal Roofs: Moisture and Noise Issues

We've addressed the different types of metal roofing and why it's becoming more popular, but it is equally important to address the problematic factors associated with metal roofs.

As with any roof, moisture management is critical. Wind-driven precipitation can cause leaks in hydrokinetic metal roofs, and leaks can also occur through water backup or ponding due to clogged drains and ice damming. Condensation of water vapor on the bottom surface of metal roofing is also of concern.

Lastly, unlike with wood or asphalt shingles, we need to address the excessive noise that can be caused by the impact of rain, sleet, and hail on metal roofing.



Leaks from Wind-Driven Precipitation

How does a roof leak? For water intrusion to occur, an event needs to transpire—high winds, heavy melting snow, roof damage, and/or installation error.

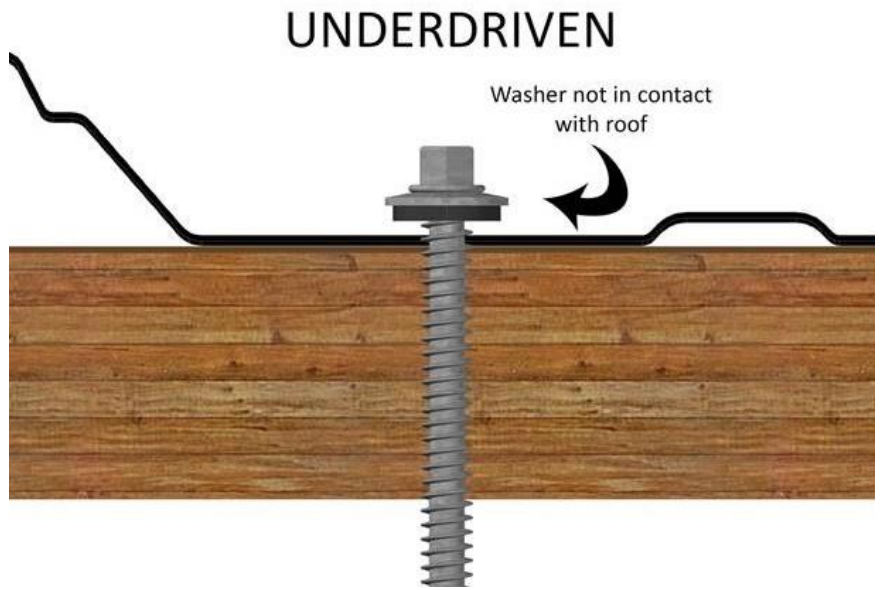
Since hydrokinetic roofs are not watertight, wind can force water into the joints. Hydrokinetic metal roofing is very dependent on gravity, but high winds and snow sometimes work against gravity and impede water drainage.

Leaks from Wind-Driven Precipitation

Installation errors can lead to damage. If the roofing fasteners are installed too tightly or too loosely or aren't installed straight into the roof, moisture will have a path of entry into the roofing system. When not installed correctly, flashings at penetrations, such as chimneys, hips, and valleys, will cause moisture-related issues on the roof.

Sealants will eventually fail and must be inspected and replaced per the manufacturer's recommendations.

The last major issue with moisture intrusion on a metal roof is inadequate details, and occasionally, an inability to read the details accurately.



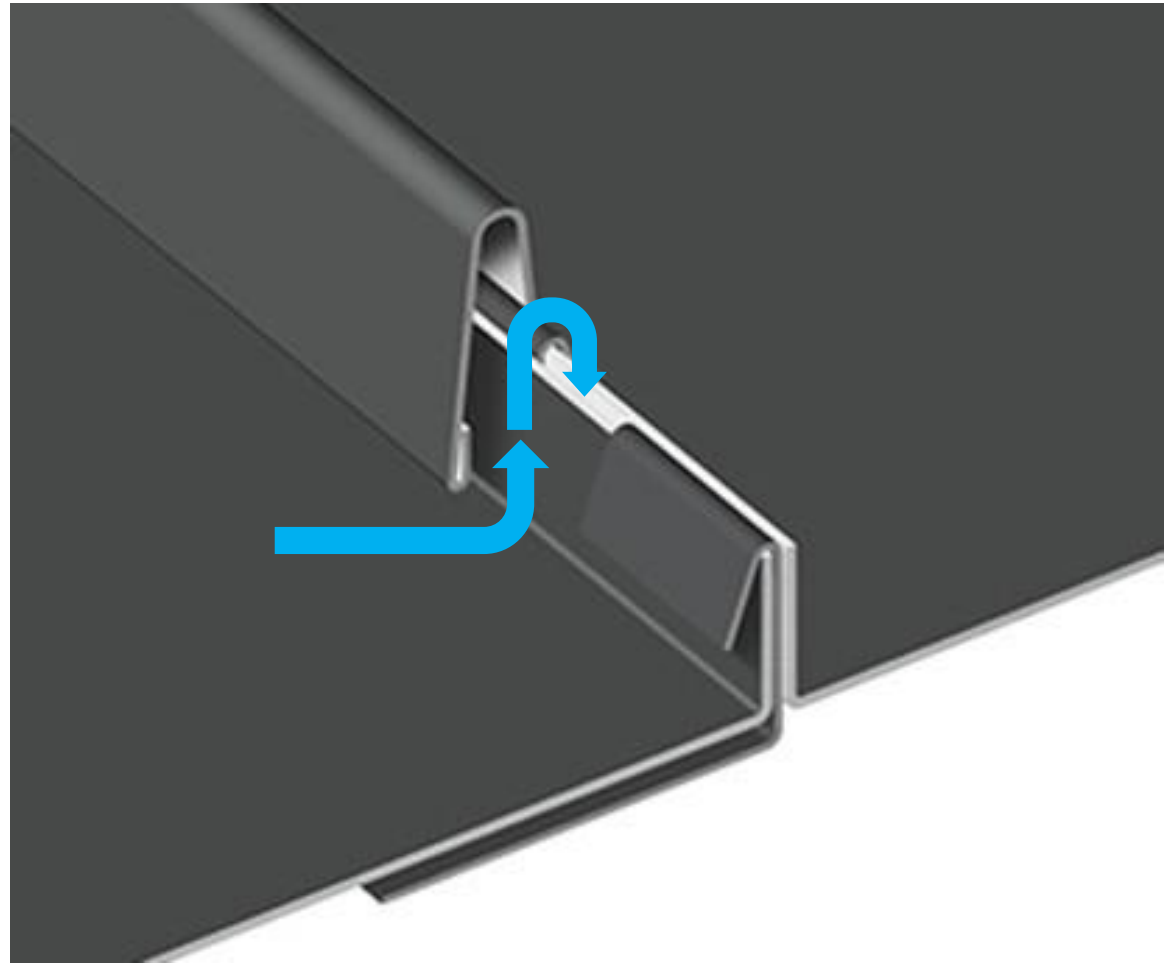
Leaks from Water Ponding

Clogged gutters are often linked to moisture damage on metal roofs.

Architects like to use box or concealed gutters because of their visual appeal, but they can be problematic if not carefully designed and constructed. Sometimes the gutters are installed too high, causing water to back up under the roof, and occasionally gutters are too small, and the overflow causes issues.

Leaks from Water Backup

As stated, a hydrokinetic roof depends on gravity to allow the moisture to drain and not remain on the rooftop. When water backs up, it will leak into the joints, and in certain geographic regions, this can lead to the formation of ice dams.



Leaks from Water Backup: Ice Dams

How do ice dams form? It starts with warm air rising through the attic space; once it meets the snow on the roofing, melting begins. As the melted snow runs down the roof to the eave/overhang, the cold temperature observed at this location causes the water to refreeze.

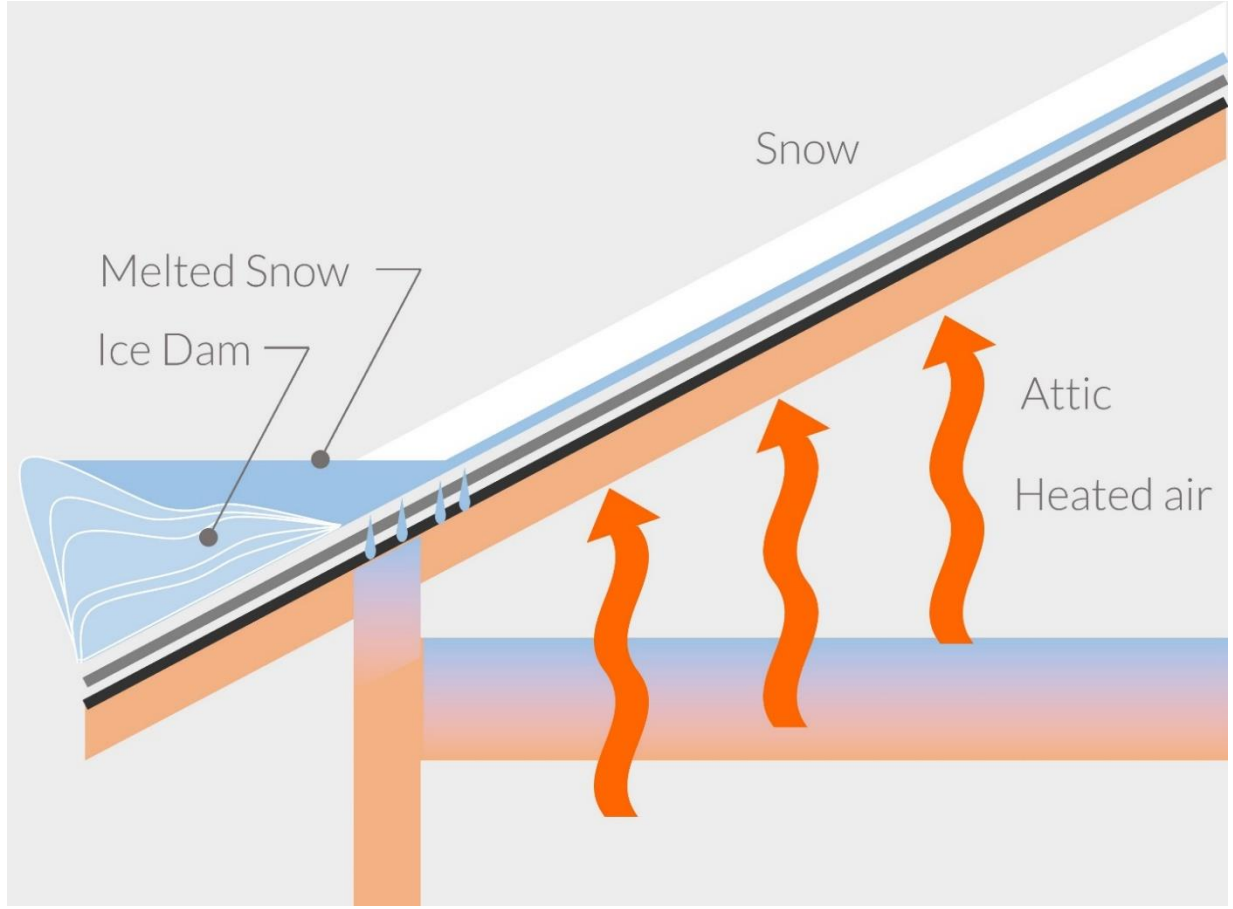
Leaks from Water Backup: Ice Dams

The constant cycle of freezing, melting, and then refreezing causes ice dams to form. As the ice continues to build up, water is driven up into the roofing joints.

Leaks from Water Backup: Ice Dams

Here is a brief video to better demonstrate how ice dams are formed.

Warm air from the interior rises to the bottom of the roof sheathing, where it causes the lower layer of snow to begin melting. That melted snow runs down to the colder roof eaves, causing the water to refreeze. Over time, the ice builds up in thickness and creates a dam. Once a dam forms, liquid water can back up under shingles or metal roof seams designed to maintain water resistance by gravity. These leaks will wet the insulation batts in the exterior walls and ceiling and cause damage to interior finishes.

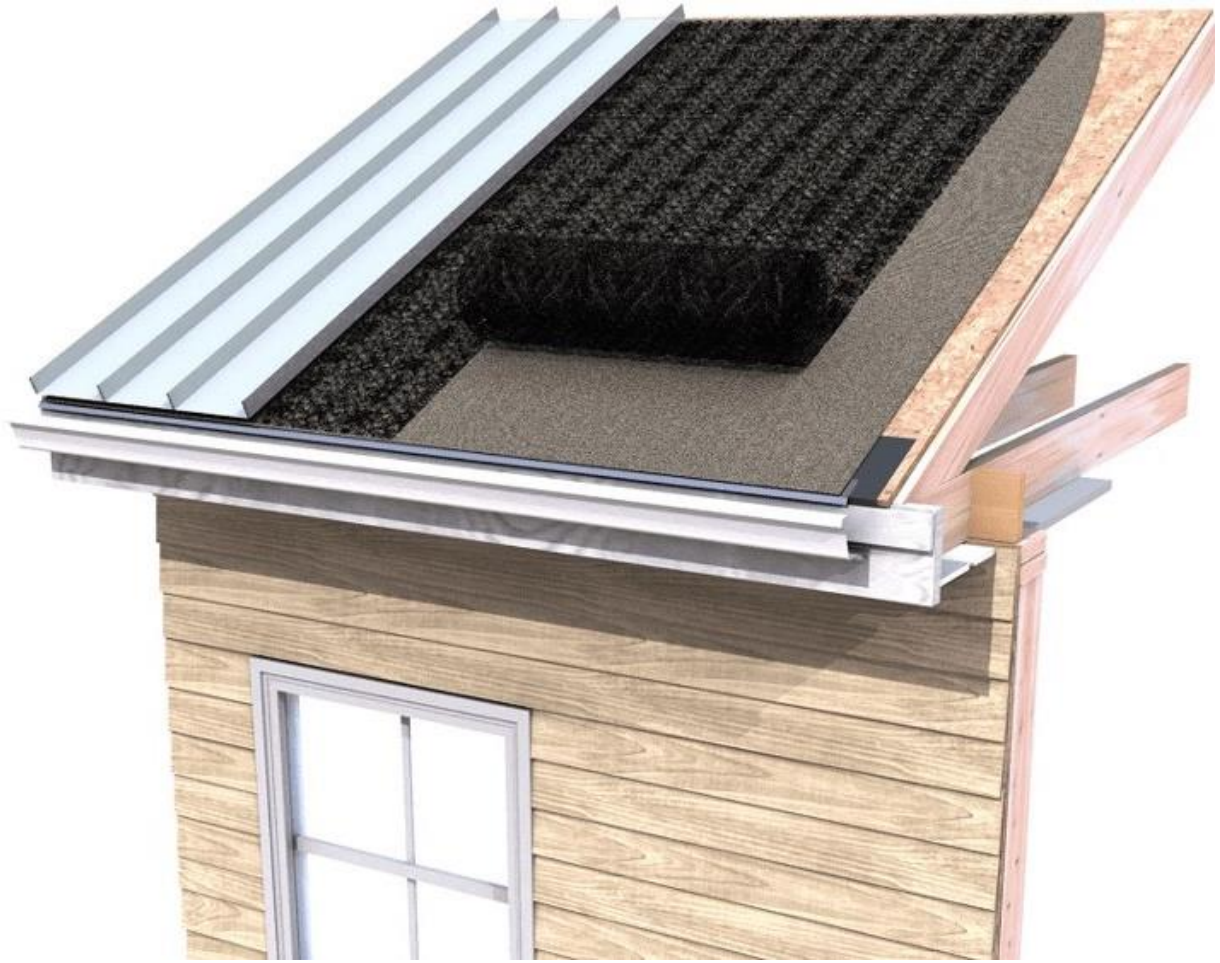


Click on the image to view the video on YouTube (no audio).

Leaks from Water Backup: Ice Dam Solution

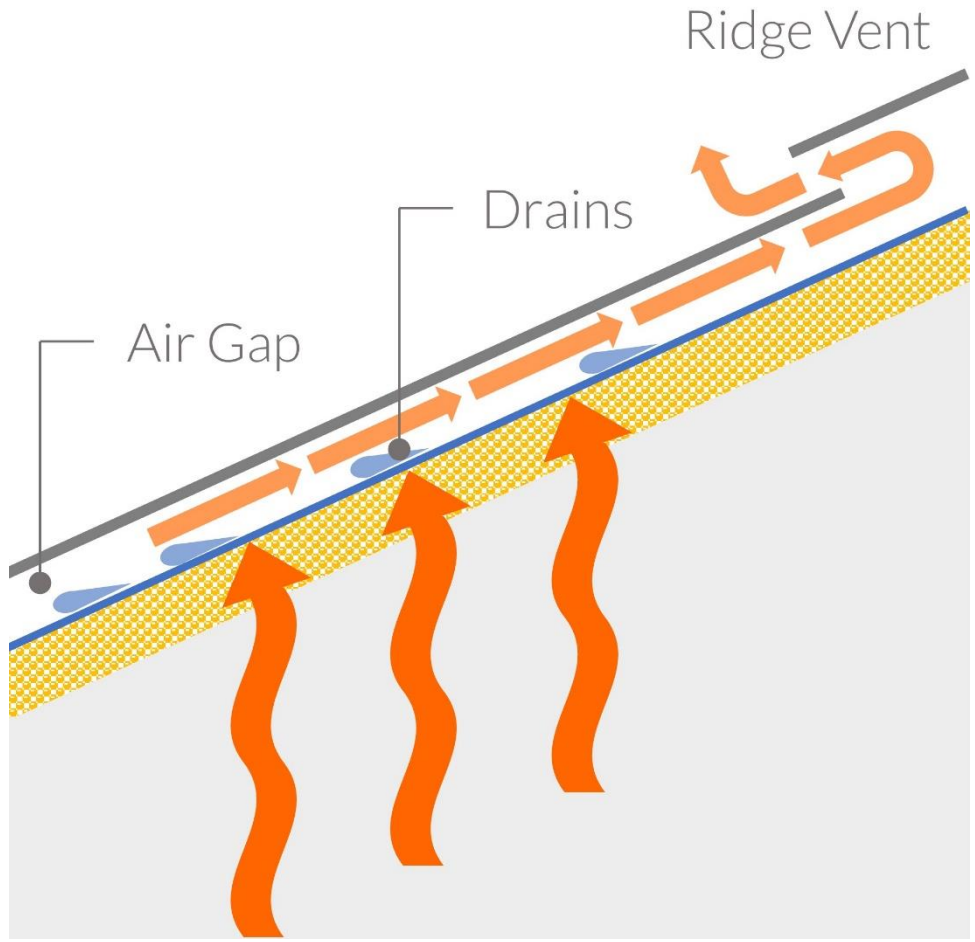
A solution to this problem is the utilization of a **three-dimensional engineered drainage and ventilation mat** that utilizes entangled-net (matrix) technology. (Going forward, we will refer to this specific type of mat as a “ventilation mat.”)

The ventilation mat is designed to create an air gap/cavity to promote airflow in all directions between the roofing material and the sheathing below. Using a thin nylon matrix profile, the mat prolongs the life of the roof structure and membrane by reducing the adverse effects associated with moisture/water damage, including mold, mildew, corrosion, or deterioration of the roofing material itself. The mat is extremely flexible and conforms to any contoured surface or roofing material (cedar, metal, tile, etc.) and is perfect for residential and commercial roof applications.



Leaks from Water Backup: Ice Dam Solution

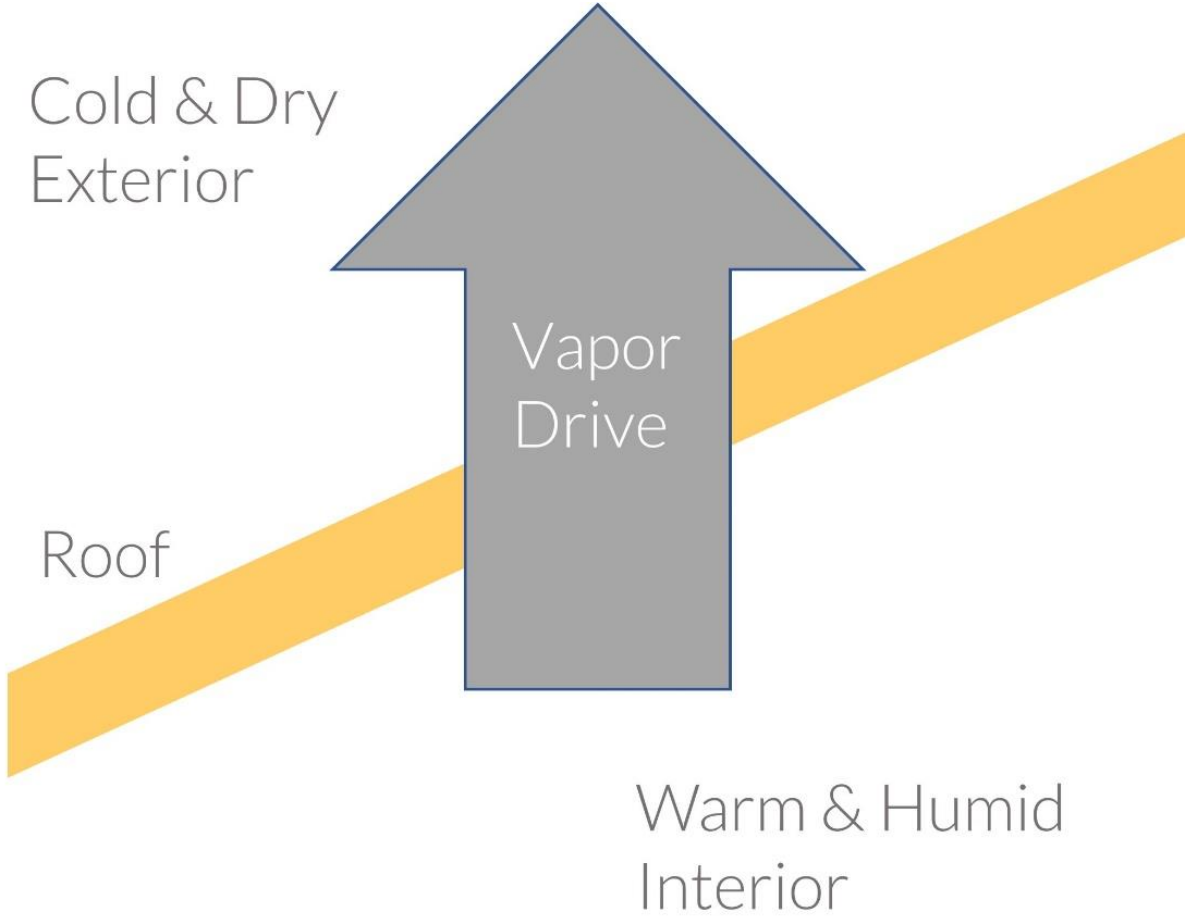
As shown here, a ventilation mat helps mitigate the ice dam issue. When installed under a metal roof, it creates an air gap that provides a drainage channel to move backed-up water away before significant damage can be done. It also maintains a thermal break between the roofing and sheathing. An air gap moderates the temperature of the warmed air from the attic by venting it up and out the ridge vent. This temperature reduction decreases the amount of snowmelt, which is what creates the ice damming effect.



Condensation under a Metal Roof

How do we create a separation between the warm, humid interior air and the cold exterior air? It is a well-known fact that heat rises. The vapor drive in the winter months causes warm, moist air to move toward the colder, drier side of the building—in this case, the underside of the roof sheathing.

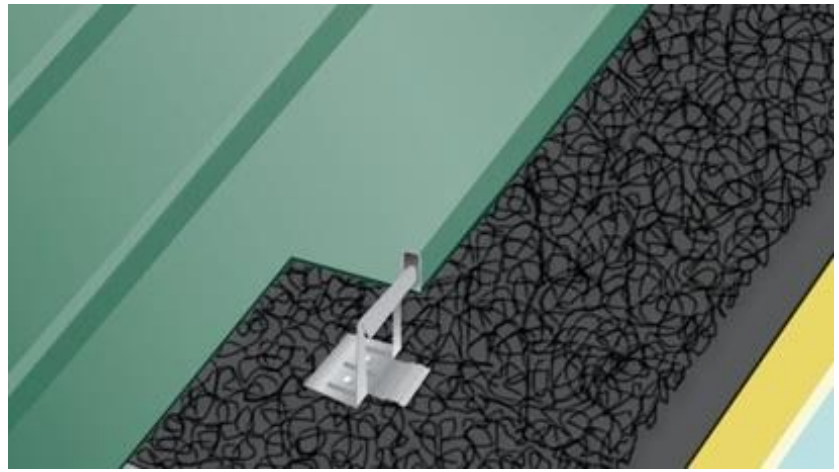
A nonpermeable weather barrier, or even one with low permeability, allows condensation to form on the plywood or OSB decking, eventually leading to mold and rot. Building envelope experts who have examined structures with this problem determined this usually happens near gaps in the roofing deck or near the ridge vents.



Condensation under a Metal Roof: Solution

With a permeable weather barrier, the vapor can pass through the deck and weather barrier but can also condense under the cold metal roof, which is not permeable. This condensed moisture needs a path to drain and dry out.

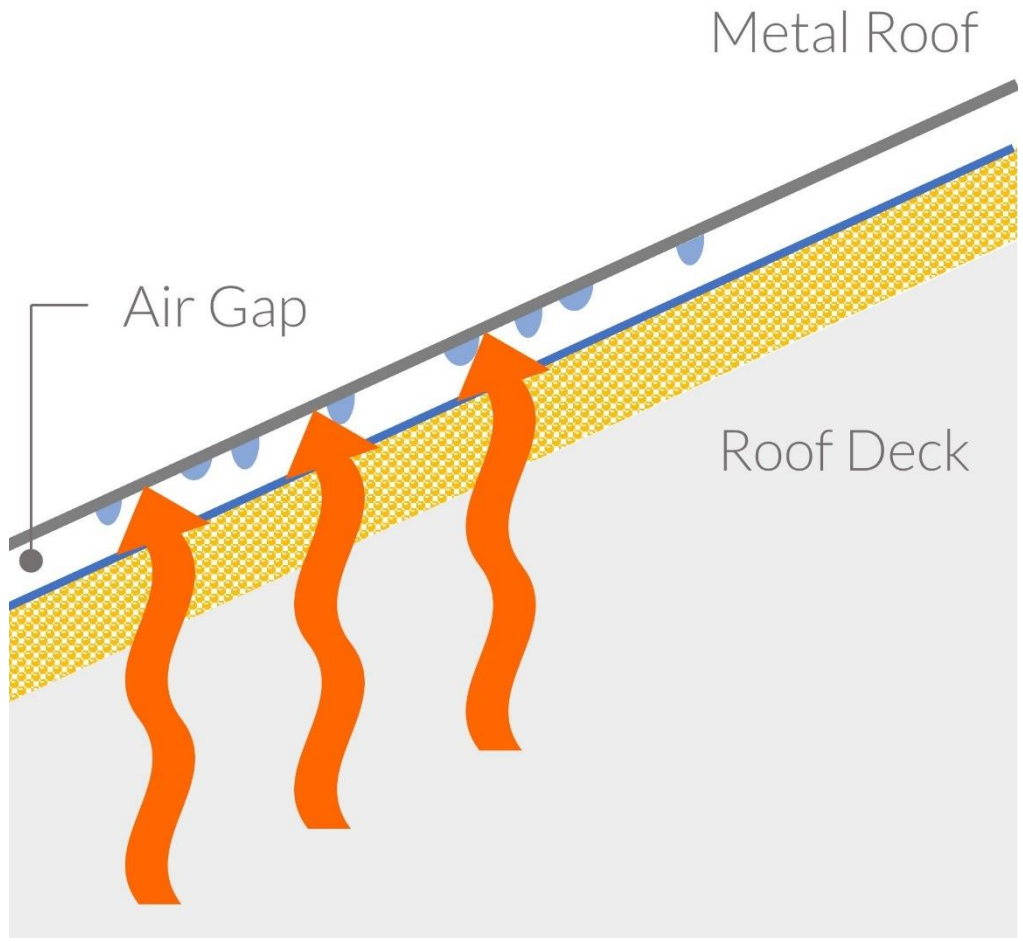
A ventilation mat with an entangled matrix lets liquid water drain and allows for venting that promotes evaporation of moisture. When specifying a ventilation mat, be sure the entangled-net material is made from nylon 6 and not polypropylene or high-density polyethylene. Nylon 6 has a memory, so when roofers install the product, they can kneel on it without damaging the entangled net. This is not true for polypropylene or high-density polyethylene. Nylon 6 also has a much higher melting point, which is vital since the mat will directly contact a metal panel exposed to sunlight all day.



Condensation under a Metal Roof: Solution

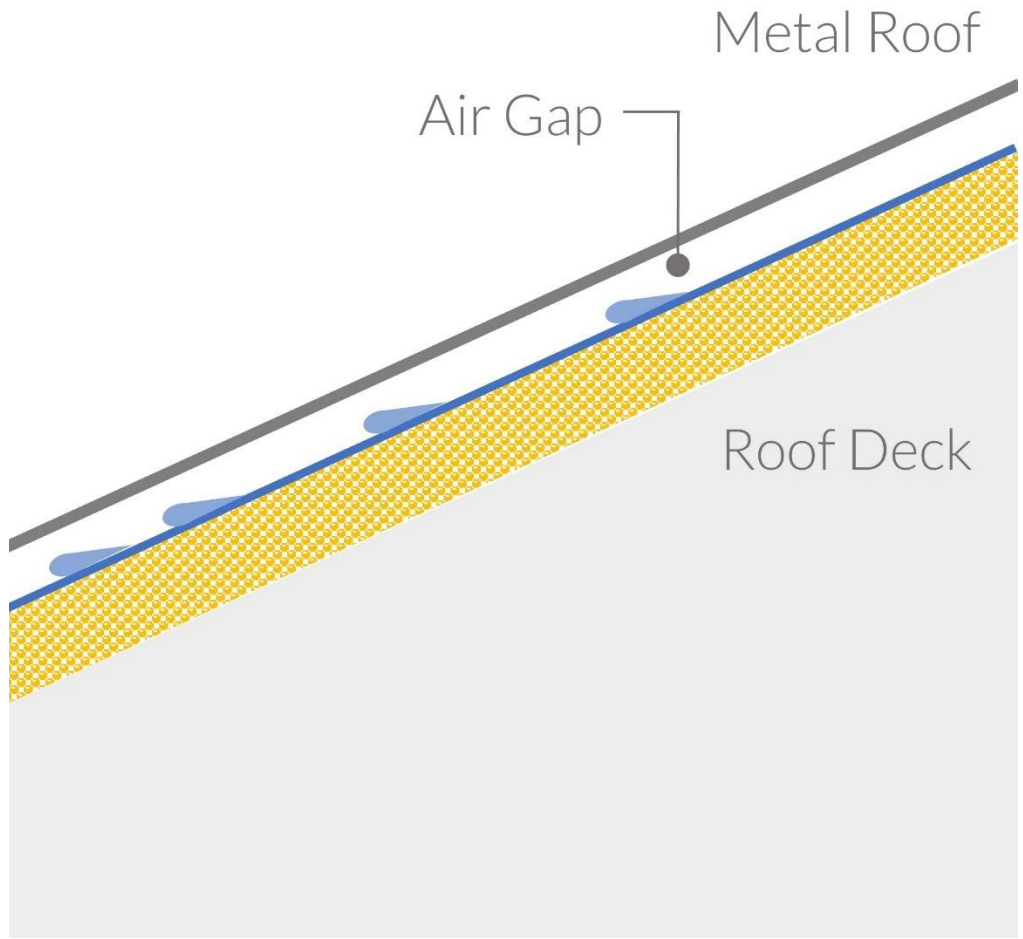
As illustrated here, water vapor moves from the humid interior through the attic and permeable roof materials and through gaps, both in the sheathing and adjacent to the ridge vent. Moisture buildup occurs on the bottom of a colder metal roof surface.

The solution is to create a small space or gap large enough for moisture to drain and air to circulate but small enough that it doesn't affect the structure of the metal roofing panel.



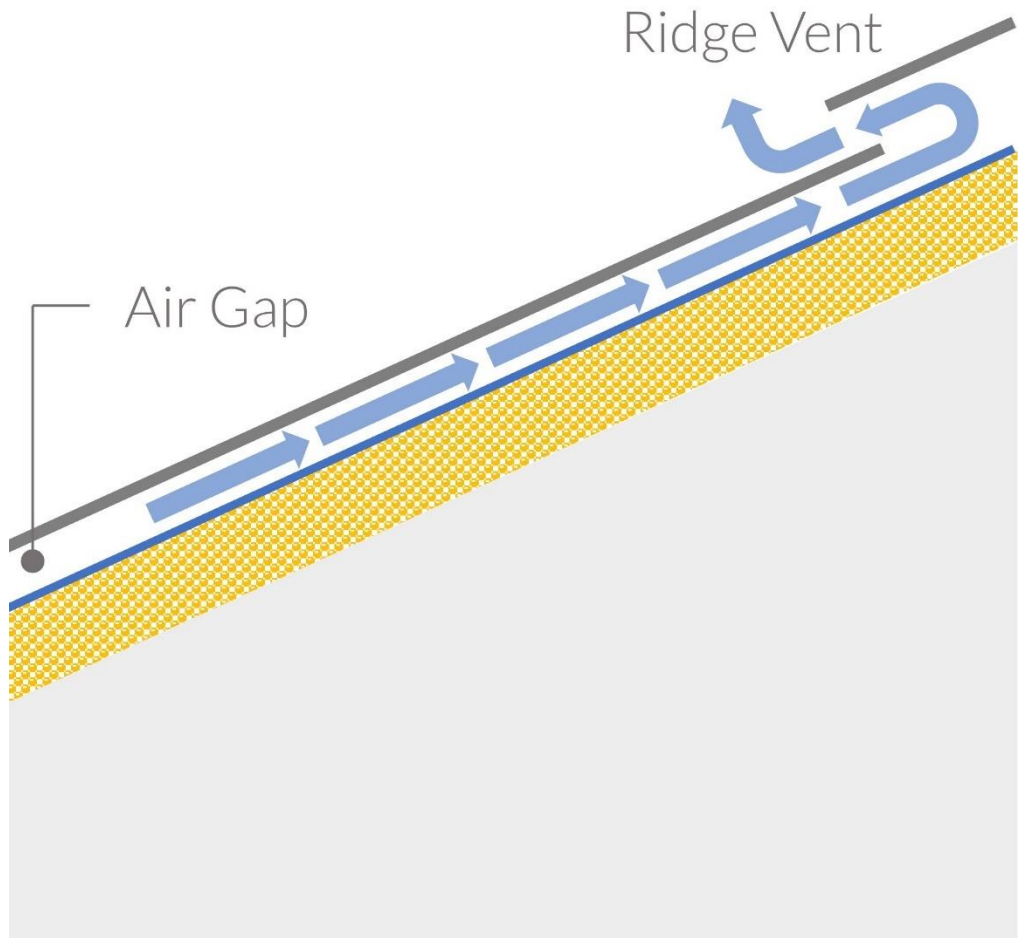
Condensation under a Metal Roof: Solution

The gap created by the entangled matrix of the ventilation mat allows for condensation drainage. As the water builds up, gravity facilitates its movement down the slope of the roof and out to the gutter.



Condensation under a Metal Roof: Solution

Air will also be introduced convectively, traveling from the eave to the ridge and drying out the roofing materials. Air movement through the ventilation mat dries any remaining moisture. This drying effect helps prolong the life of all the roofing materials.



Excessive Internal Building Noise from Rain, Sleet, and Hail

Our awareness of the impact that noise has on our daily lives is increasing. Racket, din, clamor, noise, or whatever you want to call it, unwanted sound is a widespread nuisance. But more than that, it can affect building occupants' health, well-being, and cognitive performance.

Have you been inside a building with a metal roof during a powerful rainstorm? If so, you know how loud that rain can be when in contact with the metal roof. This can be problematic, especially in building types where speech and good hearing are critical to occupants. These include educational facilities, churches, or other buildings with assembly occupancies for performances, lectures, etc. Also, noise control is essential in any facility where voice or music recording is done.

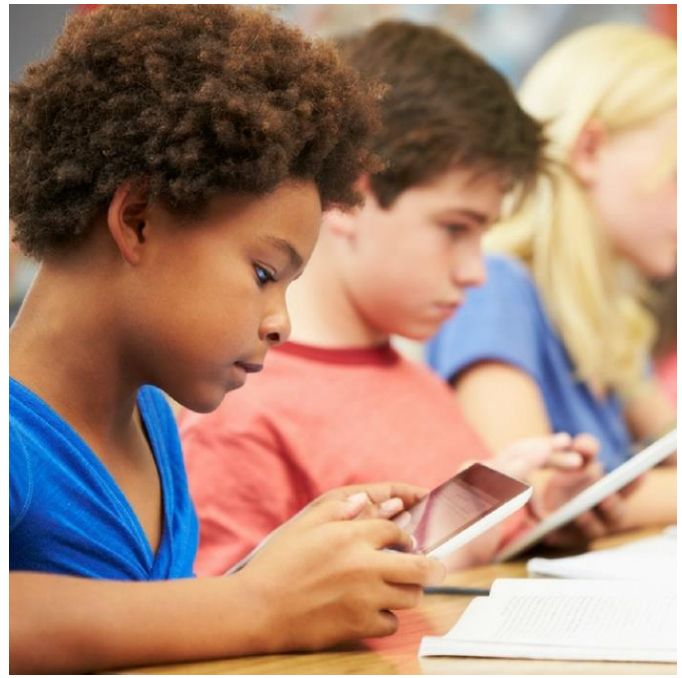
Excessive Internal Building Noise from Rain, Sleet, and Hail

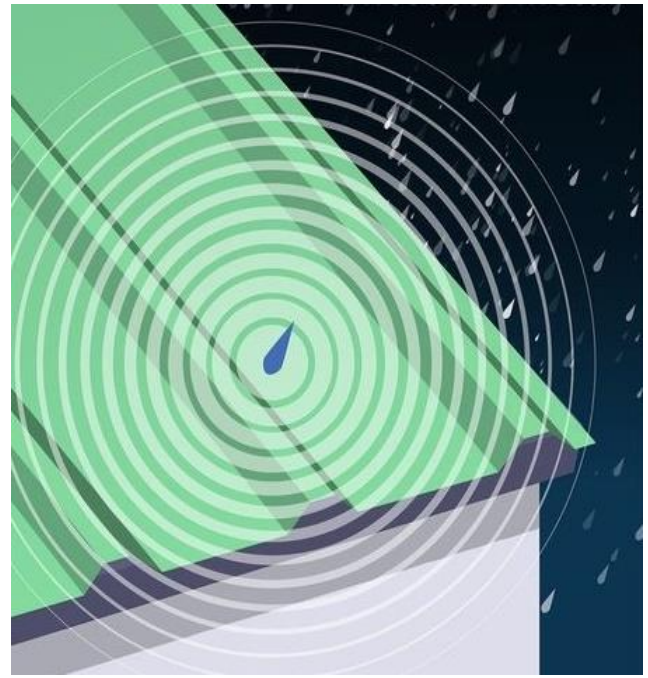
Whether you are involved in game night in your living room, trying to concentrate in school, or completing an intricate task at work, excessive noise can significantly impede your ability to focus on the matter at hand.

Among its negative impacts, exterior noise that infiltrates buildings:

- disrupts building operations and activities
- reduces efficiency in completing tasks
- affects the health of occupants
- makes communication difficult, and
- has a negative effect on student learning.

As is true of most preventative measures, it is much easier to address noise abatement in the planning stages of a project than it is to make modifications after the fact.





Excessive Internal Building Noise from Rain, Sleet, and Hail

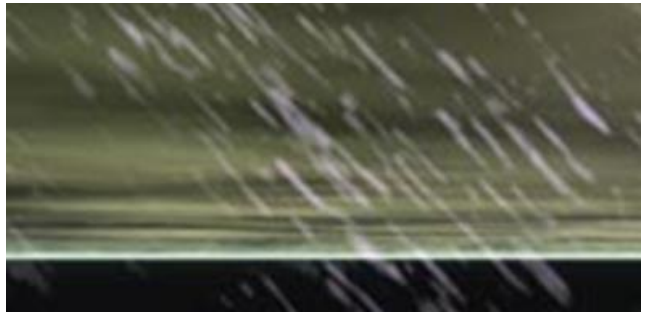
Architects, engineers, contractors, building product manufacturers, and suppliers share the common goal of ensuring occupant comfort, safety, and well-being in the structures they design, build, and create or specify materials for.

Most owners and developers want buildings that perform to the expectations of the users. The performance of the building envelope is of crucial importance for healthy and well-functioning acoustic environments.

Excessive Internal Building Noise

Impact noise from natural occurrences in the environment such as rain, sleet, hail, and wind affect the function of our buildings; however, it is not the only noise-generating component in metal roof applications.

Buildings are also subjected to a variety of airborne noises, dependent on where they are located.



Impact Sound (roofs)

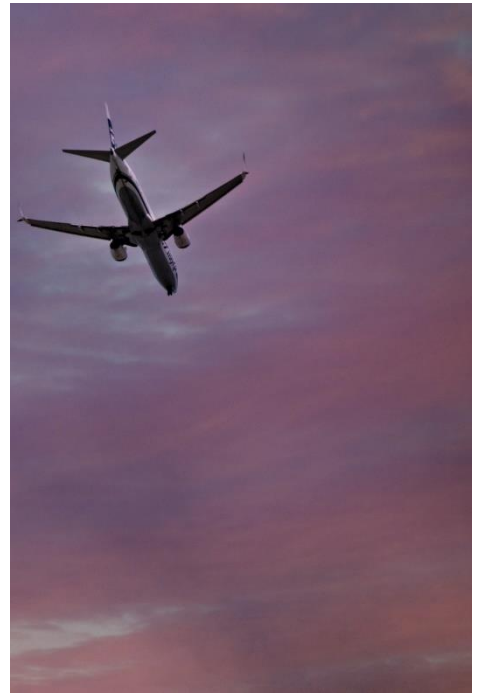
Noise pollution generated by natural events:

- Rain
- Sleet
- Hail
- Wind

Airborne Sound (roofs and walls)

Noise pollution generated by human actions:

- Street noise: cars, trucks, buses, trains, people
- Airplanes
- Industrial and construction noise



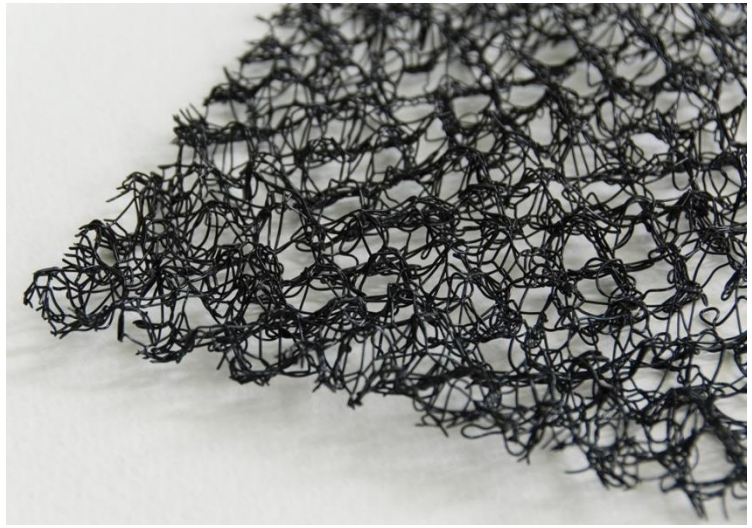
Excessive Internal Building Noise

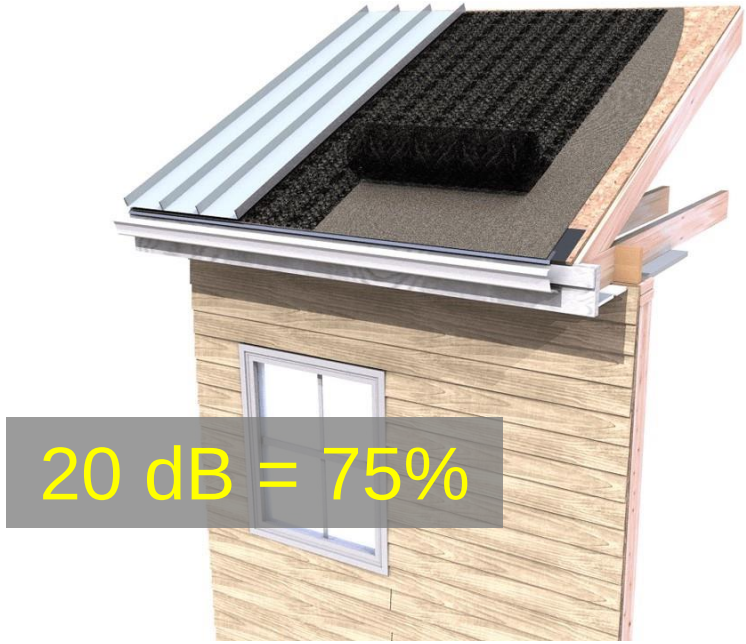
When it comes to a standing seam metal roof, the roof generally allows noise levels of up to 70 dB, which is similar to freeway noise if you're standing 50 feet away, or equal to the sound of a vacuum cleaner. Severe wind-driven sleet or hail can raise the noise level to between 80 and 90 dBs, equivalent to a garbage disposal truck running or even a nearby freight train.

Excessive Internal Building Noise: Solution

Another advantage of utilizing entangled-net technology in metal roofing applications is noise reduction; the ventilation mat acts as a sound deadener.

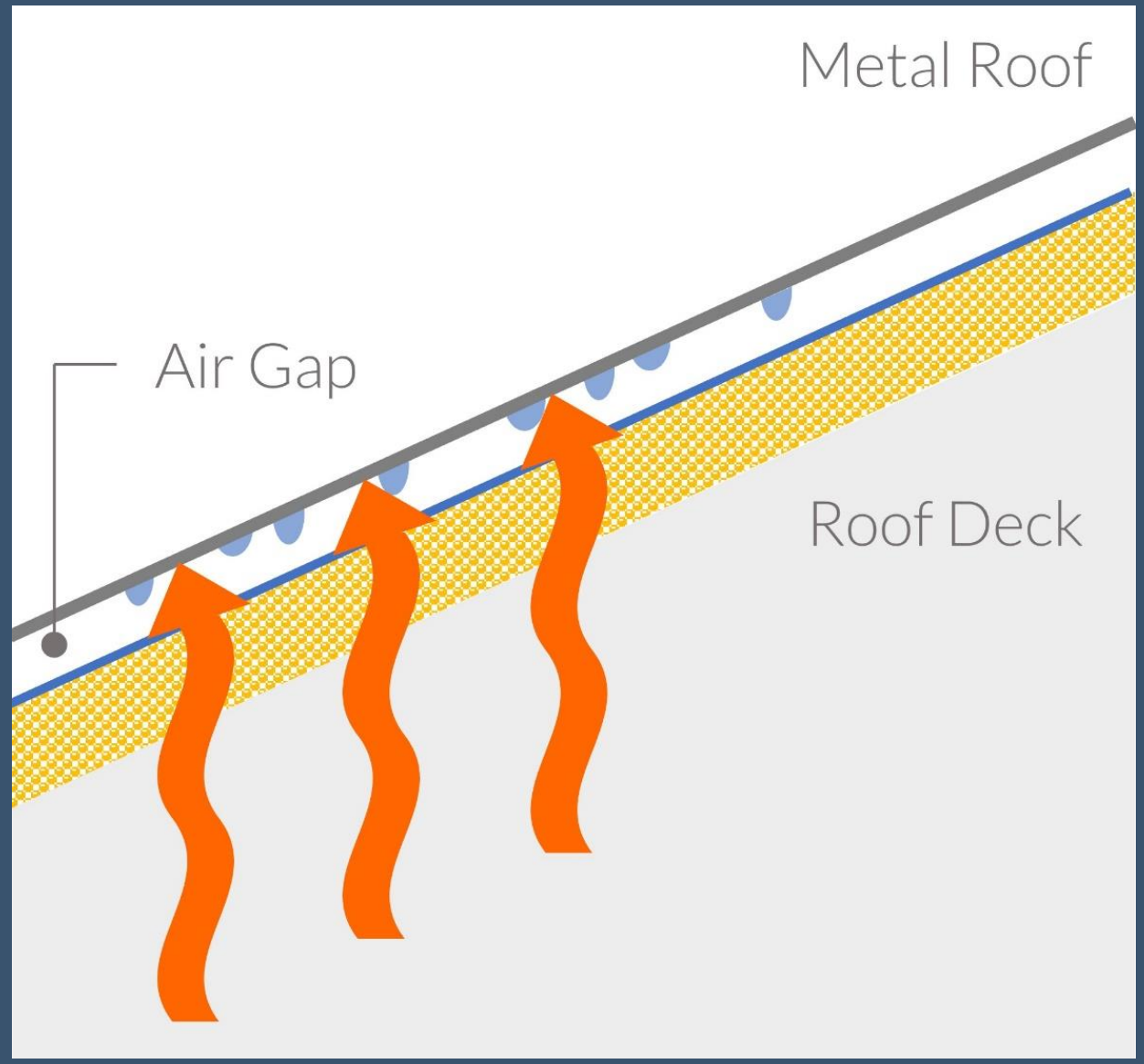
Compared to metal roofing applied directly over a weather barrier, a 9 mm thick entangled matrix made from nylon 6 can reduce noise by 10 to 13 dBs. When combined with the ceiling and typical attic batt insulation, these entangled filament mats can reduce noise by 20 dB or more. That is a 75% reduction, which is significant. Reducing noise by only 10 dB is perceived by most people as cutting the noise in half. A 20 dB reduction will help buildings function the way users expect.





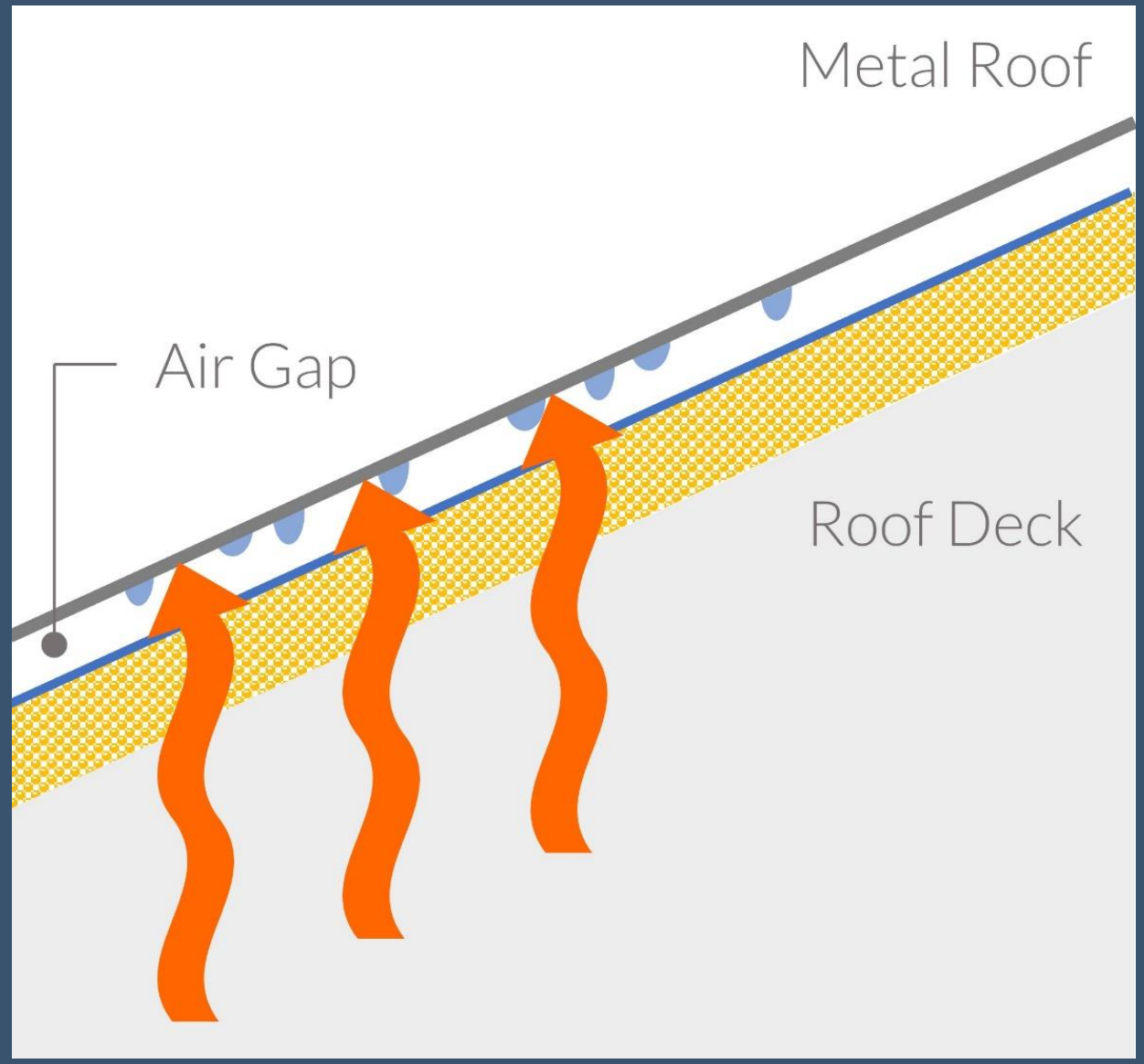
Review Question

Explain what is happening in this illustration.

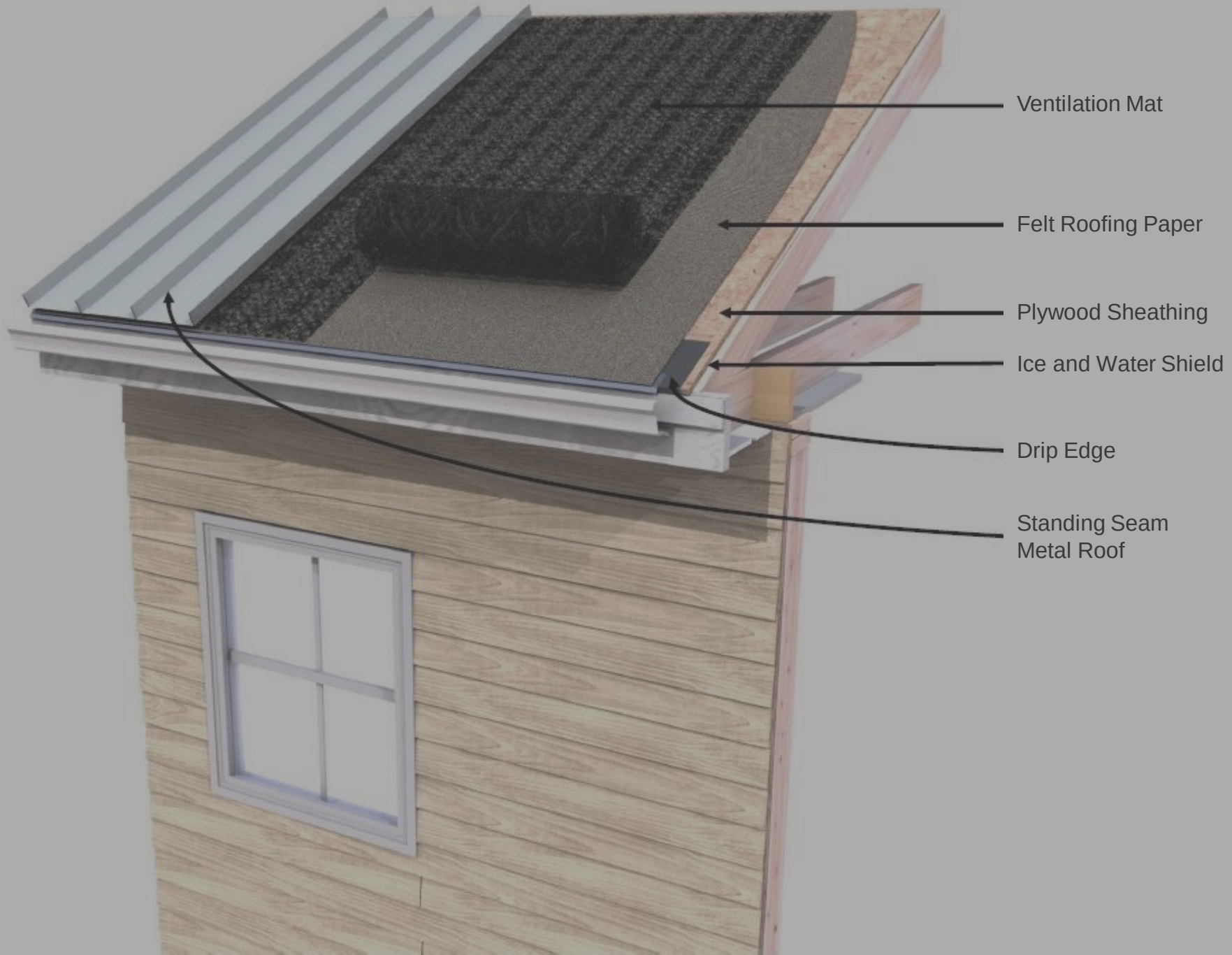


Answer

Water vapor moves from the humid interior through the attic and permeable roof materials and through gaps, both in the sheathing and adjacent to the ridge vent. Moisture buildup occurs on the bottom of a colder metal roof surface.

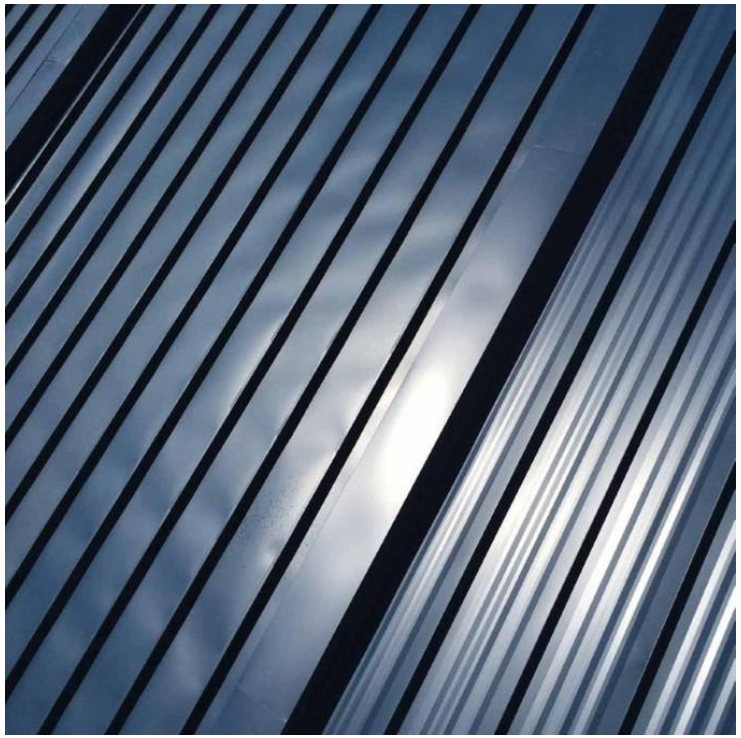


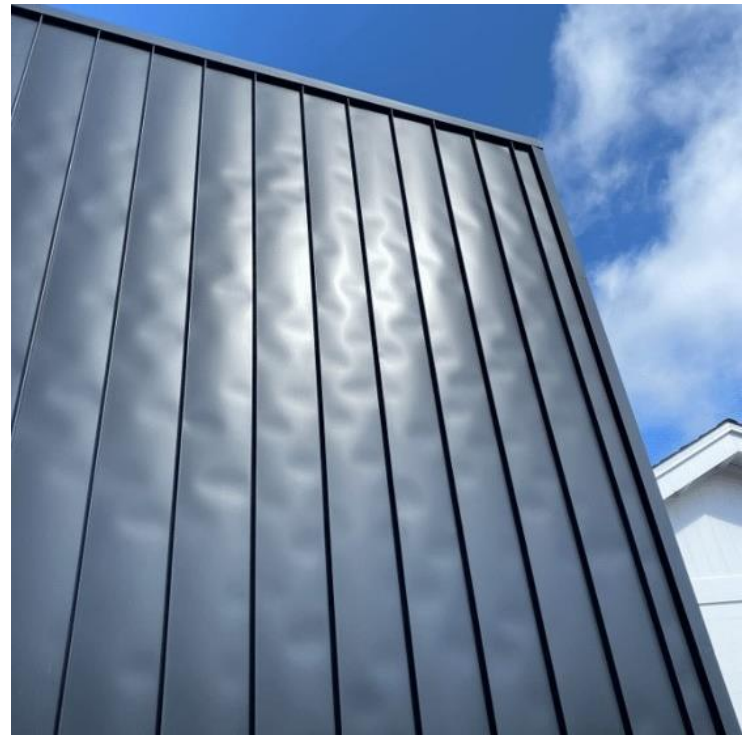
METAL ROOFS: OIL CANNING



Oil Canning

An important and commonly asked question about metal roofing is, “How can oil canning be avoided?” Most installers and suppliers of metal roofing have experienced oil canning on some jobs. It’s the elephant in the room for metal roofing. So, what exactly is oil canning?

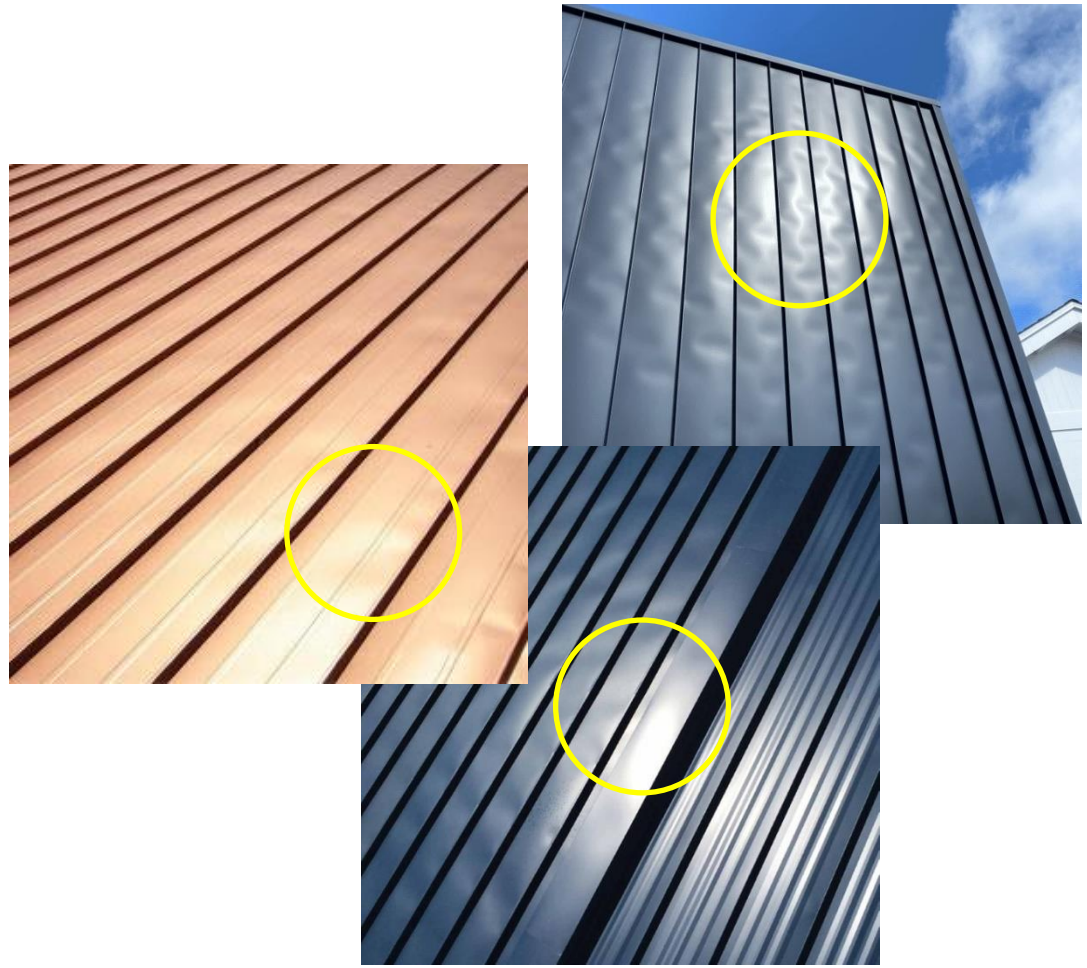




What Is Oil Canning?

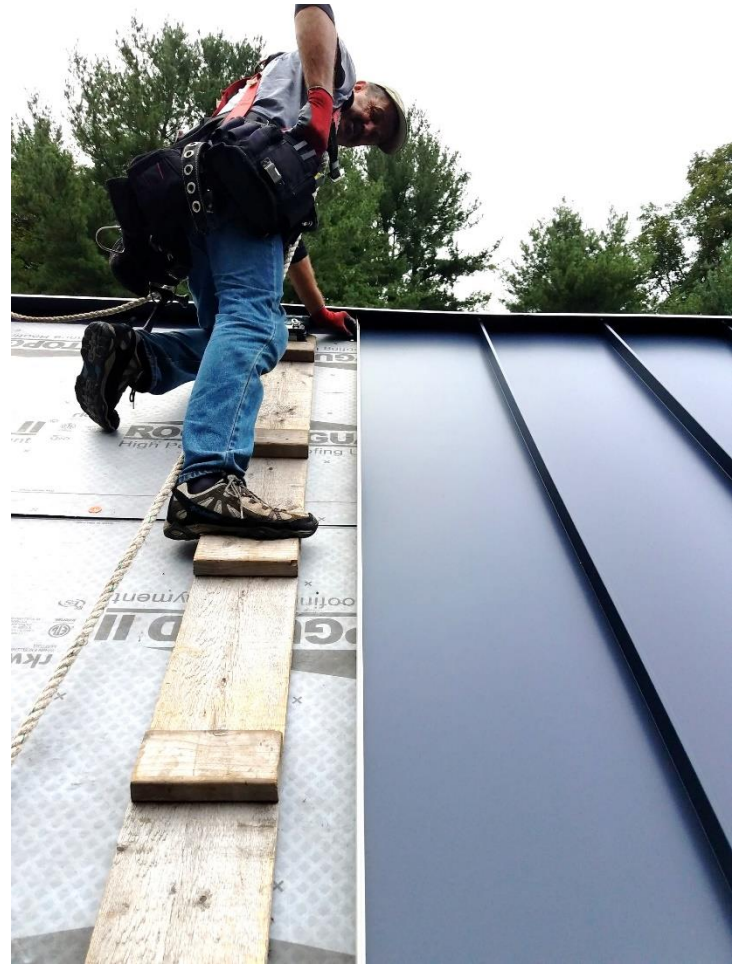
Oil canning is a perceived waviness or rippling of the metal panel. It is often associated with light-gauge, cold-rolled flat metal roofing and siding. As is apparent in these photos, it is visually unappealing to customers, suppliers, and architects, so it is beneficial to find ways to control this problem.

Oil canning is common in wide, flat areas of a roof or wall system but varies dramatically from project to project. It can be hard to determine the root cause, and the extent is difficult to measure as the waviness will appear to change under different lighting conditions.



What Causes Oil Canning?

Oil canning is sometimes caused by uneven stresses on the panels during the manufacturing process. It may also be related to the fabrication process of bending and shaping the metal. Overdriving or angling clips and constant moving and twisting of the panels can also cause this issue. Misalignment of panels during installation, uneven roof decking, movement along the supporting structure, and not making allowances for thermal expansion can all result in oil canning. Oil canning can also occur in metal roofing that is field fabricated from metal coils.



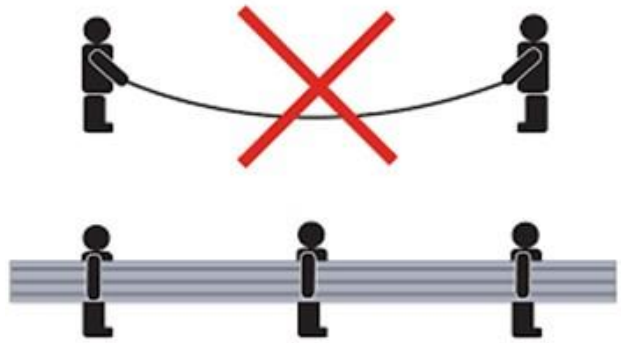
Minimizing Oil Canning

What steps can be taken to minimize the problem?

First, check the panels for signs of stress or oil canning before installation.

Second, be sure to support the panels carefully during storage, handling, and installation. During the specification phase, it is essential to consider:

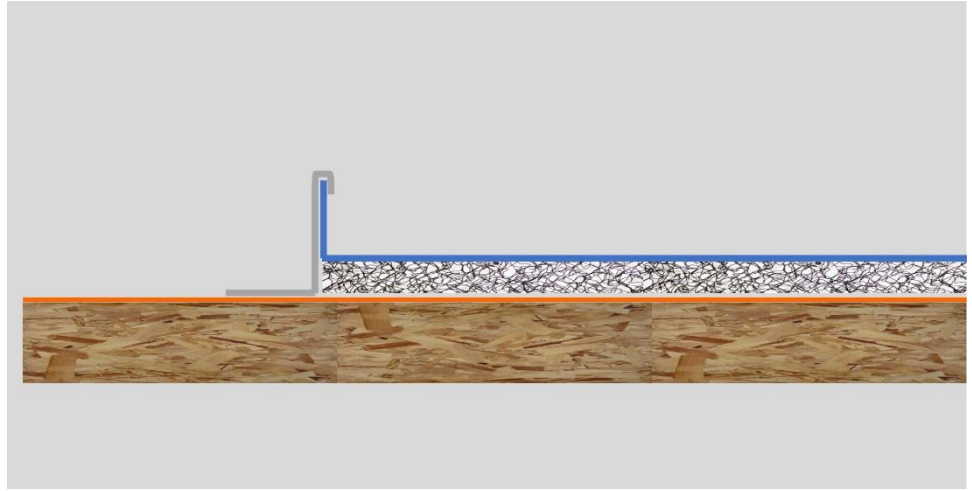
- using a low-gloss or matte finish, as this will help to hide the oil canning
- using a thicker-gauge panel, although this will affect the cost of the roof, and
- using narrower roofing panels, so they don’t span as far.



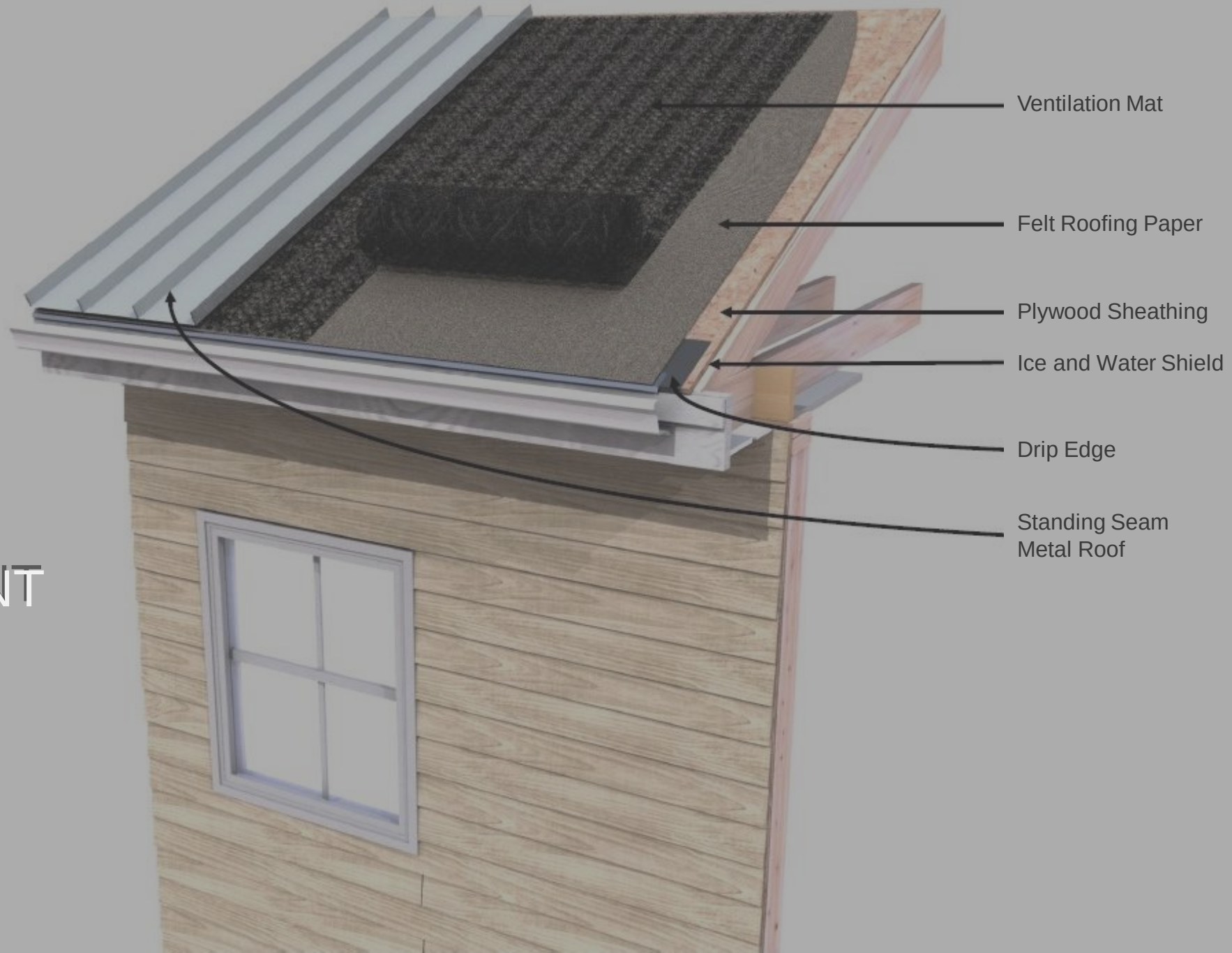
Minimizing Oil Canning

Some installers lay a backer rod under the panel to create a slight bow in the panel. The problem with this approach is that it leaves the panel unsupported.

Earlier, we addressed the drainage, ventilation, and sound-reduction benefits of using a ventilation mat in a space between the metal roof and the roofing deck; however, there is another advantage. The use of a ventilation mat under metal roofing panels provides a slight bow and tension to minimize the appearance of oil canning. The matrix creates a uniform pillowing of the panel. When installing the panels over the entangled matrix using clips, the clips must be ⅛″ shorter than the mat thickness. For example, a ¼″ clip should be used over a ⅜″ mat.



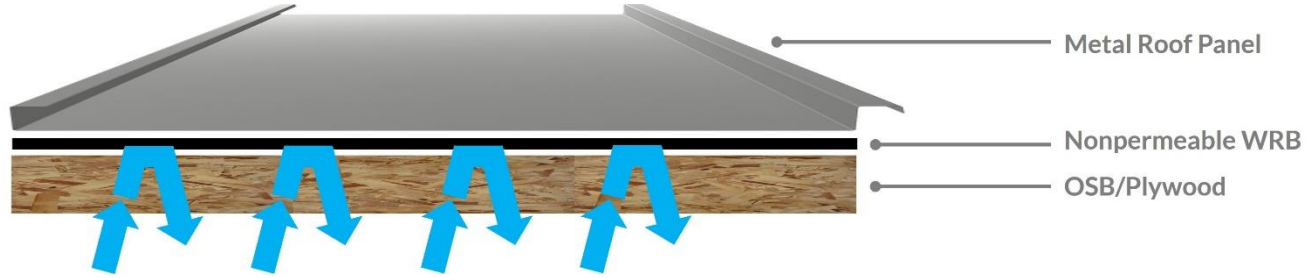
ROOF UNDERLAYMENT DESIGNS



Roof Underlayment Designs: Type 1

This roof is constructed of OSB/plywood, a nonpermeable weather-resistant barrier, and metal roofing panels installed directly on top. This configuration of components provides backup protection from water infiltration but does not limit the contact between the bottom of the metal roof and the roof decking. This means water vapor near the sheathing can be trapped, condensation under the metal roof will not be reduced, and moisture will not drain efficiently.

- ☑ Gives backup protection from water infiltration
- ❑ Separation limits contact with metal roof bottom
- ❑ No trapping of water vapor near sheathing
- ❑ Reduces condensation under metal roof – promotes drying
- ❑ Air gap gives moisture a drain pathway

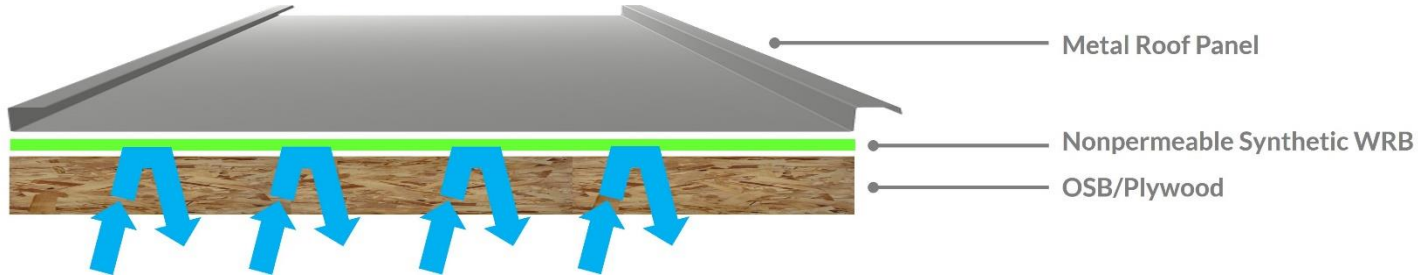


Roofing Felts | Building Paper | Ice and Water Membranes | Nonpermeable WRB

Roof Underlayment Designs: Type 2

This roof structure comprises OSB/plywood, a nonpermeable synthetic weather-resistant barrier, and metal roofing panels installed directly on top. As in the last example, this design gives backup protection from water infiltration, but that is all.

- ☑ Gives backup protection from water infiltration
- ❑ Separation limits contact with metal roof bottom
- ❑ No trapping of water vapor near sheathing
- ❑ Reduces condensation under metal roof – promotes drying
- ❑ Air gap gives moisture a drain pathway

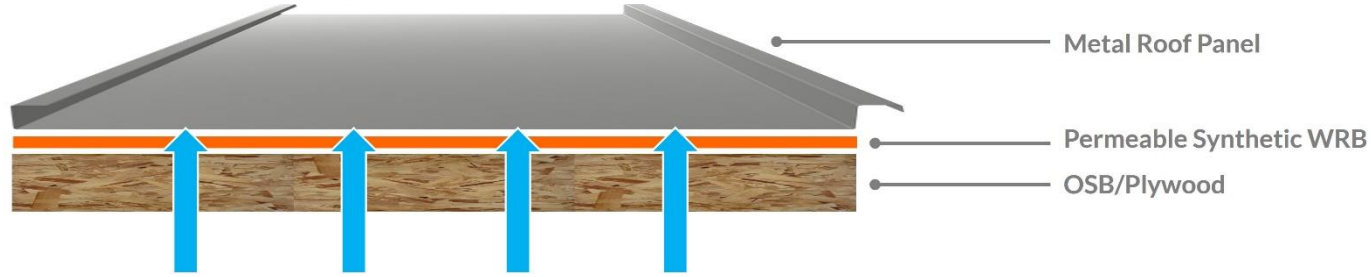


Low-Perm or Nonpermeable Synthetic WRB

Roof Underlayment Designs: Type 3

The third roof design employs OSB/plywood, a permeable synthetic weather-resistant barrier, and metal roofing panels applied directly on top. This design gives backup protection from water infiltration and doesn't allow the trapping of water vapor next to the sheathing.

- ☑ Gives backup protection from water infiltration
- ❑ Separation limits contact with metal roof bottom
- ☑ No trapping of water vapor near sheathing
- ❑ Reduces condensation under metal roof – promotes drying
- ❑ Air gap gives moisture a drain pathway

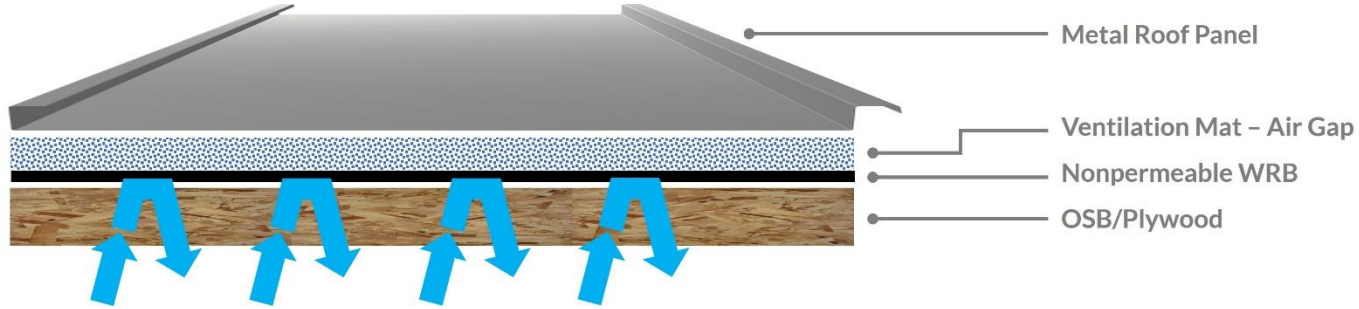


Permeable Synthetic WRB

Roof Underlayment Designs: Type 4

The fourth roof system is composed of OSB/plywood, a nonpermeable weather-resistant barrier, a ventilation mat with an entangled matrix on top of the weather-resistant barrier to create an air gap, and metal roofing panels installed directly on top of the ventilation mat. This design gives backup protection from water infiltration. It creates a separation between the bottom of the metal roofing panel and the sheathing. It reduces the condensation under the metal roof and creates an air gap to give moisture an escape route. When using a nonpermeable weather-resistant barrier, there is still the potential for some moisture to get trapped between the sheathing and the WRB, which could cause deterioration.

- ☑ Gives backup protection from water infiltration
- ☑ Separation limits contact with metal roof bottom
- ❑ No trapping of water vapor near sheathing
- ☑ Reduces condensation under metal roof – promotes drying
- ☑ Air gap gives moisture a drain pathway

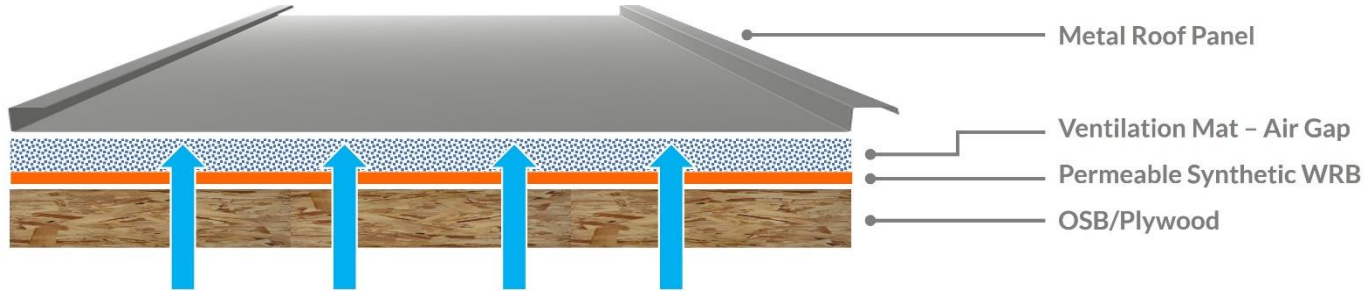


3D Entangled Mat over Nonpermeable WRB

Roof Underlayment Designs: Type 5

The final roof system is the ideal version—the optimal solution for long-term performance. It comprises OSB/plywood, a permeable synthetic weather-resistant barrier, a ventilation mat with an entangled matrix on top of the weather-resistant barrier to create an air gap, and metal roofing panels installed directly on top of the ventilation mat. This design provides comprehensive protection; it allows complete drying and does not trap moisture.

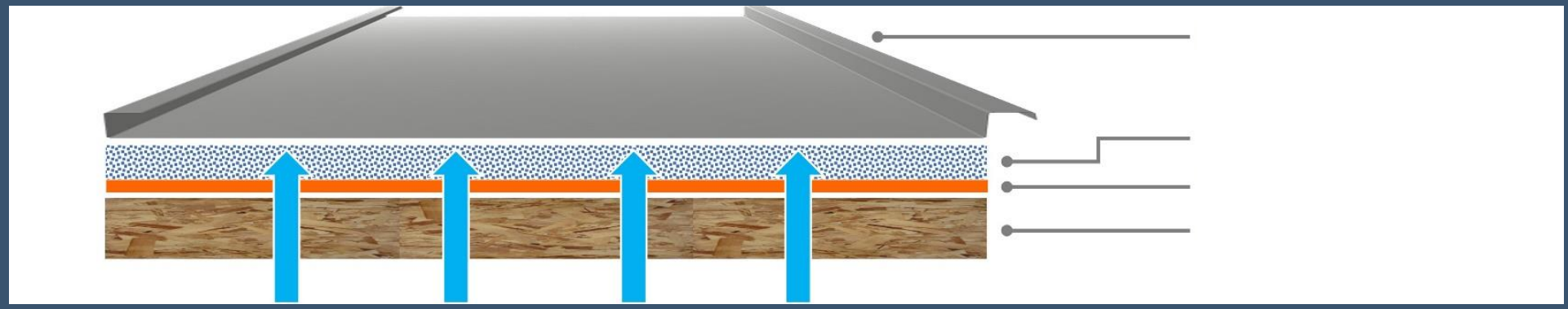
- ☑ Gives backup protection from water infiltration
- ☑ Separation limits contact with metal roof bottom
- ☑ No trapping of water vapor near sheathing
- ☑ Reduces condensation under metal roof – promotes drying
- ☑ Air gap gives moisture a drain pathway



3D Entangled Mat over Permeable Synthetic WRB

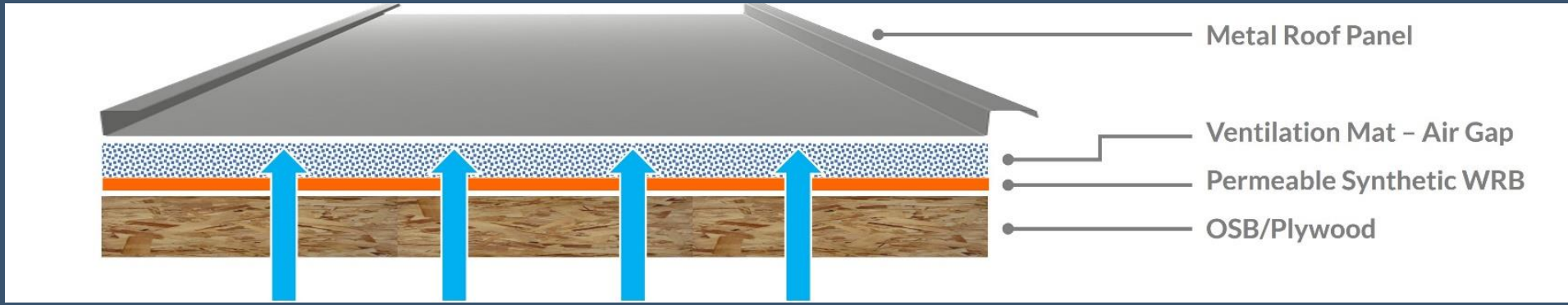
Review Question

Label the components of this roof ventilation design.

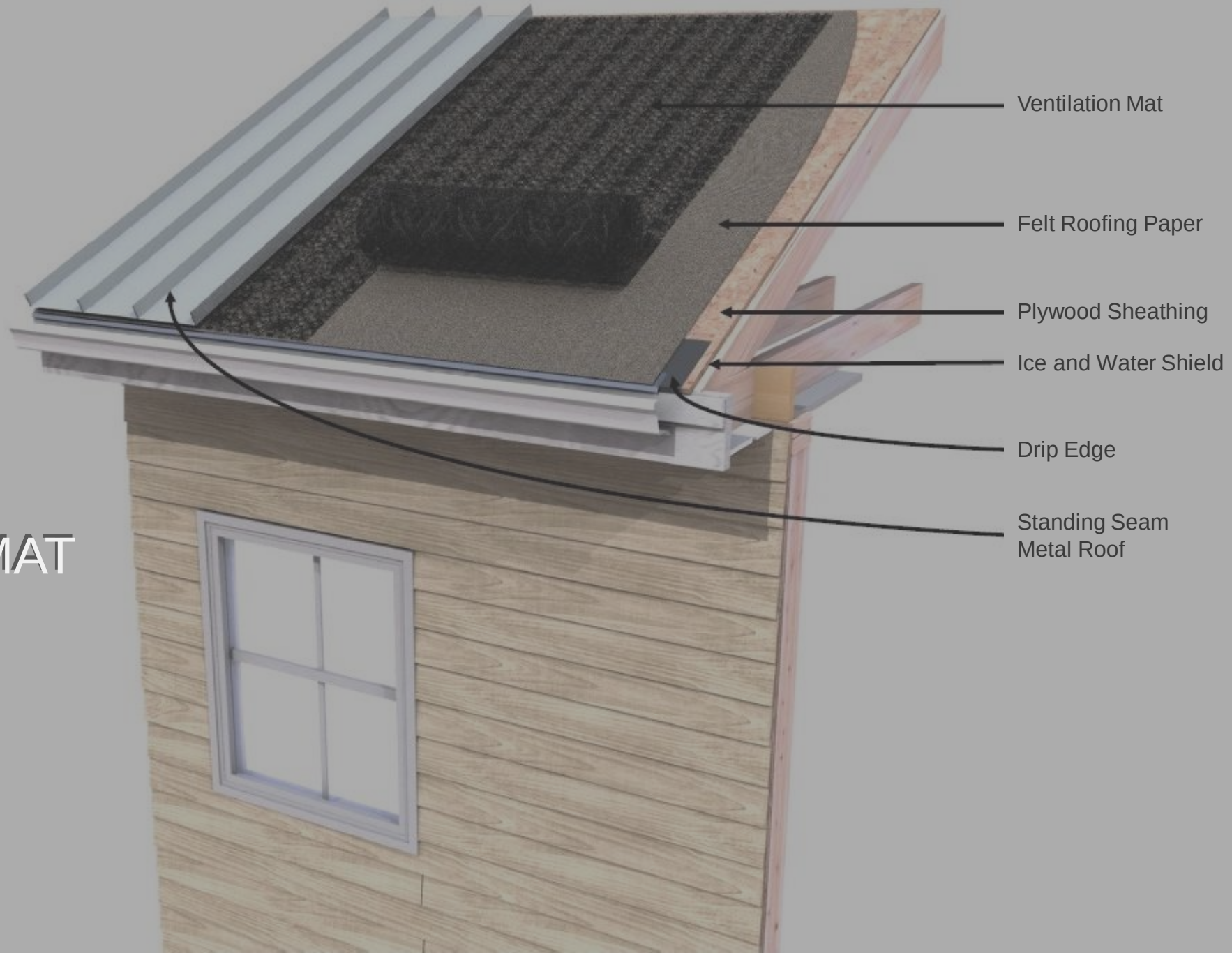


Answer

Label the components of this roof ventilation design.

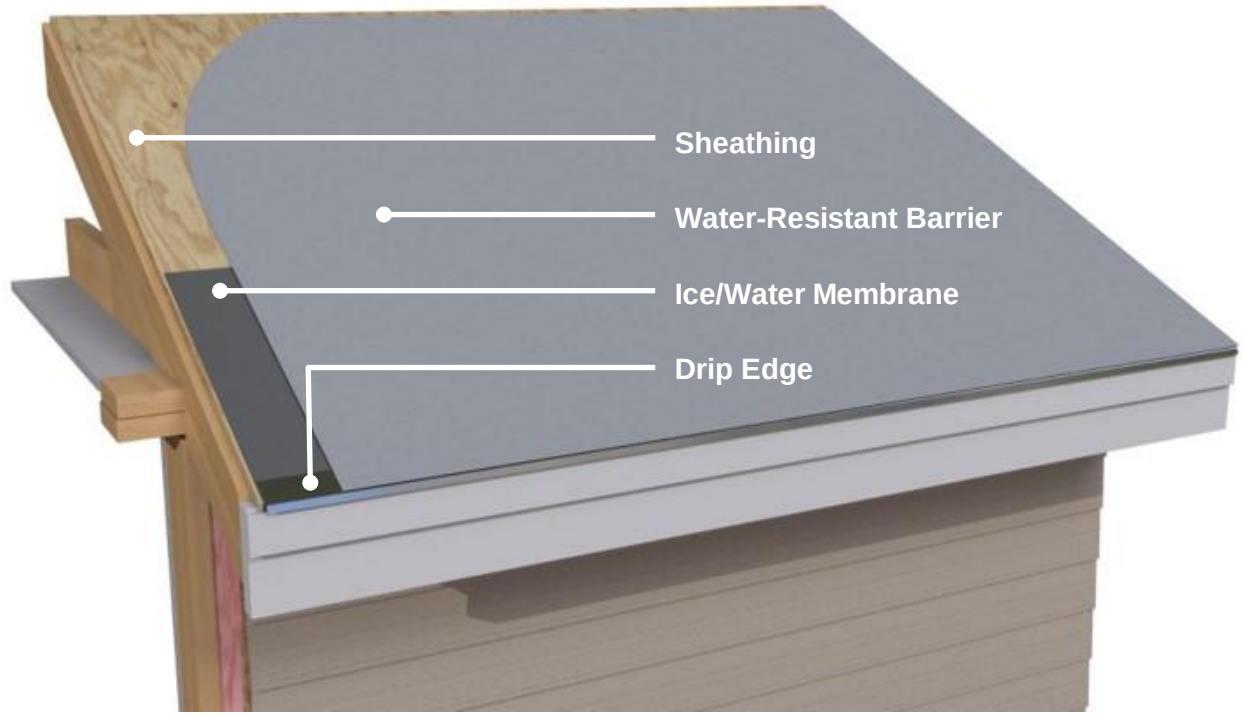


VENTILATION MAT INSTALLATION



Ventilation Mat: Location

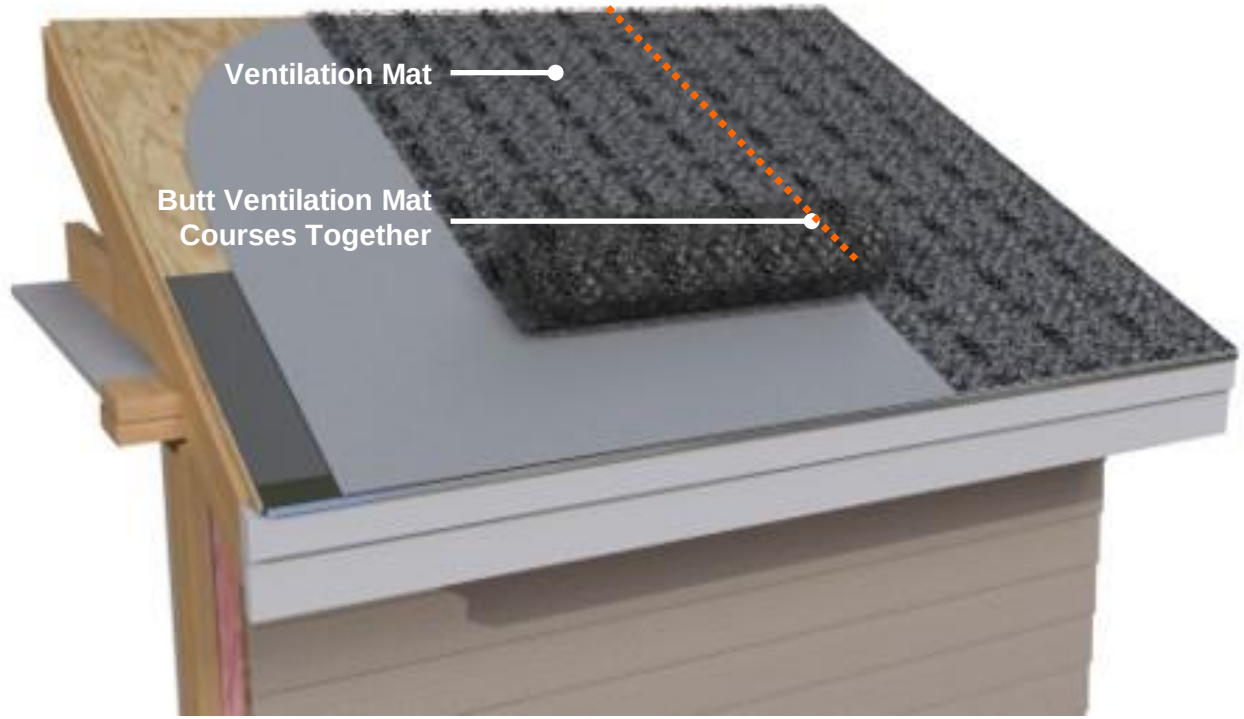
The ventilation mat must be installed over the roof sheathing, roofing felt, ice protection membrane, and metal edge flashing or drip edge and be flush against the edge of the flashing or drip edge. Regardless of the WRB is used, always check and follow local codes and manufacturer's recommendations for specific requirements.



Ventilation Mat: Perpendicular Orientation

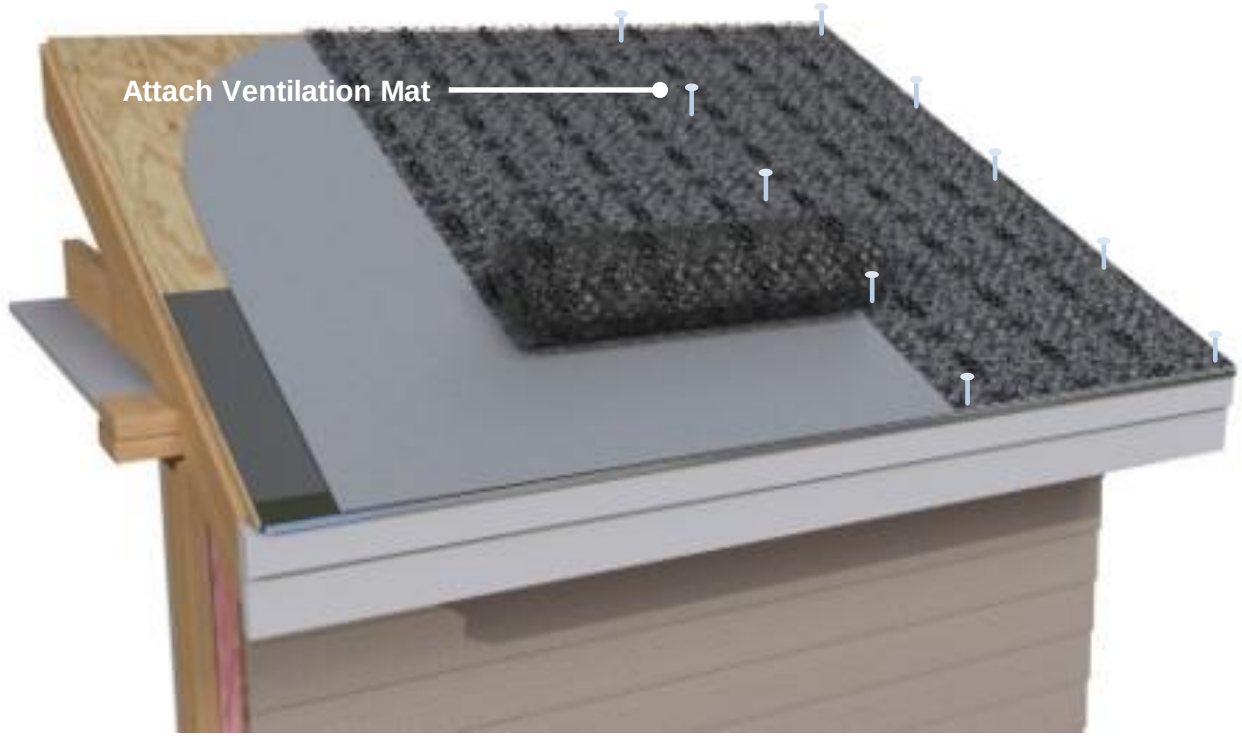
Most of the time, the ventilation mat is installed perpendicular to the roof ridge because it can be installed while the vertical metal panels are installed. The ventilation mat is rolled out vertically from ridge to eave and cut to length. The wrinkles are smoothed out, and each course is tightly butted against the previous course and at vertical seams. The layers must not overlap.

At ridge locations, the ventilation mat is extended over the ridge and butted against the mat on the opposite side of the roof. If a ridge vent is utilized, the ridge vent manufacturer's recommendations for underlayment material installation must be followed.



Ventilation Mat: Fastening

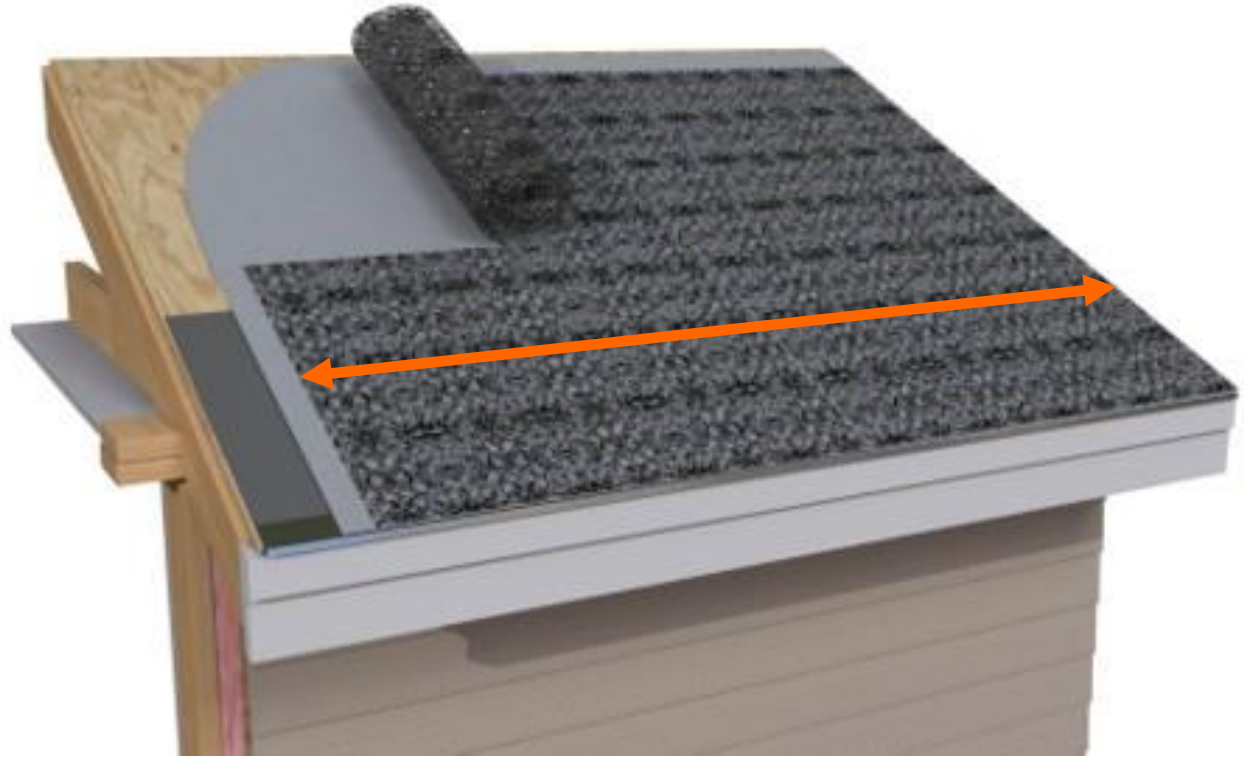
The ventilation mat is attached with staples or cap nails every three square feet to ensure the mat doesn't tear or move while metal panels are being installed.



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

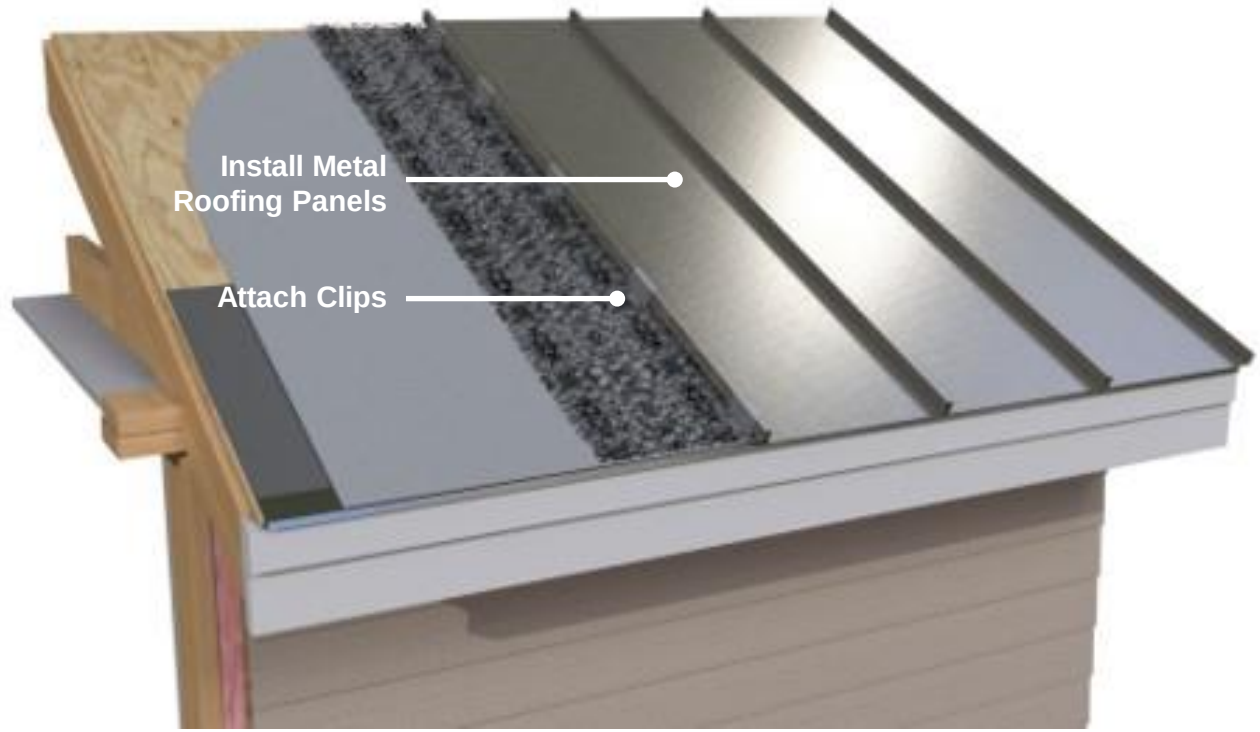
Ventilation Mat: Parallel Orientation

The ventilation mat's unique, open weave design allows the product to be installed parallel to the roof ridge as well. The ventilation mat is rolled out horizontally just ahead of the metal panels or other shingle material, such as cedar, as they are installed. Again, the wrinkles are smoothed out, and each course is tightly butted against the previous course. The layers must not overlap.



Ventilation Mat: Roofing Attachment

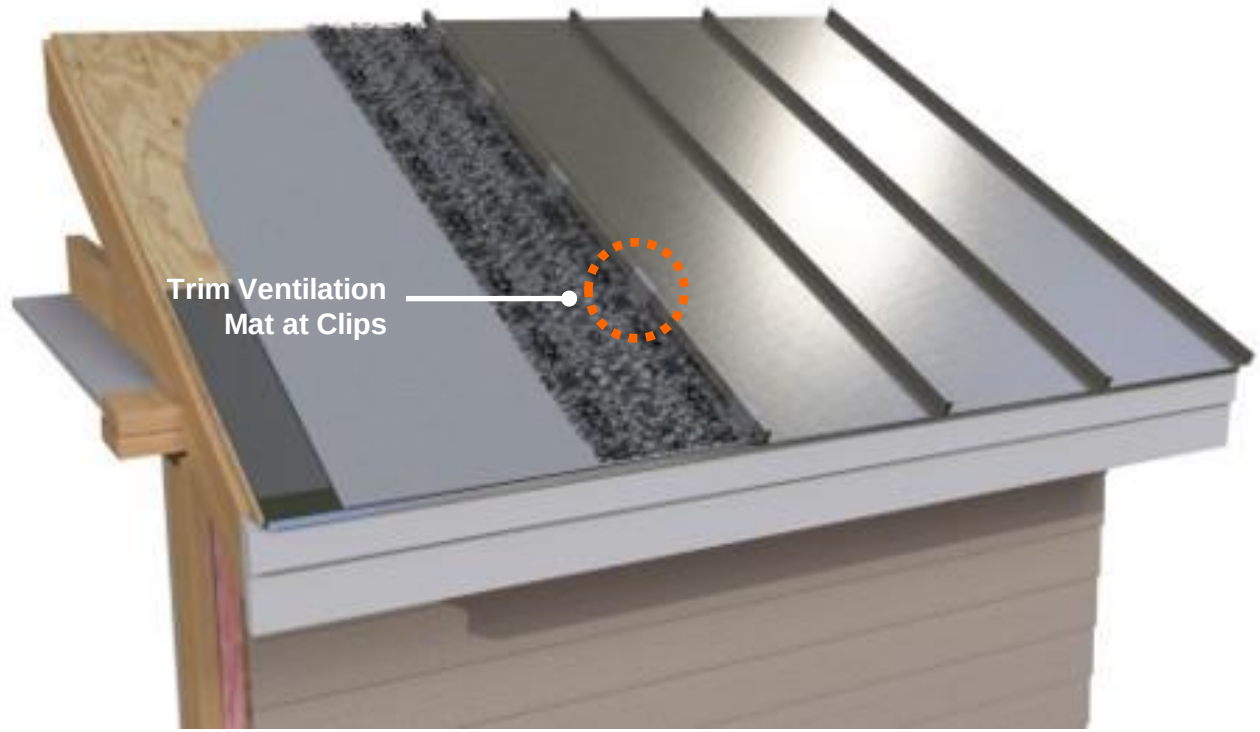
When the metal roof clips are attached, they should flatten the ventilation mat at the attachment spot. The roofing materials should be applied using the manufacturer's recommended fasteners and instructions, allowing for the additional thickness of the ventilation material—use clips ¼″ longer than clips for installing directly to the roof deck.



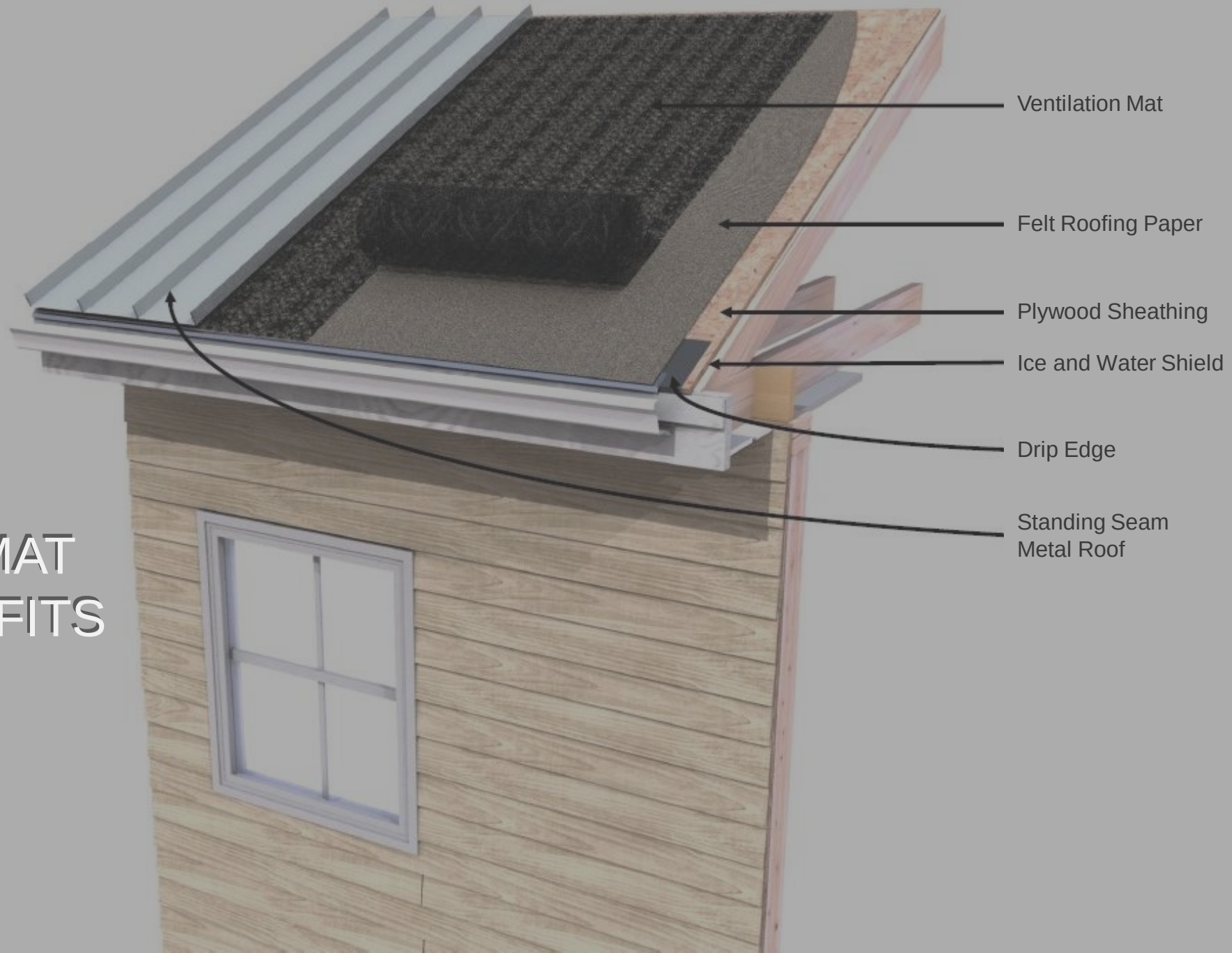
Ventilation Mat: Trimming

The ventilation mat can be trimmed away under metal roof clips so that they sit directly on the WRB. When trimming the entangled net, care must be taken to avoid damaging the WRB.

Once installed correctly, the metal roofing system will perform for many years without issue.

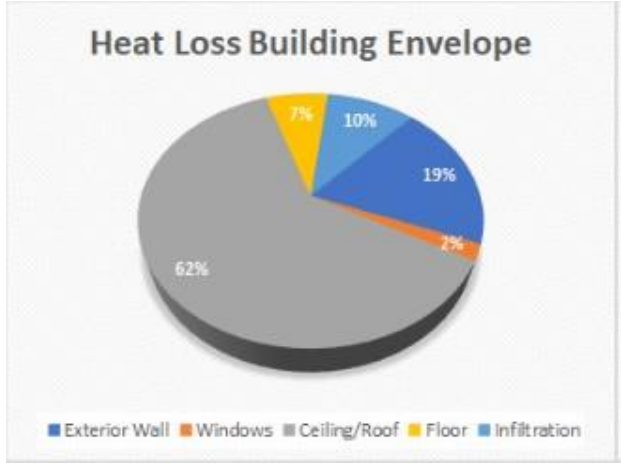


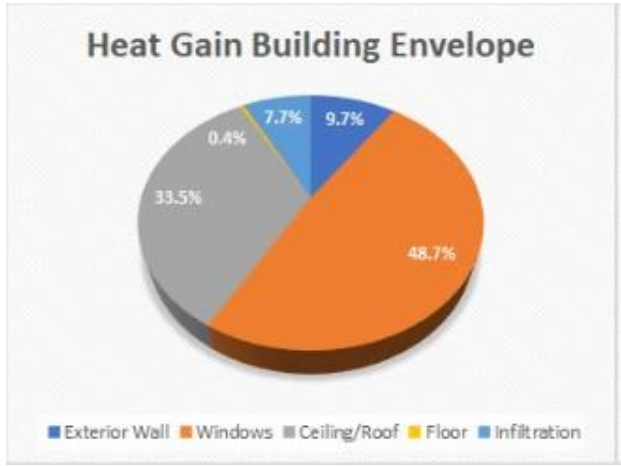
VENTILATION MAT ENERGY BENEFITS



Heat Transfer

According to the U.S. Department of Energy, of the total energy use in the U.S, 21% is used in the residential sector, where heating and cooling account for 55%. 62% of the building heat loss is through the ceiling and roof, while 33.5% of the building heat gain is through the ceiling and roof.[1] Reducing energy waste through innovative roof design should be considered carefully by architects, engineers, building envelope consultants, and builders.





Basic principles of physics explain heat energy transfer in a roof/ceiling assembly:

- Conduction: heat transfers from objects with higher temperature to objects with lower temperature through direct contact
- Convection: heat transfers from higher temperature regions to lower temperature regions by the movement of a fluid (e.g., air or water)
- Radiation: heat travels away from a hot object or surface through infrared rays or electromagnetic waves

[1]Kwan, Yuanming and Lisa Guan. “Design a Zero Energy House in Brisbane, Australia.”

Benefits of Above-Sheathing Ventilation

Metal roofs are typically attached directly to the sheathing deck. This means that radiant heat from the sun is absorbed by the metal roof and then conducted through the roof materials that are touching each other. Heat is then radiated through the attic space to the ceiling and other materials, heating the rooms below. The roofing materials can also be heated by convective air movement, and some of the heated air then vents out the ridge vents.

As discussed earlier, creating an air space or gap between the roof sheathing material and a metal roof (or a wood shingle roof) reduces the conduction of heat and allows convective cooling of the roof via air movement through the air gap. This air gap is commonly referred to as above-sheathing ventilation (ASV).

Again, using a ventilation mat to create ASV vents unwanted moisture and dries moisture from the roof sheathing, mitigating the water-related issues presented earlier. In a study on high-performance roofs by Oak Ridge National Laboratory (ORNL), it was found that “ASV accelerated the removal of unwanted moisture and reduced the moisture content well below that of the OSB in a nonvented cavity.”

Simply stated, above-sheathing ventilation improves roof durability and creates a cooler roof.

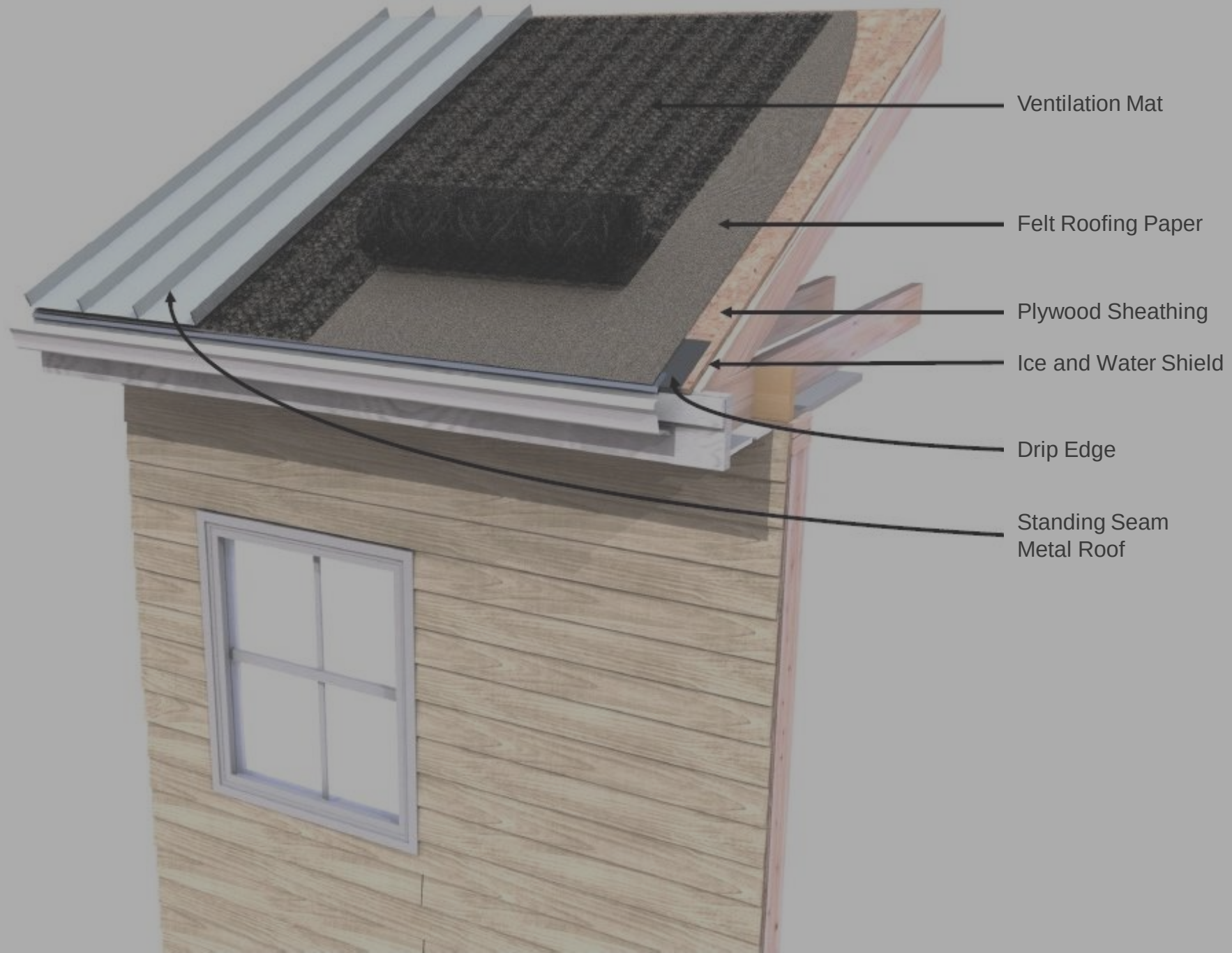
Benefits of Above-Sheathing Ventilation

Separation and venting give energy benefits in the summer and winter seasons. ORNL has completed several important research projects on ASV. In a cool roof fact sheet, researchers state, “We serendipitously discovered the second major advance in roofs for our century: We found that elevating the roof cover from the roof deck to induce above-sheathing ventilation is as important as increasing solar reflectance and may be the stronger player in reducing heat gain into the attic. The two combined can reduce heat gain through the roof by 50% compared to nailed asphalt shingles.”

California’s *Building Energy Efficiency Standards, Title 24*, require a cool roof for new and replacement roofing. A 20% reflective roof covering meets this requirement, but Title 24 also allows a ¾″ air gap in place of the reflective roof. When ASV and a reflective roof are combined, excellent energy benefits are realized.

Photo: Saj Shafique on Unsplash

CEDAR ROOFS

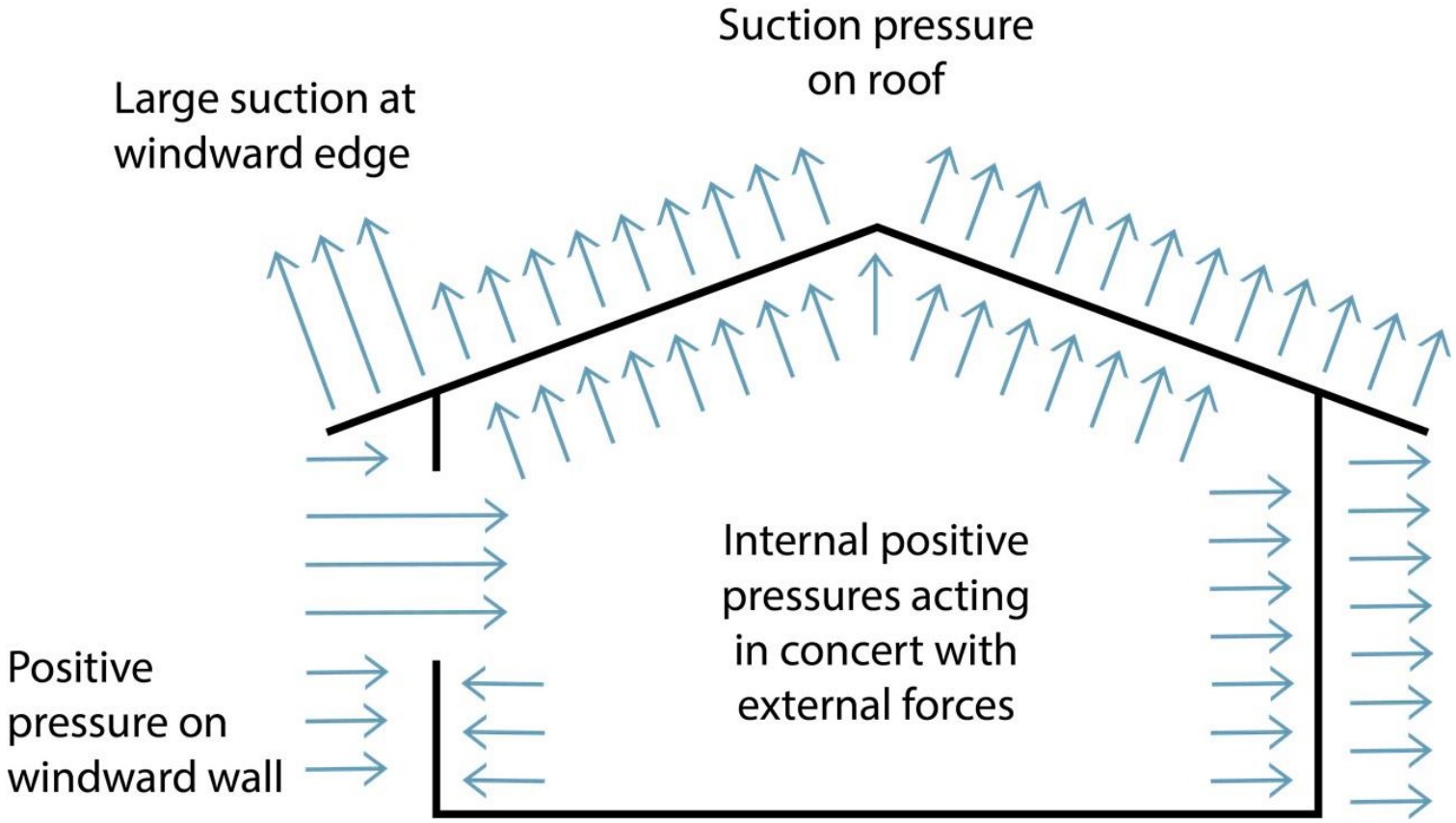

Ventilation Mat
Felt Roofing Paper
Plywood Sheathing
Ice and Water Shield
Drip Edge
Standing Seam
Metal Roof

Moisture-Related Issues

As depicted here, cedar roofing is also susceptible to moisture-related issues. Moisture trapped on the underside of the shingles will eventually cause the cedar shingles to rot. Moisture intrusion can also occur at joint locations or can be due to poor workmanship, clogged drains, or the formation of ice dams.

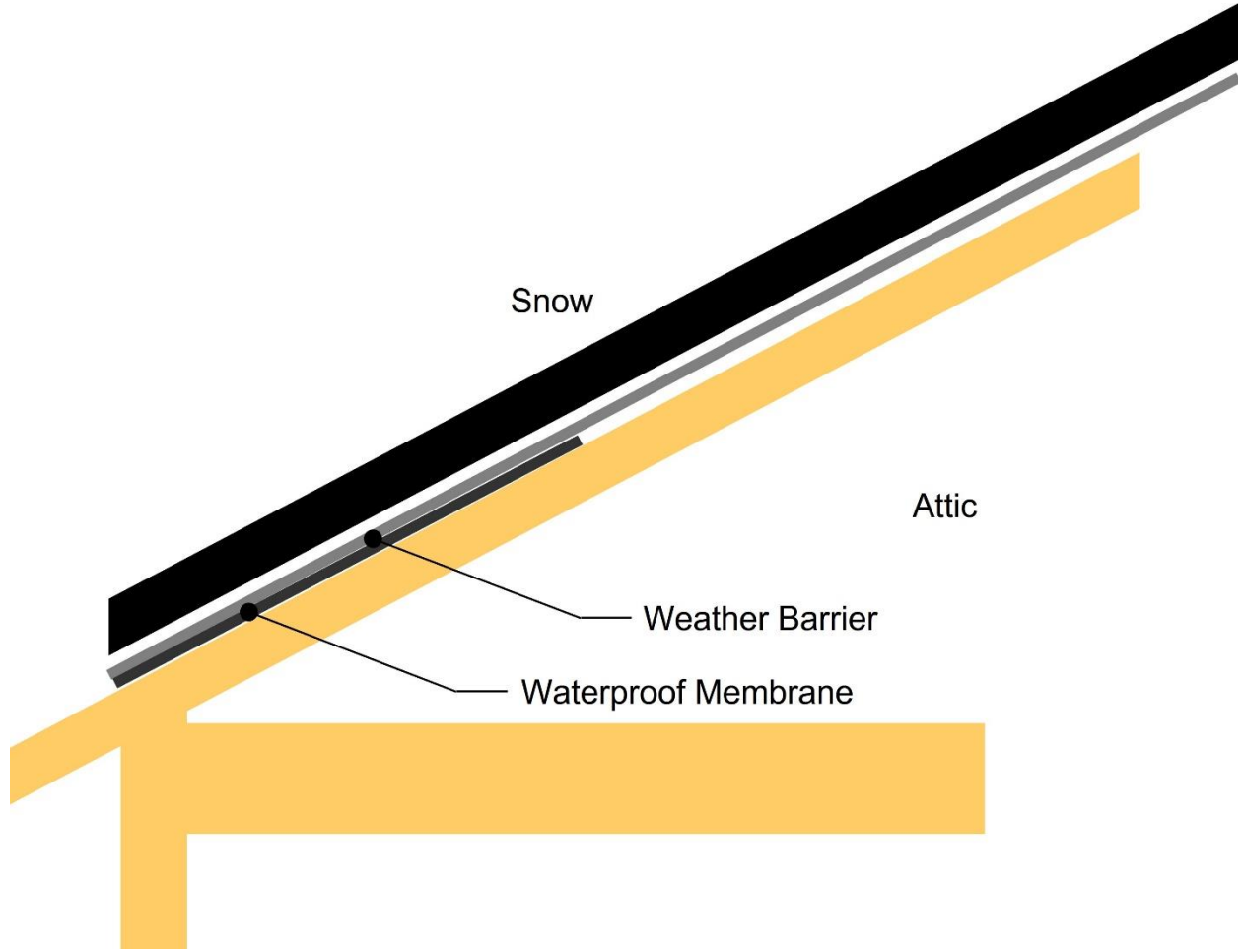
Moisture-Related Issues

When dealing with cedar roofs, heat transfer needs to be factored in. Warm air rises and moves through the attic space where it comes in contact with the underside of the roofing, resulting in the formation of condensation.



Traditional Cedar Roof Assembly

In the past, a typical cedar roof was installed with a waterproof membrane, such as a self-adhered membrane, and a weather barrier over the roof deck. This type of building has led to the premature deterioration of cedar roofing in specific geographic climates that receive heavy rain and humidity. As evident in the next slide, installing an entangled-net drainage and ventilation mat will greatly reduce the chances of trapped moisture causing havoc within the roof assembly.

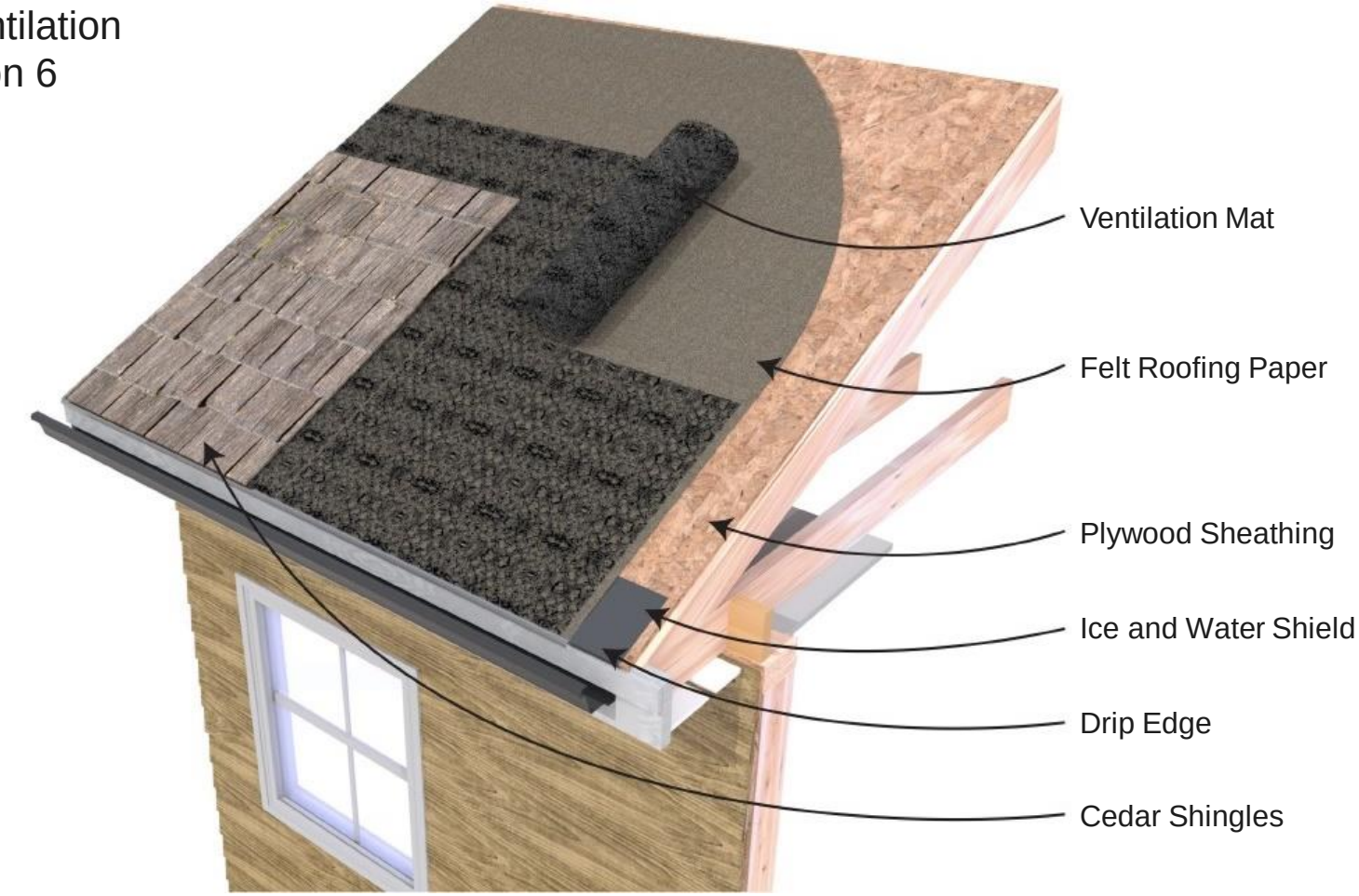


Cedar Roof Assembly

As with metal roofing, the installation of a ventilation mat with an entangled matrix made from nylon 6 allows the moisture to drain rather than become trapped between the backside of the roofing and the front of the sheathing. The materials must be installed in the proper order to shed moisture, and moisture must not be allowed to run down behind any of the membranes.

Order of materials:

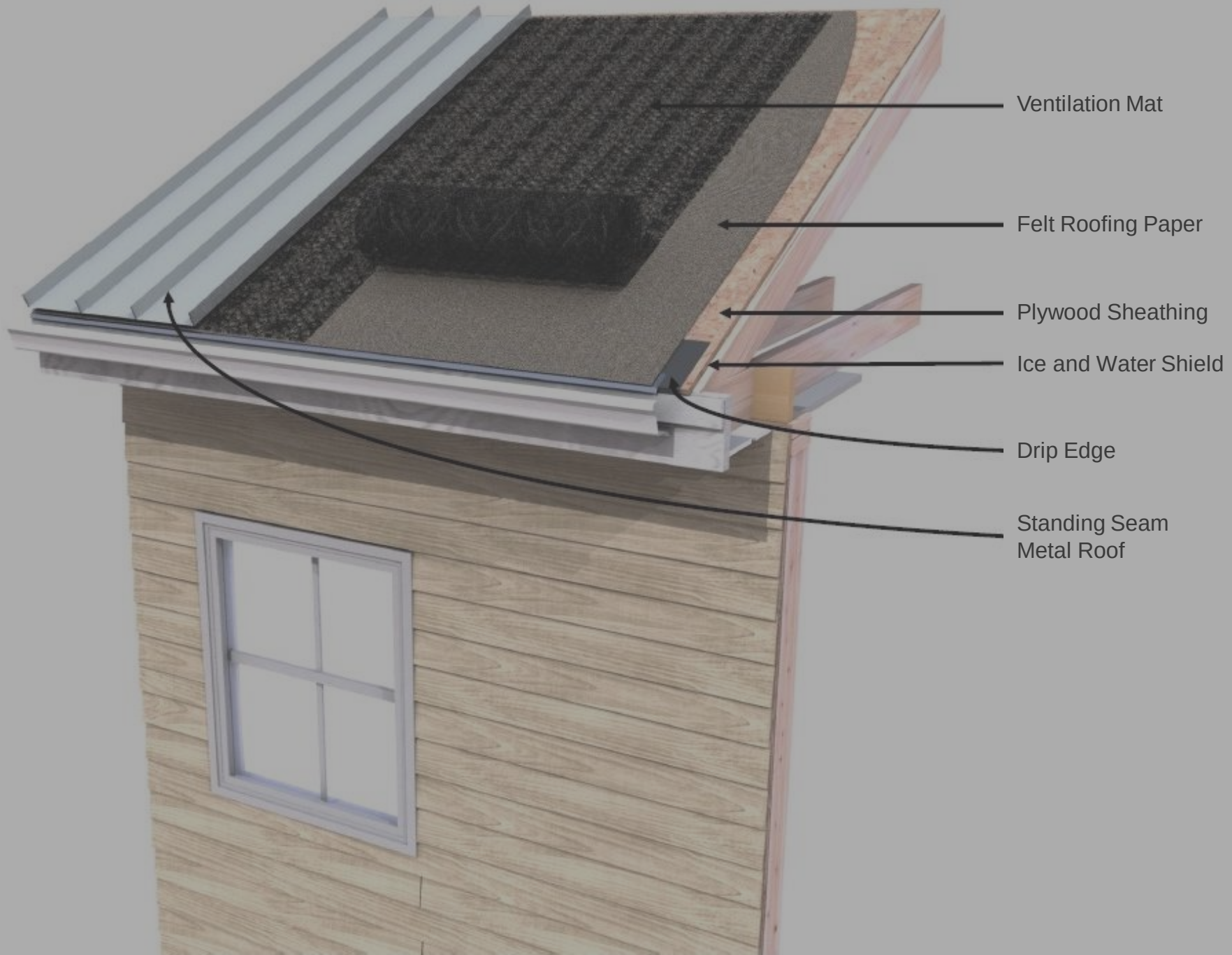
1. Plywood Sheathing
2. Ice and Water Protection
3. Drip Edge
4. Roofing Felt Paper
5. Ventilation Mat
6. Cedar Shingles



Mat Thickness

When specifying a roof ventilation mat, be sure to consider its thickness—the thicker the ventilation mat, the better the ventilation. You can see that in the image on the right, a thicker (10 mm) ventilation mat has been used; it will outperform the thinner (6 mm) mat in the image on the left.

SUMMARY AND RESOURCES



Summary

Metal roof types:

- Hydrokinetic metal roofing, referred to as architectural roofing, is designed to move water. The panels are not watertight and depend on gravity to shed rainwater, and they are therefore suitable for steep-slope applications.
- Hydrostatic metal roofing, referred to as structural roofing, is watertight and employs a sealant along the seams/joints to protect against water intrusion. It is suitable for low-slope applications subject to standing water.

Hydrokinetic metal roofs can experience leaks due to wind-driven precipitation, water backup from ice dams or clogged drains, and condensation from water vapor on the underside of the metal roof. Excessive internal building noise can result from rain, sleet, or hail and other airborne noise.

The best way to prolong the life of a metal roof, prevent oil canning, and reduce sound transmission is to install an engineered drainage and ventilation mat over the entire surface area of the roofing deck. A three-dimensional drainage and ventilation mat with an entangled matrix made from nylon 6 allows the installer to kneel on it without causing damage and is compatible with the temperature range associated with metal roofing. In hydrokinetic roof applications, the ventilation mat creates a capillary break that allows moisture to drain down the roof and away from the structure, increasing the overall longevity, beauty, and energy efficiency of the metal roof installed. A ventilation mat can also be used with cedar shingles to promote drying and prevent rotting.

Resources

Kwan, Yuanming and Lisa Guan. “Design a Zero Energy House in Brisbane, Australia.” *Procedia Engineering,* vol. 121, 2015, pp. 604–611, https://doi.org/10.1016/j.proeng.2015.08.1046. Accessed Nov. 2021.

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