

# Types of Metal Roofs

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Published on [www.lorman.com](http://www.lorman.com) - March 2020

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## Types of Metal Roofs

I want to start by looking at two general categories of metal roofs and then we will break things down further from there. Those two types are vertical seam panels and what we call “modular” panels. Rather than run in long lengths from the bottom of the roof upward, modular panels usually install horizontally, more like traditional shingles. And they often have been engineered to have the look of shingles, wood shakes, slate, or tile. Let’s break down the vertical seam category first and then we will dig into the world of modular panels.

So, there are two basic types of vertical seam panels. One type is called standing seam. These products are characterized by raised interlocking seams on the sides of the panels. The other type of vertical seam panel is corrugated sheet roofing. These are panels that overlap on the sides and usually have exposed fasteners.

While history has shown the design of many variations, standing seam panels come in two basic varieties today. These panels are typically run in custom lengths either in a manufacturing plant or on the jobsite. Oftentimes, these panels are produced regionally in order to avoid excessive shipping costs. The most common is a snap lock panel which consists of a female lock that snaps down in place over the male lock. There are two variations of this type of panel. With one, the panels are secured to the roof deck using hidden clips. The panels are free to expand and contract on the clips for thermal movement. The second type uses what is called a hidden nail hem, similar to vinyl or metal siding but running along one of the vertical edges of the panel. Screws are usually driven through slotted holes which allow for thermal movement. My general advice is for a maximum panel length of 25’ for the nail hem panels. If rafter lengths exceed 25’, then I suggest a clip-fastened system. Most snap lock panels require a 2:12 roof pitch. Various seam heights are available and, of course, the seam height determines the depth of how much water each panel can hold.

Another type of standing seam panel is a mechanically seamed panel. These panels are also secured using clips to the roof. Once the panels are secured to the roof using the clips, a mechanical seamer is run down the seam to crimp the panels together. These panels are designed for complete watertightness, whereas the earlier snap lock panels can “flood out” if the water depth exceeds the seam height. Mechanically seamed panels are often designed for roofs of any pitch including even pitches as low as a ¼” in 12 inches.

The other type of vertical seam panel are corrugated panels. These are common on agricultural applications. Whereas standing seam panels are rarely lapped top to bottom on the project except in the case of buildings such as large warehouses and factories, the corrugated panels are sometimes lapped top to bottom so that they can be shipped in standard lengths. These panels have exposed fasteners, usually screws with rubber washers and cap heads. There are many varieties of profiles of these panels. Each panel will have specifications for the spacing, placement, and types of screws that should be used. Always specify that manufacturer instructions be followed. One drawback to these panels is that they do not allow for thermal movement of the metal. The screws may loosen over time and need to be tightened or even

replaced. Most manufacturers allow these products to be used down to 2:12 pitch though I suggest 3:12 as the pitch requirement.

In regards to vertical seam panels, both structural and architectural panels exist, usually determined by the metal thickness and the panel design. Structural panels can be installed over horizontal battens without solid decking and architectural panels require solid decking. Always refer to the manufacturer specifications for this determination and also to determine appropriate fastening frequency and location.

Now, let's talk a bit about modular panels. Typically, modular panels are architectural and require solid decking though there are some, usually tile designs, that can be installed over horizontal battens. Modular panels come in a variety of designs including products designed to look like shingles, wood shakes, tile, and slate. Oftentimes these panels interlock on all sides though some panels just have an overlap on their sides. In many cases, the panels are fastened to the roof deck along their uphill edges, and the fasteners are concealed by the next course of panels. In most cases, these panels require a 3:12 roof pitch.

Some tile profile panels look like modular panels but actually are available in custom lengths from the eave up to the ridge of the roof. These products have exposed fasteners but the horizontal steps that resemble courses of tile act as little accordion pleats and accommodate the metal's thermal movement without excessive pressure and pulling on the fastening screws.

## **Metals**

Now, let's talk about the metals commonly used in metal roofing panels.

Steel is the most common material and, in steel, we see both galvanized and Galvalume. Galvanized steel has a zinc coating on the carbon steel to help protect it against corrosion while Galvalume has a coating that is an aluminum-zinc alloy. Both galvanized and Galvalume are available in different grades as determined by the thickness of the anti-corrosive metallic coating. For galvanized, the preferred roofing grade is G90 which refers to 0.90 ounces of zinc applied per square foot of steel. For Galvalume, the preferred grade is AZ50 for painted metal roofing or AZ55 for clear coated metal panels. The 50 and 55 refer, respectively, to 0.5 and 0.55 ounces of aluminum-zinc alloy per square foot of metal.

With both galvanized and Galvalume, the metallic coating should be applied in a hot dip process and applied to both sides of the metal sheet. Both galvanized and Galvalume receive their cut edge protection from the zinc coating. When water runs across a cut edge of the metal – both factory and field cut edges alike – the hydrogen from the water carries zinc ions which are then deposited on the exposed carbon steel edge. As the zinc builds up, it protects the edge from corrosion.

To help this process work correctly, all cuts in the steel should be made with a crisp, shearing action to expose as little of the raw steel as possible. Saw cuts should not be made, not just for

this reason but also because hot shards of metal will melt into the paint systems on many types of metal roofs, and cause rust problems down the road.

Galvanized is more costly than Galvalume. Because aluminum does not go into solution with water, a bare piece of unpainted Galvalume will out-perform a bare piece of galvanized. Of course, with painted metal roofing, you have the long life expectancy of the paint before the metallic coating is ever exposed to the weather. However, in all situations, the extra zinc in galvanized will provide better cut edge protection than you get with Galvalume. So, I recommend galvanized for more heavily formed or fabricated products as well as for steel roofs installed in corrosive environments such as coastal applications or areas prone to acid rain.

Metal thickness is usually determined by the metal roof profile including whether it is a structural or an architectural panel. Many corrugated metal roofs are 28 – 29 gauge while steel shingles are usually 27 – 28 gauge and steel standing seam is usually 24 – 26 gauge.

Aluminum is the second most common metal used in metal roofing. Aluminum is always used with a paint finish. Aluminum is lower weight than steel so the aluminum used in roofing is usually thicker than the steel used to form the same product. Aluminum's formability allows it to be made into some very intricate products with the modular panels in particular. Because it will never rust and is a very stable metal, aluminum is commonly used on salt and brackish water coasts. Some of the more heavily formed aluminum modular panels offer optional EPS foam backers that are specially contoured to fill up the airspace between the metal and the roof deck, enhancing walkability as well as hail resistance.

There are also many other specialty metals that can be used in roofing including copper, zinc, stainless steel, and even titanium. These products are sometimes factory-fabricated but sometimes also they are custom-fabricated to meet the project's exact design requirements. While, of course, these products are more expensive, the sky is often the limit in terms of design options. It is perhaps most common to see these metals used on landmark buildings such as government buildings and churches.

Copper roofing will of course develop its characteristic blue-green patina over time which will then be carried off the roof with rainwater. It is important to take steps to get the copper run-off safely off of the rooftop so it does not streak and stain other building materials. One thing to be aware of with zinc roofing is the need for an airspace between the zinc and the roof deck. This is to avoid trapping any moisture against the back of the zinc, which would cause the metal to corrode. This airspace is often achieved by using battens or an entangled mesh material.

## **Coatings**

So, the exotic metals we just talked about such as copper and zinc are typically used in their natural mill finish form – without any sort of coating, though there are zinc products available that have been stained for different shades and tones of gray. While most steel roofs have colored paint finishes, AZ55 Galvalume is sometimes used in mill finish. With those products,

the steel has an acrylic clear coating on it which allows the metal to be fabricated and also protects the metal during transit and installation. The coating, however, wears away after a few years, exposing just the bare Galvalume steel.

When it comes to the paint finishes used on steel and aluminum roofing, in virtually all cases, the metal is painted while it's still in coil form – prior to its fabrication into roofing panels. This is done on a high speed coil coating line which typically applies a primer, top coat, and back coat on the metal all in one pass. Today's fancier "print coat" finishes which blend multiple colors on the metal sometimes require a second trip down the coating line and sometimes have a clear coat put on top for enhanced durability.

There are two primary chemistries of paints used on metal roofing today. One is polyester and the other is polyvinylidene fluoride, or PVDF for short. These products are named based upon the resin that is used in the paint. The resin is what holds the color – the pigment – in place and also what bonds the paint to the metal surface.

The PVDF coatings offer greater life as well as chalk resistance and color retention. PVDF coatings, sold under the trade names of Kynar 500 and Hylar 5000, require the incorporation of man-made ceramic pigments which offer superior fade resistance. There is a variant of polyester finish, often called super-polyester – that also uses these superior pigments. But, the polyester resin still begins to show degradation after a few years, especially compared to the performance of the PVDF coatings. The difference usually begins to show pretty dramatically after about seven to ten years of exposure.

Some of the areas of growing technology in terms of these paint finishes include multi-hued finishes and also powder-applied finishes that are put on the panels after they have been fabricated. In some cases, we're seeing textured finishes as well which help with aesthetics and also roof safety.

My advice on paint finishes is to require that they meet Metal Construction Association (MCA) certification requirements. We have seen some folks using lower cost thin film paint systems which will not perform as well as the MCA certified products will.

Finally, some modular products use aggregate or stone coatings. These finishes are often available in multi-hued colors and have a very nice look. They are typically available on certain shake and tile profile products made from steel. Generically, they are called stone-coated steel. One drawback to these products is their lack of recyclability due to the aggregate surface.

It is important to realize that, in certain environments, any roof coating can attract mildew over time. These are typically dark and damp or tropical environments. The stone-coated products can be more prone to this than the painted products, and they can also be harder to clean.

## **Flashings and Trims**

When specifying a metal roof, request sample CSI format specifications from your manufacturer. These will detail many important aspects of the roof specifications, especially pertaining to metal and coating quality and performance. Specifying a metal roof, though, also requires detailing out various flashings and that can be a bit more involved. Manufacturers will be glad to work directly with you to facilitate proper specifications.

With many roofing materials such as shingles and tile, various sealants are used whenever the roof plane intersects something but, while sealants are used with metal roofs, you do not want to have too great of dependence upon them because the sealant will not last the life of the metal roof. Therefore, either factory or field-formed flashings are used.

It is important that such flashings be made from the same metal as the roof system, both for color matching and warranty and performance purposes. Most manufacturers offer a number of standard pre-formed accessories but they also offer coil or flat stock for field fabrication. In developing your details for a metal roof specification, most manufacturers will gladly consult with you and provide detailed drawings of various flashing areas for their products. There are of course, always situations such as dead valleys and other areas that require custom design and fabrication. This is usually done by the roof installer but sometimes manufacturers can do it as well.

I want to mention a couple of flashings as examples of things to think about. Because of the way that everything that lands on a roof – tree leaves, pine needles, ice, and snow – flows into the valleys, valley systems must be open and self-cleaning. There are some companies who have experimented with closed valleys designed to carry water on hidden channels beneath the metal roof's surface. Such systems, unfortunately, are prone to clogging with debris. Make sure that you specify only open or self-cleaning valley systems.

Next, I want to mention flared or flying gables – where the ridge of the roof is wider than the eave. A common straight gable flashing consists of a raised channel running along the gable. However, with flared gables, much like a closed valley, such raised gables will trap debris. So, flared gables need a gable system that allows water and debris alike to flow over the gable edge of the roof rather than be carried in a channel of some sort.

One additional flashing I want to mention is a low to steep pitch change flashing. Such flashings must be carefully designed and installed so that they maintain a positive pitch and do not accidentally force water uphill and under the roof system.

Finally, when dealing with standing seam roof systems roof shapes where upper roofs will shed water onto lower roofs, it is important to think about where that water will flow. You do not want to dump a large amount of water from the upper roof into one standing seam pan on the lower roof for fear that it will overwhelm or flood out the lock of that panel. In some cases, this can be avoided by special pan flashings to re-direct the water into two or more standing seam pans.

Do not be afraid to specify how you want things flashed but, whenever possible, refer to details from the manufacturer of the roof panel. Additionally, the Metal Construction Association has produced a metal roofing installation manual that illustrates many common details and can be downloaded on their website at [metalconstruction.org](http://metalconstruction.org).

## **Solar**

We frequently see metal roofing and solar installations on the same buildings. Both products have similar goals – environmental friendliness, lower energy usage, and lower building operating costs. Additionally, the durability of metal roofing provides a great base for solar installations that will easily surpass the life of the solar installation itself. The cooler temperatures of metal roofs can also be beneficial by increasing the efficiency of the solar collectors.

While traditional crystalline PV panels can be added to an existing metal roof, there can be things done during an initial metal roof installation to help make it solar ready. This can include such things as adding permanent brackets or using foam inserts for extra strength beneath various modular panel profiles.

Traditional solar panels can be mounted to standing seam roofs using special clamps which do not penetrate the actual roof system. These systems are very popular. With modular metal roofs, there are a variety of brackets that can be used, oftentimes similar to those used with asphalt shingles. Batten-mounted stone-coated steel roofs have brackets that do not require any sort of lag screw through the roof.

Thin film solar is available as an option on standing seam metal roofs. My advice is to have the thin film applied in the factory. Trying to install it on the jobsite under imperfect conditions will lead to problems. Additionally, the thin film must only be installed on flat metal panels, not panels that have ribs or striations.

One up and coming development in regards to solar is solar shingles that can be integrated right into a modular panel metal roof. We will be seeing these systems available in the near future. At some point, way down the road, I believe we will also see where the coatings used on metal roofs themselves can be used for solar collection. While this has been done on a small scale, the technology is not yet commercially viable.

## **Condensation**

Let's address a common concern with metal roofing – condensation. For the most part, this is an unfounded concern. Thermal dynamics are such that, if condensation does form beneath a metal roof, it is from moisture that originates inside of the structure and is driving outward. For that reason, normal methods of moisture control suffice typically even when a structure has a metal roof. That would be things like vapor barriers behind the ceilings, insulation, and ventilation. By the way, closed cell urethane spray foam works well with metal roofing though I

prefer to see it sprayed to the back side of the roof decking and not to the back side of the metal roof panels themselves. The problem with applying foam to the back side of the panels is that it will make it very difficult to ever remove the roof and also the closed cell foam could hide roof leaks until a major problem exists.

Back to condensation ... if a structure has limited ability for moisture control such as no vapor barrier or little or no ventilation, then a metal roof can be the straw that breaks the camel's back and causes condensation in an attic space that formerly did not have problems. Fact is, a metal roof does drop the roof deck temperature so, if warm moist air is trapped in the attic, the lower roof deck temperature makes it more possible for dewpoint to be hit and condensation to form.

In that case, installing the metal panels with an airspace can be helpful. This could be achieved with battens if the roof panels are approved for application over battens, or with an entangled mesh product. If you have some sort of ventilation on top of the sheathing, a breathable underlayment rather than a non-breathable underlayment may be helpful as well.

One final note, I never recommend installing a metal roof without solid decking on a residential structure or any structure that is a relatively small space with potential for high moisture levels. Almost invariably, doing so will result in condensation on the back side of the metal panels, especially during the Spring and Fall when night time temperatures drop very cool but yet there is a lot of warm moist air in the attic.

At this point, I have covered many of the major topics pertaining to proper metal roof specification. I am now going to catch up and talk briefly about a number of small subjects.

### **Roof Pitch**

We touched on this earlier when we discussed the various styles of metal roofs and their required roof pitches. However, I want to stress – in no case should a metal roof ever be installed at lower than its manufacturer's recommended minimum pitch. And, in the case of very large or complex roofs, even the minimum required pitch may be too low. Always check with the manufacturer if you have any concerns and under no circumstances should you allow someone to try to make up for low pitch with a beefier underlayment.

### **Underlayment**

Speaking of underlayment, premium synthetic underlayments have become the norm under most architectural metal roofs at this point. The days of traditional felt papers are pretty much gone. Ice and watershield of course should be used as required by code and, in the case of situations where certain fire ratings are desired or required, fire-resistant underlayments may be necessary. Additionally, keep in mind the availability of breathable underlayments as well as entangled mesh products. The mesh products can be helpful for sound attenuation and also for enhanced energy efficiency by creating a thermal break.

## **Warranties and Installers**

Warranties are provided by panel manufacturers and cover the products themselves. The coverages vary by manufacturer. One thing to watch for is that, sometimes especially with site-formed standing seam where there may not be a “bricks and mortar” manufacturer involved, the warranty may cover only the coating on the metal panels and not the panels themselves. This provides far less coverage for the property owner.

The installer for a metal roofing project should provide a workmanship warranty. I typically see workmanship warranties of five years or longer. Some manufacturers, especially for larger projects, may provide a limited leakproof warranty on the project, something which usually will require jobsite progress inspections.

Metal roofing installers should have training and experience with the system being installed. It would not be uncommon to write into the specs that at least a crew foreman be present who has a minimum of three years experience along with training from the manufacturer.

## **Oil Canning**

Oil canning is something that can occur with standing seam roof systems. Oil canning appears as ripples in the flat areas of the panels after they have been installed. The industry generally says that oil canning is not reason for rejection. The most common reason behind oil canning is an uneven roof deck which forces stress into the panels. In some cases, an astute installer can somewhat float the panels in order to accommodate uneven roof decks. Other causes of oil canning include inherent stresses in the metal coming right from the mill, forming machines that are out of adjustment, or physical damage to the metal panels during transport or installation. In some cases, a 3/8” diameter backer rod can be installed down the center of the panels in order to put a crown in the panels and take up any ripples. Another option offered by many manufacturers for limiting oil canning is striations or ribs in the flats of the metal panels.

## **Snow and Ice**

While metal roofs typically have some good characteristics in regards to ice and snow, they are not the answers to rooftop ice problems. Most ice dams on roofs are the result of poor ventilation and heat leaks from the living space. Metal roof systems require good ventilation. Commonly, though, snow will build up on a metal roof and then be released once the sun comes out and radiant heat from the sun passes through the snow load, and strikes the metal. This then causes the bottom side of the snow to melt and it slides off the roof. Most metal roof systems have available snow guards or snow bars that can be used on the roof for the purpose of preventing violent snow slides from the roof. My general advice is to think in terms of breaking up the snow as it slides, not holding it on the roof until it melts.

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