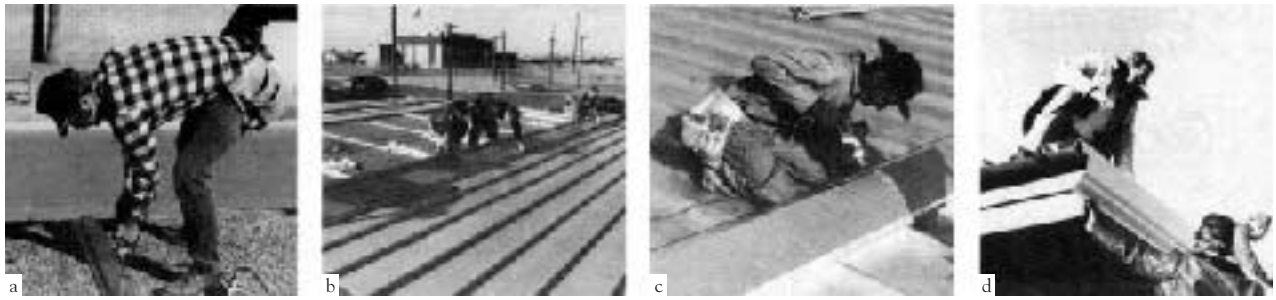
Shopping for Structural Metal Roofs

by William Rose

Examine a manufacturer's flashing and attachment details before you sign up to install his system



On a low-slope commercial roof: A worker screws metal purlins (a) through the old built-up roof. Panels are attached to the purlins with special clips (b) that allow for thermal movement. Movement is also accommodated at the ridge (c) by a flexible cap. To finish up, trim is installed at the rake (d) to be followed by the eave. (Manufacturer: Armco Building Source)

Poking holes in metal roofs invites leaks. And with pre-engineered standing-seam metal roofs, the contractor can easily get caught without the protection of a manufacturer's warranty. That's because these roofs are designed at a factory – and it's next to impossible to design for every problem that can occur in the field.

Before signing up to install a manufacturer's roofing system, the contractor had better take a good close look at the details. Wherever pluming vents, skylights, scuppers, or parapet walls penetrate or join the roof, there's a chance leaks will occur. These roof penetrations can also cause the roof to self-destruct. If the manufacturer's manual shows these roof penetrations clearly, and if the details make sense, the contractor can go ahead. But if the details are ambiguous or flawed, it's the contractor who will be the big loser (see "Metal Roofing Partners").

The Structural Metal Roof

Pre-engineered structural metal roofs are part of a manufactured roofing "system" This means a manufacturer has designed all the parts needed to install the roof (panels, attachment system, and details). Generally the roof is made up of metal panels attached with clips to widely spaced structural members like purlins or rafters (Figure 1). These panels are called "structural" because they provide the roof and the structure both. The seams are sealed in many ways. One common way is to use a crimping tool (Figure 2). A mechanical seaming machine follows along behind.

The contractor buys the complete package with the manufacturer's specifications for how all the pieces go together. Most manufacturers provide a warranty on the materials for 20 years. But contractors can buy an additional warranty for about 10 cents a square foot. This optional warranty guarantees the roof will stay weathertight.

Standing-seam metal roofs work well in certain conditions:

- When the roof has few penetrations (for example, plumbing vent stacks, skylights, equipment curbs)
- When the roof form is fairly simple (gable or shed)
- When the roof slope is more than 1/4:12

Simple roofs make the job easier. With complex roofs or roofs with a lot of penetrations, you'll lose time handling details.

You can also use metal roofs for one of the most common reroofing jobs – covering a worn-out built-up roof (BUR). On reroofing jobs, you can leave the old roof in place unless water has soaked the insulation below. If the old roof is flat, you can install a wood or metal framework to provide slope for drainage (Figure 3). Purlins fasten to the framework, and the roof is finished in the normal way. You can also put purlins on sleepers and apply them directly to sloped built-up roofs.

How the Pieces Fit

Every structural metal roof has a field and flashings. Large, continuous panels make up the field – the main body of the roof. The flashings are the interruptions. If you could install a metal roof with just the purlins and panels, it would never leak. But that's seldom the case. There are usually many interruptions, and it's how you detail these that count. Poor flashing details can cause a metal roof to tear itself apart in a very short time.

Thermal expansion. Each metal has its own rate of expansion and contraction. A 40-foot length of aluminum roofing, for example, will be _ inch shorter at 0°F than at 120°F. Thermal movement is primarily a problem along the length of the panels, where the movement must be accommodated by flashings. Movement across the panels is easily absorbed by the standing seams.

A contractor installing a metal roof must account for the movement of metal in the field. But each detail on a metal roof expands and contracts too. Where will it move, and how much will it move?

The fixed edge. Each roof section must have a line of fixity. This is the line where the roof is attached (Figure 4). The rest of the roof moves, but the fixed edge stays put. The line of fixity must be perpendicular to the run of the panels, that is, parallel with the ridge. The line is usually at the ridge of the eaves, but it can also be centered over one of the purlins.

If the object is to keep water out, having the line of fixity at the ridge is best. That way, any penetrating fasteners are up where only small amounts of water can reach them.

However, it's easier to install a roof that has the line of fixity at the eaves. The advantage of having the line at the eaves is that a flexing ridge detail is much simpler to install than a flexing eaves detail.

Who decides? The manufacturer of the system – that's who. He's the one

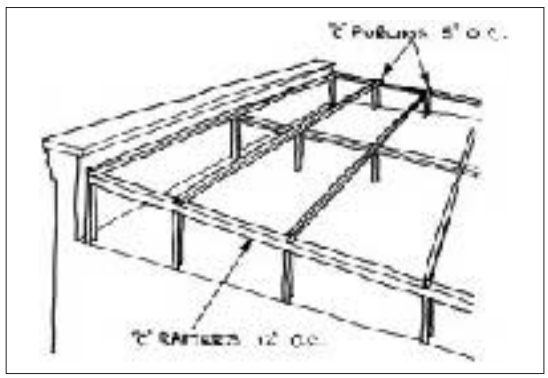


Figure 1. *Widely spaced trusses and purlins provide structural support for metal panels.*

Figure 2. *A crimping tool seals the ridges as tight as a tin can.*

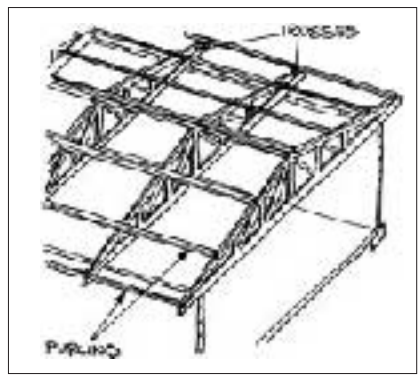


Figure 3. *To create a slope over a flat-roofed building, contractors can install a sloped purlin framework.*

Architectural Metal Roofs

Architectural roofs have been used for centuries. On these roofs, it's up to the contractor to work out the details. The details – wall flashing, chimney flashing, roof vents, gutters, etc. – are created with the same materials, tools, and techniques as the field of the roof. Metal panels are applied to solid structural decks, using hand-formed panels of lead, copper, zinc, and coated steel. The panels are held to the deck with cleats. The joints are formed in metal-breaks or soldered (see photo).

Today, those classical methods are collected in the Architectural Sheet Metal Manual, a basic text so complete, so clearly and richly illustrated (using silver ink!) that it belongs on coffee tables as well as in truck cabs. It illustrates sheet metal detailing from termite shields to church steeples. All of the common details found on roofs – seams, stacks, scuppers, scuttles, spires – are shown in vivid three-dimensional drawings.

One important lesson from classical metalwork is that it is possible to waterproof, relying only on the strict geometry of the metal components – without relying on the use of sealant. (When you look at details for standing-seam metal roofs, notice how often they call for sealant.) If a contractor working with a pre-engineered roof finds a detail that doesn't make sense, he may want to look in the Architectural Sheet Metal Manual to see how the problem would have been handled traditionally. You can order the book from the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), P.O. Box 70, Merrifield, VA 22116. Price of the manual is $75, ($45 to practicing architects and engineers). All orders must be prepaid.

signing the warranty with the client.

Panel profile. Before signing up to install a manufacturer's product, take a close look at the panel profile. Open-profile systems are popular with manufacturers because the panels nest for easy transport (Figure 5). Open profiles require closer strips ("birdstops") at the ends. These are usually rubber or foam pieces inserted wherever the standing seam is cut.

Make sure the closure strips look like they'll stay in place after you leave the job. It's common for these strips to fall into the gutter as the roof expands and contracts – and you're going to be a lot closer than the manufacturer when the client wants to complain.

Details make the difference. While there are hundreds of possible metal roof details, a contractor should look for well-thought-out details for the following common conditions:

- Field edge – ridge, hip, valley, rake, eaves
- Wall or parapet – upper, side, bottom, chimney
- Curb – scuttle, skylight, equipment base, expansion joints
- Miscellaneous – plumbing vent, equipment support, gutter, scupper, L-shaped corners.

To keep water out, you must have watertight details at every location. We're going to compare three typical details to see how different manufacturers handle the same condition. You'll see that some details have weaknesses, while others look like they'll perform reliably.

Figure 4. *The roof expands and contracts perpendicular to the line of fixity, where panels fasten to the structure. Movement across the roof is absorbed by the standing seams.*

Figure 5. *Open-profile panels nest for easy transport.*

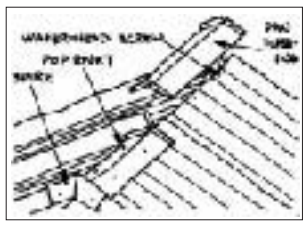


Figure 6. *This system is fixed at the ridge. Pan flashings and spires cover the open joint where the two panels meet at the ridge.*

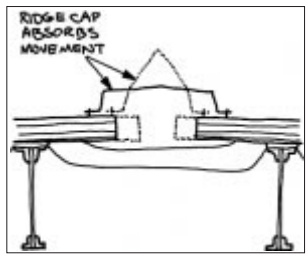


Figure 7. *This system is free at the ridge, fixed at the eaves. Thermal movement of the panels is accommodated in the profile of the ridge cap.*

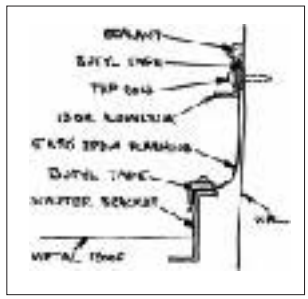


Figure 8. *The rubber flashing creates a weathertight seal and lets the roof panels move next to the wall.*

Ridge Details

Although the water volume is usually light at the ridge, wind effects at the ridge can be variable and strong. A ridge can be fixed or floating. Fixed-ridge details may be as simple as mated panel edges with a tight closure strip. Floating ridges usually require closure strips on the upper edges of the panels, then a hat section that joins the closure strips.

Riveted ridge flashing with spire. Roof panels are screwed to the ridge purlin, so panels have to float at the eaves (Figure 6). Lots of exposed fasteners mean more chances for leaks. Here you're depending on sealant below the pan flashing to keep water out.

Ridge cap with profile enclosures. Some ridge-vent details allow longitudinal thermal expansion of the roof panels at the ridge (Figure 7). Other manufacturers show ridge-vent details that don't allow for expansion, which could cause problems.

Wall/Parapet Flashing

You need flashing wherever one of these roofs joins a wall or parapet. The most difficult detail is the one where the roof meets the wall at the edge of the slope. Because the metal panels expand most along their length, there's a good chance thermal movement will make this joint leak.

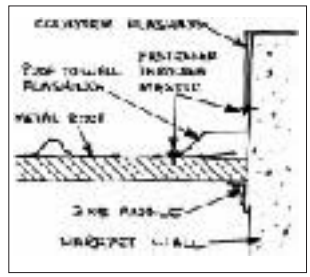


Figure 9. *What not to do: This roof-to-wall flashing is fastened directly to the parapet wall and to the roof panel. Thermal movement will tear the flashing from the wall or from the roof.*

EPDM flashing at sidewall. This detail is simple but effective (Figure 8). The EPDM (rubber) flashing creates a weathertight seal and allows expansion and contraction of the roof panels next to the wall.

Metal flashing at sidewall. This detail has a serious flaw – the roof-to-wall flashing is fastened directly to the parapet wall. And it's fastened to the roof panel (Figure 9). Thermal expansion of the roof panel would tear the flashing from the wall or from the roof.

Pipe Penetrations

Skylights and scuttles can be made to float with the roof. Most pipe penetrations will stay put while the expanding and contracting roof panels float around them. Pipe flashings are handled a couple of different ways.

Pipe flashing at panel rib. With one manufacturer's detail, pipe flashings have to be centered on the rib to allow the roof to move around the pipe (Figure 10). This detail shows a rubber boot used to provide a tight seal between the pipe and sleeve. But, the pipe's location is not always under your control. If the pipe isn't centered on the sleeve, you could have a problem.

Rubber gasketed pipe flashing at panel rib. The detail in Figure 11 calls for a very flexible flashing material to seal around the rib. But even if the flashing material works, there is still little room (only 1/2 inch) for expansion of the roof relative to the pipe.

Problem Areas

Comparing these details, you can see that many systems have a lot of room for improvement. But if the detail looks faulty, you'd better do it the way

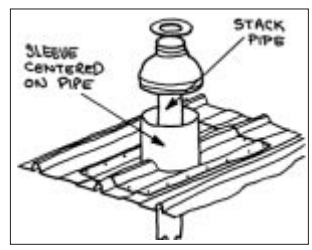


Figure 10. *For this detail to work, the pipe must be centered on the sleeve. But that's not always within your control.*

Metal Roofing Partners: You and the Manufacturer

Structural metal roofs are sold as "systems." This means the manufacturer is responsible for testing the product and recommending installation practices. Manufacturers' installation manuals carry the legal weight of contracts. If you deviate from illustrated details or specified accessories, the manufacturer will not honor the warranty for the roof (see photo).

You need more support from a manufacturer than a good manual. Find out how long the manufacturer has been in business. How long has the roofing product been used in the filed? Find out whether the product has been tested prior to field use. If you are satisfied with what you learn about the manufacturer, you are ready to become a "certified installer."

Think of this step as forming a partnership. You, as the erector, are making a long-term commitment to the quality of the roof installation. But the responsibility for good performance of the system must be correctly parceled out between you and the manufacturer. What do you have to do to become a certified installer? It may be one or all of the following:

- Buy a franchise from the manufacturer.
- Attend a training course.
- Host a site visit by the manufacturer's tech rep during a roof installation.

Just as the manufacturer will evaluate your performance, you should evaluate the support you will receive from the manufacturer. You can tell a lot about your partner by a close examination of the support manual. Make sure it's a good one.

Visualizing details. The contractor trying to visualize details can have a tough time. Some manuals only show the roof panels in section. But these drawings don't give the contractor the complete picture because they fail to show what happens at the ends of sections. Isometric or perspective drawings give a better picture of what's really going on.

The best manuals show three-dimensional drawings that include inside and outside corners for any detail. But in many manuals, one corner is hidden, so you're on your own.

Missing pieces. Some manuals are not complete. Contractors should check to make sure every detail likely to be encountered on the roof is described in the manual.

Without written approval from the manufacturer, the contractor could be liable if problems occur. If you find a condition that is not illustrated on the manual, or if you're inclined to deviate from a manufacturer's detail, seek approval from a technical representative – in writing.

Details vary. Unfortunately for the contractor, details vary widely from one manufacturer to another. If you install more than one company's product, make sure you keep the details straight.

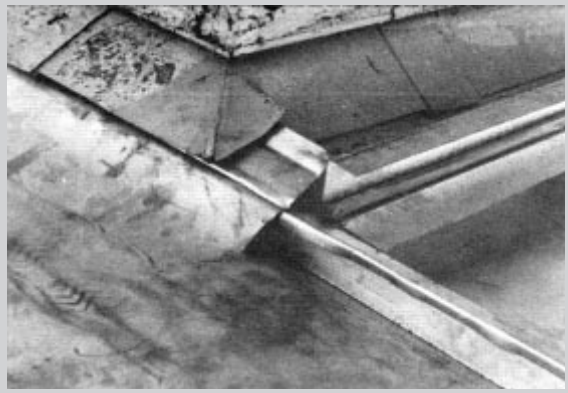
Trade associations. If you're seriously considering becoming a licensed roofing installer for standing-seam metal roofs, the following trade associations can give you additional information.

National Roofing Contractors Association (NRCA), One O'Hare Center, 6250 River Road, Des Plaines, IL 60081.

Roofing Industry Educational Institute (RIEI), 7006 South Alton Way, Building B, Englewood, CO 80112.

Metal Building Manufacturers Association (MBMA), 1230 Keith Building, Cleveland, OH 44115-2180.

Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), P.O. Box 70, Merrifield, VA 22116.



This site-modified corner detail voids the warranty. When changes in the field are necessary, first check with the manufacturer.

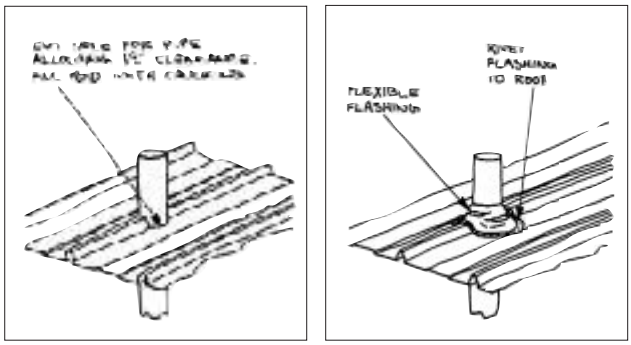


Figure 11. *This opening relies on a very flexible flashing material to seal around the rib. Even if the seal holds, there's only 1/2-inch tolerance for movement.*

the manufacturer says, or else get the technical representative to approve your modification – in writing. In my roofing evaluation work, I have spotted design weaknesses in three critical areas. Very few manufacturers have provided adequate information or detailed support to guide their installers in these areas.

Gutter. Some engineered systems are sold without gutter accessories. Big mistake. The gutter design should be integrated with the roof design so that thermal movement of the gutter is part of the plan. Usually the gutter is fixed to the edge of the building. (If the eaves are designed to float, they can expand and cause water to overshoot the gutter). Drip flashing into the gutter should also be provided. And a secondary gutter or drip pan to catch condensation from the underside of the primary gutter is a necessity in cold climates.

Scupper. I have yet to see a manufacturer's manual with an effective scupper design.

L-shaped sections. A contractor can get stuck in the middle of a roof installation and find that there is no detail in the manual. One of the most critical areas where the manufacturer should provide guidance is the nook formed by L-shaped sections. Stresses at inside corners are much greater than the stresses in any other part of the roof.

If the manufacturer doesn't illustrate a solution, the contractor may be forced to resort to "field modifications." One peculiar field modification I ran into was one contractor's attempt to deal with the problem of an inside corner. He cut a quarter section out of a rubber vent boot made for plumbing and fastened it to the roof and the walls, much like a rubber bumper. While this wins a prize for creative thinking, the contractor should be in trouble if the roof leaks.

Market Share

Metal roofing has not yet won 25 percent of the low-slope roofing market. But an informal check around the continent indicates that builders in extreme climates – for instance in Alaska and Central America – will tell you it's the kind of roof to put on a building.

The reason is this: Standing-seam metal roofs can virtually ignore the temperature – as long as the temperature stays constant. What metal roofing does not like is temperature swings. Where the temperature goes up and down, details make the difference. ■

William Rose is an architect and roofing consultant for the Army Corps of Engineers and the U.S. Air Force.