Manual highlights metal roofing

NRCA's metal roofing manual explains application techniques and materials

by **James R. Kirby, AIA**

The metal panel roof system, one of the oldest roof systems used in the United States, continues to rely on traditional materials and installation methods. *The NRCA Metal Roofing Manual,* a section of *The NRCA Roofing and Waterproofing Manual, Fourth Edition,* was written to provide unbiased technical information about the design and installation of architectural and structural metal roof systems.

It begins with a description of the variety of metal panel roof systems available today, as well as a list of project requirements that should be considered when selecting such a system (e.g., life expectancy, climatic conditions). A discussion of common metal types, panel configurations, seam types, manufacturing methods and systems also is included.

In addition, the introduction differentiates between architectural (hydrokinetic-watershedding) and structural (hydrostatic-water barrier) metal panel roof systems. The manual states: "Architectural standing-seam roof systems are usually installed on steeper slopes with relatively shorter panel lengths. They often do not have sealant in the seam because architectural metal roof systems are designed to shed water off the panel at a relatively rapid rate." These types of metal panels do not provide structural capacity and/or load resistance.

Structural metal panel roof systems are described as follows: "Structural standing-seam roof systems are versatile metal panel systems that can be used on both steep- and low-slope roofs and are designed to be water-resistant. Most structural standing-seam systems incorporate a factory-applied sealant in the standing seams to help ensure watertightness." These types of metal panels do provide structural capacity and load resistance.

In addition to these topics, the manual addresses the American Society for Testing and Materials standards applicable to metal roof systems and reroofing considerations. Detailed drawings of common metal roofing conditions encountered in the field and a glossary of metal roofing terms also are included.

Substrates for metal roofing

The manual's first section discusses metal roofing substrates. The two general categories of substrates are solid roof decking and spaced or intermittent supports. Most solid roof decks include cementitious wood fiber, concrete, steel, and wood planks or panels. Solid roof decks typically carry architectural metal panel roof systems.

Common spaced supports include bar joists, light-gauge framing, and post and purlin systems. Structural metal panel roof systems usually are installed over spaced supports. Because structural metal panels can be installed on slopes as low as ¼-in-12 (2 percent), the panel design and seam profile must be considered to account for the span and slope.

The manual provides brief descriptions of each metal panel roof substrate type and appropriate design, attachment and/or support requirements.

Underlayments, slip sheets

Underlayments are used with steep-slope architectural metal panel roof systems. The installation of nonperforated asphalt-saturated felt is similar to that of asphalt shingle roof system underlayment. When specified, single-layer underlayment requires 2-inch- (51-mm-) minimum side laps and 4-inch- (102-mm-) minimum end laps; double-layer underlayment requires 19-inch- (483-mm-) minimum side laps and 4-inch- (102-mm-) minimum end laps. Downslope edge metal is installed under the underlayment, but rake edge metal is installed over the underlayment.

When bonding of the metal panels to the roofing felt is a concern, a slip sheet should be used. Slip sheets consist of a layer of smooth building paper (e.g., red rosin paper) and are installed to prevent the metal roof covering from bonding to the underlying asphalt-saturated roofing felt.

An ice-dam protection membrane also is suggested in regions where the January mean temperature is 30

F (-1 C) or lower. The manual's figures and text provide descriptions of underlayment installation, slip sheets and ice-dam protection.

Vapor retarders and ventilation

Information about vapor retarders, insulation and ventilation issues unique to metal roof systems also is presented. The need for a vapor retarder depends on the individual building and construction type and must be determined on a job-by-job basis.

For structural metal panel roof systems, especially those of preengineered buildings, the vapor retarder (e.g., a white polyethylene film) usually is the bottom surface of the blanket (or draped) insulation. When the insulation is installed over support purlins, it becomes compressed. This changes the R-value and may subsequently allow the dew point temperature to occur below the vapor retarder, potentially resulting in condensation problems. Installing spacer blocks will reduce the insulation's compression and can reduce or prevent thermal transfer at the spaced supports. Even when spacer blocks are installed, the location at which dew point is reached should be calculated and accounted for in the design.

For steep-slope architectural metal panel roof systems designed as "cold," the vapor retarder typically is located on the warm side of the insulation at ceiling level, allowing the attic space and roof assembly to remain at ambient temperatures.

A vapor retarder and ventilation space may be needed within a "compact" metal panel roof assembly if condensation is anticipated. (In compact roof assemblies, insulation is placed directly on top of the roof deck, and the membrane is applied directly on top of the insulation.) The manual states: "When rigid insulation is installed over a solid roof deck, panel clips are typically fastened to wood nailers, a batten/counterbatten grid or a Z-purlin, which is typically placed over the deck and between the insulation boards. The nailers are typically the same thickness (or thicker to create a ventilation cavity) as the rigid insulation boards."

Ventilation is recommended "between the underside of metal panels and the substrate ... because of the great potential for condensation on the underside of metal roof panels. Condensation ... is problematic because the panels themselves are excellent thermal conductor[s] and often fall below the dew point." If condensation is anticipated, an air space between the metal panels and substrate is necessary. The manual goes on to say, "The depth of this ventilation space is a function of climate, interior relative humidity, effectiveness of the vapor/air retarder, roof slope, and air-flow efficiency of eave, hip and ridge details."

Metal roof systems

The manual also describes metal types, protective coatings, panel and seam configurations, and seaming methods.

This section begins with a discussion of the galvanic series and possible galvanic action between differing metal types. The principle is that a more "active" metal (e.g., zinc) will corrode in the presence of moisture and a more "noble" metal (e.g., plain steel). The electrode potential (a metal's potential to corrode) is greater in active metals than noble ones.

Although a variety of metal types are used to fabricate metal roof panels, they all fit in one of two corrosion-protection categories: metals that naturally weather and those that need a protective coating. Aluminum, copper, stainless steel, lead and zinc are naturally weathering; steel requires a coating, such as paint or another metal (e.g., galvanized with zinc).

Metallic-coated steel is the most prevalent and includes the following types: galvanized steel, aluminized steel, Galvalume™ and terne-coated steel. The coating's primary purpose is to protect the steel from the environment, therefore reducing the chance of corrosion. The coating acts as a barrier to the environment, as well as providing sacrificial protection by corroding before the steel.

The manual provides a description, history and specific attributes (e.g., common thicknesses, joining methods) of each metallic-coated steel type, as well as insights into the characteristics of these products.

Natural weathering metals also are discussed at length. For example, information about copper's natural weathering process and resulting blue-green color (i.e., patina), chemical patinas, types of solder and hardness range is provided. Similar information about lead-coated copper, lead, zinc, aluminum and stainless steel is included. For easy reference, a chart (see Figure 1) lists the commonly available gauges and thicknesses of metals and approximate weight per square foot (m^2) for each.

The manual also provides a table that lists some of architectural sheetmetal's properties. It has information about fastener compatibility; the ability to solder, weld or braze; expansion coefficients; corrosion resistance/durability; and the unfinished material's weathering characteristics.

In addition, two common types of factory-applied paint systems, fluoropolymer (Kynar® 500 or Hylar™ 500) and siliconized acrylic or polyester, are discussed and performance measurements are given. Other coating methods mentioned in the manual include: powder paints and coatings (dry powders electrostatically applied to the base metal); anodizing (an electrolytic process resulting in a relatively thick aluminum-oxide film); and laminates (applications of plastic film).

The manual also addresses profiles, the most common being corrugated panels, which use round or square breaks to achieve their shapes. Corrugated panels, or structural metal panels, are easy to install—usually with exposed fasteners and overlapped seams. The manual provides many examples of ribbed or corrugated panels.

According to the manual: "The flat pan with a vertical rib is the most

common for traditional architectural roofing. It is a ... basic design that [uses] an unlimited assortment of vertical ribs. These ribs dictate the actual panel profile and seam shape ... ." Examples of possible seam shapes, trapezoidal panels and intermediate rib panels also are given.

Detailed information about standing seams, batten seams, flat seams (soldered and nonsoldered), bermuda seams and shingle panels is included in the manual. For flat-seam copper panels, figures showing panel size and shape, lock configurations, field layout assembly and a well-soldered seam profile are provided, as well as a discussion within the text.

The five basic seaming techniques also are explained in the manual: mechanical, completed by hand seamers, tongs or electrical devices; snap-together, featuring separate caps or battens that snap on; integral, a tongue-and-groove type; hooked, a soldered or sealed flat-lock type; and overlap, which has shapes that nest.

Metal	Gauge	Nominal thickness (inches)	Nominal thickness (mm)	Weight per square foot (lbs./square foot)	Weight per square meter (kg/m²)
Copper:					
16 oz.	23	0.022	0.55	1	4.87
20 oz.	21	0.027	0.69	1.25	6.1
Steel:					
Galvanized and	26	0.018	0.45	0.91	4.44
aluminized steel,	24	0.024	0.61	1.15	5.61
Galvalume™	22	0.03	0.76	1.41	6.88
	20	0.036	0.91	1.68	8.2
Stainless steel	28	0.015	0.38	0.66	3.22
Terne-coated stainless steel	26	0.018	0.46	0.78	3.81
Aluminum	20	0.032	0.81	0.45	2.2
	18	0.04	1.02	0.5	2.44
Zinc	24	0.02	0.51	0.75	3.66
	21	0.027	0.69	1	4.87
Terne	28	0.015	0.38	0.67*	3.27**
	26	0.018	0.46	0.8*	3.91**

* 40-pound coating weight
** 88.2-kg coating weight

Source: The NRCA Roofing and Waterproofing Manual, Fourth Edition.

Figure 1: *Common metal gauges, thicknesses and weights per square foot (m²).*

Design and application

With a number of diagrams and figures, this section covers on-site storage and hoisting, expansion/contraction, slope considerations, drainage, decking, panel layout, fastening, flashings and valleys, as well as inspection and maintenance. It provides some additional information about underlayment, slip sheets, vapor retarders and insulation.

The manual states, "The expansion and contraction of metal that takes place with temperature changes can cause many problems for metal roof [systems] if it is not accommodated in the design of the metal roof system." Expansion can cause problems to flashings, create leaks and make the roof system more vulnerable to wind damage. System design must account for expansion and contraction at panel-to-panel, panel-to-substrate, panel-to-flashing and flashing-to-substrate locations. A chart listing the expansion coefficients of common metals is provided.

For architectural metal panel systems, shorter panels will help limit thermal movement and problems from expansion and contraction. For longer panels, the expected movement must be accounted for by the flashing/closure detail either at the top or bottom of the panel. There also are sliding clips specifically designed for panel movement at the clip location.

Fixing a panel is a design consideration that requires careful planning. Panels may be fixed at the eave, midpoint, ridge or line of penetration. Possible fixed-point locations are shown in figure format. For structural metal panels, panels typically are attached at every structural support and, therefore, fixed at every support location. This helps limit panel movement caused by thermal expansion and contraction.

Another issue, oil-canning (i.e., the distortion in a metal's flatness), can be an aesthetic problem. Because of some highly reflective surfaces, oil-canning can be quite noticeable and problematic for customers. The manual discusses a number of causes for oil-canning (e.g., poor-quality metal, roll-forming equipment) and several precautions (e.g., thicker metal, stiffening ribs).

Considerations and options regarding overall roof and metal panel layout are mentioned, as well. Matching panel seams at valleys and balancing panel layout within sections of a roof are discussed—figures also are provided. Reviewing this section will help contractors ensure the overall roof system is visually balanced and aesthetically pleasing.

The manual also describes a typical sequence for installing an architectural metal panel system. This description includes a discussion of metal edge flashing and fasteners, underlayment and/or ice-dam protection, slip sheets, clips and panels.

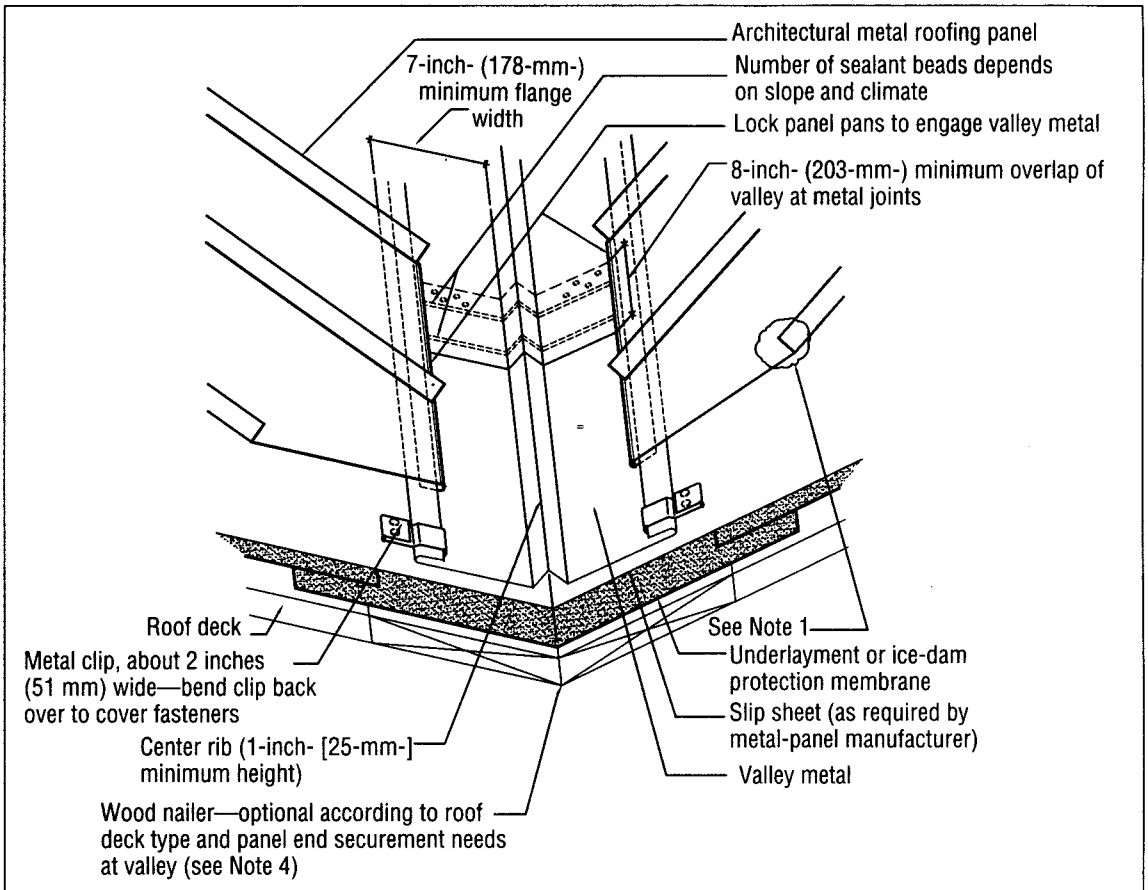
Considerations for structural metal panel system installation also are addressed. For structural metal panel systems, installing the exposed fasteners is critical. The manual describes potential problems with incorrectly installed fasteners and illustrates properly and improperly driven fasteners.

For long panels, expansion or sliding clips often are necessary. The clip's position relates directly to temperature conditions at the time of

installation and, if done incorrectly, could lead to panel and/or clip damage. The manual provides a diagram showing clip setting with respect to temperature.

The manual also discusses proper valley design, which depends on a number of factors, such as severity of climate and adjoining roof slopes. Numerous diagrams provide many options for functional and durable metal panel roof system valleys.

A list, with each item explained, provides considerations for upgrading standard or manufacturers' valley details.



Notes:
1. Seam and panel profiles vary.
2. Specific fastening requirements are not indicated because they vary from system to system, depending on the panel manufacturer's requirements, wind zone and local code.
3. Minimum slope recommended for use of this valley construction is 6-in-12 (50 percent).
4. If wood nailer is used, attach nailer to wall/deck with suitable fasteners.

Source: The NRCA Roofing and Waterproofing Manual, Fourth Edition.

Figure 2: *Detail of an open metal valley.*

Reroofing

This section will help roofing professionals determine whether a complete tear-off is necessary or a recover system can be used. It provides a list of some of the important and often overlooked design considerations for reroofing with metal panel roof systems, such as aesthetics, ventilation, historic preservation requirements, loading of the existing roof deck, water runoff/redirection of water runoff and fastener pull-out capacity.

Because metal panel roof systems are being used to re-cover low-slope roof systems, this section also discusses some of the possible structural framing systems that can be used to carry the metal panel re-cover system. Framing requirements will vary depending on the existing deck. For example, frames installed over existing joist and metal deck systems must transfer loads directly to existing framing members. The new framing also must be attached directly to the deck and the existing roof system removed to allow proper load transfer.

Details and tables

The manual contains details that describe 19 architectural metal roofing conditions and 15 structural metal roofing conditions common on roofing projects. All details are drawn in isometric view (see Figure 2). A table for recommended minimum thicknesses of fascias and cleats, examples of downslope securement options, and seam and clip profiles also are provided.

Summing it up

The NRCA Metal Roofing Manual provides the latest technical information tailored specifically for metal roofing applications. Because this segment of the roofing industry is changing constantly, the manual will help keep roofing professionals informed. PR

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