TECH TRANSFER

Metal roofing: "Fixing" for thermal movement

by **Thomas L. Smith, AIA, CRC**

For standing-seam metal roofing systems, provision for movement is made between the roof panels and attachment clips to accommodate the change in panel length caused by temperature changes. However, the panels must be "fixed" (typically along a line perpendicular to the roof slope) to keep the panels from sliding off the roof. A number of considerations are necessary to avoid problems related to fixity and thermal movement.

Temperature differential

The roof designer should determine the design change in temperature (ΔT) for the proposed roof. This will be a function of climate and roof color. For a dark-colored roof, the maximum roof temperature may exceed 180 F (82 C). The minimum temperature of the roof may be 20 F (10 C) or more below the low ambient air temperature, due to radiative cooling (see "Temperature variations caused by solar heating and radiative cooling," April 1992 issue, page 20). It is not uncommon for the ΔT to exceed 200 F (110 C).

Once the ΔT is calculated and the type of metal and length of panels are known, the total design thermal movement can be determined. For a 100 F ΔT, an 8-foot length of steel panel will expand or contract about $\frac{1}{16}$ inch. For copper, the movement is $\frac{3}{32}$ inch, and for aluminum it is $\frac{1}{8}$ inch (1.2 mm/m/100 C for steel, 1.8 mm/m/100 C for copper and 2.3 mm/m/100 C for aluminum).

Therefore, it is common to design for a few inches of panel movement at panel ends.

Line of fixity

The panels are fixed to a line of clips or to the roof structure. The location of the "line of fixity" is a critical design decision, because if the panels are fixed at inappropriate locations, significant panel deformation or flashing damage is likely. There are four primary choices for the location of the line of fixity:

The mid-point between the eave and the ridge. This provides for an equal amount of movement at each of the panel's ends. Therefore, the eave and ridge details need only accommodate half of the total panel movement.

Along the ridge. With this location, the eave detail needs to accommodate all of the total panel movement. Roofs with valleys are typically fixed at the ridge.

Along the eave. With this location, the ridge detail needs to accommodate all of the total panel movement. Roofs with hips are typically fixed at the eave.

At large openings. For example, if there is a row of skylights or a large HVAC unit, the line of fixity can be placed at this area (perpendicular to the slope). This eliminates differential movement between the panels and the flashings at the skylights or units and simplifies the flashing details.

It is desirable to fix panels along the same line to minimize relative movement of adjacent panels. However, diagonal fixed points can be acceptable for certain roof configurations.

Unusually shaped buildings with combinations of hips and valleys create special considerations (see Figure 1). Also, buildings with unusual geometries (i.e., irregular perimeters) or separated segments (e.g., a C-shaped building) may require the use of a slip joint at the standing seam to accommodate differential panel movement.

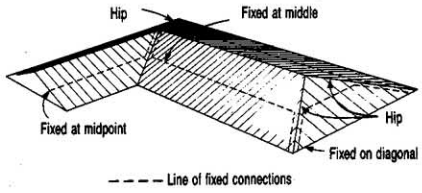

Figure courtesy of Merchant & Evans Inc.

***Figure 1:** Fixed point locations with combined hips and valley.*

For these complex conditions, consultation with a knowledgeable manufacturer is recommended.

Achieving fixity

After the location of the line of fixity is determined, the technique for achieving the attachment can be evaluated. The panels can be fastened to the clips in a variety of ways to prevent differential movement between the clip and panel (consult with the panel manufacturer for options).

Or, the panel may be attached directly to the structure with screws. When this method is used, typically, the screws are located under the ridge flashing to avoid exposure to weather. Spacers between the panel and structure are usually needed to avoid depressing the panel at these screws.

The designer should determine the load on the fixed point by calculating the friction forces, panel weight and snow load. If the fixity is achieved by locking the clip to the panel, the capacity of the connection should be obtained from the manufacturer. If the design load is high (e.g., caused by a large snow drift load), it may be necessary to provide a line of fixity along two or more adjacent rows of clips.

During construction, it is recommended that the panels be fixed the same day that they are installed to keep the panels from "walking."

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