WJE

PRIMER

BY **JEFFREY S. LEVINE**
Wiss, Janney, Elstner Associates, Inc.

Little Things Can Make a Big Difference

Flat Seam Roof Pans

Is bigger better? When it comes to ice cream sundaes or TV screens, sure! When it comes to flat seam roof pans, not so much. Economy or misguided logic might lead a person to conclude that a flat seam roof made up of larger pans requires fewer pans and less labor to install or will have fewer seams to potentially crack and leak in the future. Large pans, however, often lead to premature failure of the roof.

Large pans often lead to premature failure of the roof.

One of the biggest design considerations with flat seam metal roofs is the accommodation of thermal movement. All metals expand and contract with changes in temperature, some more than others (see chart to right). The coefficient of thermal expansion is a number indicating how much each type of metal will move with changes in temperature. Cold-rolled copper, for instance, has a coefficient of thermal expansion of 0.0000098 inches/inches/°F. This means that copper will expand/contract 0.0000098 inches, per inch of length, per degree of temperature change. It is important to keep in mind that the temperature of a metal roof pan over the course of a year will vary more than ambient air temperature. On a sunny summer day, a copper roof pan can reach up to 155°F[1] and can dip to 43° to 68°F below ambient air temperature on a winter night due to a phenomenon called nighttime radiative cooling.[2] Therefore, over the course of one full year, a metal roof pan may be expected to experience a temperature change of 150° to 200°F. With that in mind, a ten-foot-long copper pan exposed to a temperature differential of two hundred degrees will move approximately 0.24 inches (0.0000098 x 120 inches x 200 degrees) over the course of a year.

material	coefficient of thermal expansion
steel, medium	.0000067
iron (galvanized)	.0000067
iron (wrought)	.0000067
monel	.0000078
stainless steel	.0000098
copper	.0000098
tin	.0000117
aluminum (1100)	.0000138
lead	.0000164
zinc, rolled	.0000174

In flat seam metal roofs, the pans are cleated to the roof deck and locked and soldered together, which prohibits movement at the seams. In properly detailed flat seam roofs, the individual pans can accommodate a certain amount of thermal movement via "oil canning," whereby the surface of the pan flexes upward slightly when the metal heats up (i.e., when it expands) and flattens when the metal cools (i.e., when it contracts). Large pans can suffer severe distortions as a result of oil canning or may not be able to oil can enough, depending on their size. With oversized pans, the strain produced by

Location:
WJE Philadelphia
601 Walnut Street
Suite 875W
Philadelphia, PA 19106

Contact:
T: 215.567.0703
E: jlevine@wje.com

www.wje.com

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS
Wiss, Janney, Elstner Associates, Inc.

Flat Seam Roof Pans (CONTINUED)

Flat seam lead-coated copper gutter comprised of very large pans and suffering from fatigue cracks.

Fatigue cracks in a flat seam gutter formed from large pans with no expansion joints.

Flat seam copper roof comprised of pans no larger than 18"x24". Note also the expansion batten.

thermal movement can cause the soldered seams to crack or fatigue cracks to form in the metal, thereby undermining the watertightness of the roof system. For this reason, industry standards, such as Revere Copper Product's *Copper and Common Sense*, limit the size of flat-seam roof pans to a maximum of 18"x24" (prior to hemming the edges). Based on the formula above, a pan of this size will expand/contract less than 1/16" per year in each direction.

Correct pan size is not the only critical factor for a long-lasting flat seam roof. Metal gauge selection, seam dimensions, fully sweating the soldered seams, and properly detailed expansion joints (if the roof is larger than thirty feet in any direction) are also essential to the longevity of flat seam metal roofs, but these are topics for other primers!

[1] Revere Copper Products, Inc. *Copper and Common Sense*. 8th edition. Rome, NY 2005.

[2] Hollick, John. "Nocturnal Radiation Cooling Tests." www.sciencedirect.com/ science/article/pii/S1876610212016219. 2012.

www.wje.com

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS
Wiss, Janney, Elstner Associates, Inc.

Location:
WJE Philadelphia
601 Walnut Street
Suite 875W
Philadelphia, PA 19106

Contact:
T: 215.567.0703
E: jlevine@wje.com
W: www.wje.com