

## THE EFFECTS OF THERMAL MOVEMENT ON STANDING SEAM ROOFS

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One of the main reasons Standing Seam Roofs were invented was to accommodate the thermal movement that takes place as metal roofs heat up and cool down. This is typically accomplished by using a floating clip that has a top portion that moves with the roof, and a bottom or base portion that is anchored to the substructure that remains stationary. Roof panels are fastened to the substructure at either the eave or the ridge and allowed to float toward the unfastened end. The roof must be fastened to the substructure at one end to prevent it from sliding off of the building. Conversely, it cannot be fastened to the substructure at both ends or it will not float.

While most people understand the concept of floating roofs, few really understand the engineering principles involved in designing a roof to accommodate thermal movement. You may have seen specifications for a project calling for the roof to be designed to a particular temperature differential. For example, 150 degrees is common, although the U.S Corps Of Engineers will typically specify 220 degrees for their projects. When trying to determine what temperature differential you should use for a particular project, keep the following in mind:

The temperature differential is not the difference between the lowest ambient air temperature in the winter and the hottest ambient air temperature in the summer. Metal panels can reach temperatures of 170 degrees in summer under certain conditions. Typical factors affecting temperature are location (Florida, Arizona and Southwest Texas), paint color (dark colors will be hotter) and roof pitch. On cloudless nights, the metal panels can be colder than the surrounding air by radiating heat into space. A roof panel can actually be experiencing a significant temperature difference and still not require a floating clip. How is this possible? If the building substructure is steel, and it is experiencing the same temperature as the roof panels, the structure will be expanding or contracting at the same rate as the roof panels. This happens frequently on uninsulated or poorly insulated metal buildings. In this situation, a floating clip is not needed. On roofs that are well insulated, or roofs with subdecks that are of a dissimilar material, such as wood,

the difference in the movement of the roof and the substructure is significant. In these instances, it should be assumed that the deck is not moving and the roof should be designed to accommodate the full anticipated thermal movement. The engineer or designer must take these factors into account to determine the "working temperature differential".

Once the "working temperature differential" has been determined, the roof panel clip must be checked to insure that it can accommodate the anticipated movement in each direction. This is calculated by using the formula: length of steel x temperature change x expansion coefficient of steel (0.0000065) = change of length in feet. This can be converted to change of length in inches by multiplying the previous result by 12. For example, a 100" length of steel that changes temperature by 150 degrees, will change its length by 1.17 inches ( $100 \times 150 \times 0.0000065 = 0.0975$  feet - converted to inches  $0.0975 \times 12 = 1.17$  inches).

Why does the clip need to be able to move the total amount in both directions when the calculation was based on the total temperature difference? This should require only half the total movement in each direction. In theory, the total movement in one direction would only be needed if the roof were installed in the dead of summer or winter. At these two times, the roof would be near its maximum temperature (hottest in summer ? coldest in winter) and therefore it would need to move more in one direction than it would if the roof was installed in spring or fall. An erector could move the clip top on the base (clips come from the factory centered so that the clip can move in either direction) before installation and double its potential to accommodate the thermal movement in a particular direction. However, engineers will not take this scenario into account because (1) they do not know when the roof is to be erected and (2) they cannot depend on the installer moving the clip top to the proper position to increase its ability to move with the roof.

On wide roofs that would normally experience more thermal movement than the clip can accommodate, there are ways to design the roof to keep the thermal movement within the capacity of the clip. One way is to create a step-up in eave height (or break in the roof plane) at the point at which the clip is reaching its maximum allowable movement.

This can be done as many times as is necessary until the ridge or high eave is reached. By doing this, you are isolating the thermal movement at each roof plane. Another way is to attach the roof panels to the substructure in the middle of

the roof run (run is defined as length of roof from eave to ridge or high eave) instead of at the eave or ridge. This will double the effective roof width that the clip can accommodate. In other words, if the clip is capable of handling the thermal movement of a roof run 150' wide when the roof is attached to the substructure at the eave, it will be capable of handling the thermal movement of a roof run 300' wide if it is attached to the substructure in the middle of the roof run.

In addition to ensuring that the clip can accommodate the thermal movement, one must also design the trim to move with the roof. The rake trim must be capable of moving freely as the roof expands and contracts. This cannot happen if the rake trim is fastened to both the endwall and roof. It must be designed to slide either at the endwall connection or the roof connection. On roofs that are tied to the substructure at the eave, the ridge flash, high eave flash or parapet flash must be capable of handling the anticipated thermal movement. You should take into consideration the long-term effects on the trim as it bends countless times over the years. The trim should be flexible enough that the metal does not rupture at a break from this constant flexing as the roof expands and contracts. Remember, all standing seam roofs (including trim) should be designed for thermal movement; taking into consideration the distance the roof clip can move in each direction, the anticipated temperature differential for the project location and the anticipated temperature differential between the roof and the substructure.