# The Effects of Thermal Expansion with GreenGirt CMH

**Abstract:**

GreenGirt effectively accommodates thermal expansion through four approaches:

1) Similar or better thermal expansion coefficients of adjacent framing/sub-framing materials.
2) Minimal movement at total of Δ200°F, allowing for 100 degrees in each direction from install temperature.
3) Proper design – configuration and accommodation for expansion and contraction.
4) Utilizes steel inserts for fastener attachment – proven compatibility and use.

**Thermal Expansion Coefficients:**

With the use of steel and fiber reinforced polymers, GreenGirt CMH will be more resistant to thermal expansion than other common materials used on a building. Whether it be extreme high or low temperatures, GreenGirt CMH should not pose problems when it comes to expansion or contraction. See Table 1 below for values for coefficients of thermal expansion.

*Table 1*

| Material | Coefficient of Thermal Expansion (10^-6 in./°F) |
|---|---|
| Wood[1] | 1.7 |
| Brick masonry[3] | 3.1 |
| Terra Cotta[5] | 4 |
| Cementious panels[6] | 5 |
| Glass[1] | 5 |
| Steel[1] | 7.2 |
| GreenGirt CMH[4] | 8 |
| Concrete[1] | 8 |
| Aluminum[1] | 13 |
| ACM[1] | 13 |
| Phenolic (glass reinforced)[6] | 18 |
| Phenolic resin[6] | 44 |

**Minimal Movement at Δ200°F:**

A coefficient of thermal expansion of 8 x 10^-6 in./°F will result in a total change in length of approximately 1/32" for every 4' of GreenGirt per change of 100°F from the installation temperature. See Tables 2 and 3 below. Thermal expansion is calculated by $d_l = L_0\alpha(t_1 - t_0)$, where $d_l$ is the change in object length (in.), $L_0$ is the initial length of the object, α is the coefficient of thermal expansion, $t_1$ is the final temperature, and $t_0$ is the initial temperature.

*Table 2*

| Material | Change in length (in.) per 4' |
|---|---|
| Wood | 0.0082 |
| Brick masonry | 0.015 |
| Terra Cotta | 0.019 |
| Cementious panels | 0.024 |
| Glass | 0.024 |
| Steel | 0.031 |
| GreenGirt CMH | 0.038 |
| Concrete | 0.038 |
| Aluminum | 0.062 |
| ACM | 0.062 |
| Phenolic (glass reinforced) | 0.086 |
| Phenolic resin | 0.21 |

*Table 3*

| Material | Change in length (in.) per 8' |
|---|---|
| Wood | 0.016 |
| Brick masonry | 0.030 |
| Terra Cotta | 0.038 |
| Cementious panels | 0.048 |
| Glass | 0.048 |
| Steel | 0.062 |
| GreenGirt CMH | 0.077 |
| Concrete | 0.077 |
| Aluminum | 0.12 |
| ACM | 0.12 |
| Phenolic (glass reinforced) | 0.17 |
| Phenolic resin | 0.42 |

**Expansion Due to Moisture:**

GreenGirt CMH has negligible expansion due to moisture content, which is an issue with materials like wood, concrete, and brick. Wood generally has an expansion coefficient of .0025, which makes for an expansion/contraction of 1 percent of the width of the wood for each 4 percent of moisture change. See Table 4. Expansion is calculated by multiplying the moisture expansion coefficient by the width (wood) or length (concrete and brick) of the material and the moisture percent change**.**

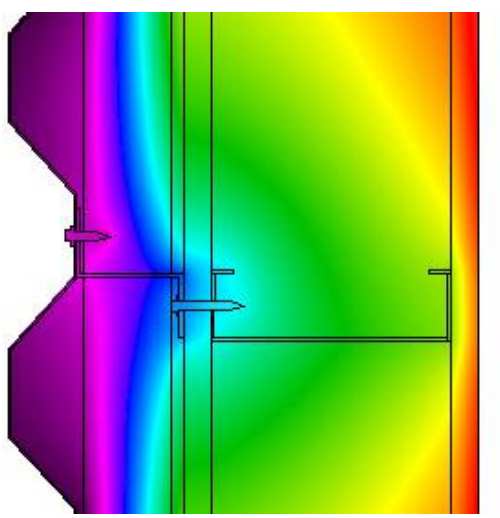
*Table 4*

| Material | Moisture expansion coefficient |
|---|---|
| Wood[2] | 0.0025 |
| Concrete[3] | 0.0004 |
| Brick[3] | 0.0005 |

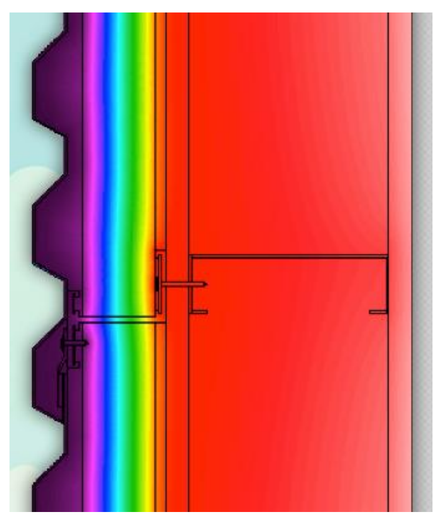
**Legacy Systems:**

A legacy insulated wall configuration consisting of a through wall steel or aluminum girt or hat channel will transfer and distribute exterior heat to the interior girt web and interior girt flange, resulting in significant linear expansion compared to the static interior cavity wall temperature. This creates either deformation, fastener hole elongation, or "hogging" of the fastener hole. It should be noted this design deficiency is rarely considered, however, it does not contribute positively to a building's lifespan, nor is it the best technology use for energy efficiency performance.

*Metal Girt*



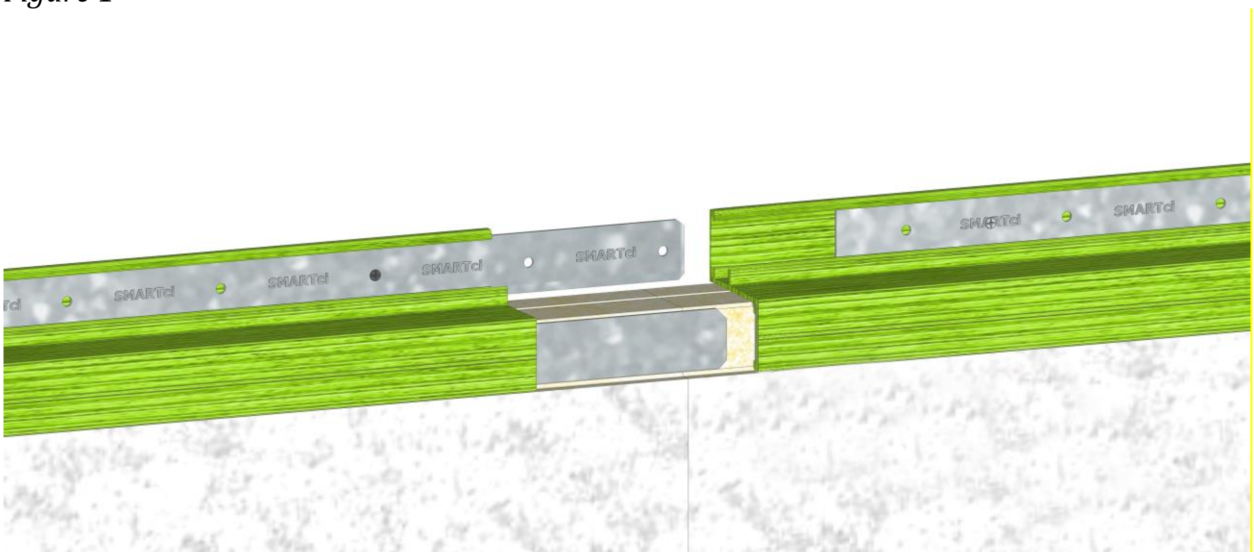
*GreenGirt CMH*



**Proper Design and Configuration:**

To accommodate the expansion that does occur, Advanced Architectural Products recommends a 1/16" to 3/16" gap between GreenGirt CMH pieces. That gap will adequately address the thermal expansion concerns in using GreenGirt CMH. See Figure 1 below.

*Figure 1*




*Steel inserts extend min. 3" with 1/16" to 3/16" gap for thermal expansion*

**Utilizes Steel Inserts for Fastener Attachment:**

As shown in Figure 1, GreenGirt utilizes steel inserts for its attachment to the substrate. Steel has been proven to be compatible with GreenGirt and has a lower coefficient of thermal expansion than the surrounding framing/sub-framing, making the 1/16" to 3/16" gap more than enough to accommodate the thermal expansion.

## CMH Result Summary

An analysis of GreenGirt composite metal hybrid (CMH) indicates that CMH with typical building use temperatures at the:

- **Building interior side** of the cross section will experience relatively static changes in temperatures, resulting in nominal (<1/64" per 4' per *Δ30°F*) lengthwise expansion. This is due to the thermal separation of the interior flange from the exterior flange.

- **Building exterior side** of the cross section will have values closest to that of steel, allowing for traditional compatible expansion allowances for interfaces and cladding materials.

GreenGirt CMH not only provides improved energy efficiency by eliminating through wall thermal bridging, it also provides an improved method to handle interstitial thermal expansion.

**Sources:**
[1] Hibbeler, R.C., "Mechanics of Materials." 4th Ed. *Prentice Hall*, 2000.
[2] "How to Calculate Wood Shrinkage and Expansion," *Popular Woodworking Magazine.* Aug. 24, 2012.
[3] "Volume Changes – Analysis and Effects of Movement," *The Brick Industry Association.* October 2006.
[4] "FRP vs. Traditional Materials," Bedford Reinforced Plastics.
[5] "Guide to the Repair of Architectural Terra Cotta," Edison Coatings, Inc. 2016.
[6] "Coefficients of Thermal Expansion," The Engineering Toolbox. http://www.engineeringtoolbox.com. May 2016.
Values for coefficients of thermal expansion may vary in accordance with specific material content and other factors.
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