Thermal Break Strategies for Cladding Systems in Steel Buildings

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PROJECT GOALS
• Identify archetypal thermal bridges in steel structures
• Explore and validate various mitigation strategies focusing on FRP structural members and shims
• Thermally model proposed mitigation strategies to determine effectiveness
• Structurally model mitigation strategies
• Experimentally verify mitigation strategies
• Publish results and propose changes to the design code
• Develop ancillary recommendations regarding FRP-to-steel connections

BUILDING SUSTAINABILITY
Building structures are susceptible to energy loss through their structural systems. This is especially true for steel buildings, as steel is thermally conductive. Steel structural members which span the building envelope are particularly problematic (such as cantilevers, cladding supports, and roof posts which support mechanical units).

Thermal imaging cameras demonstrate global heat transfer

These structural members are referred to as thermal bridges. Mitigation strategies generally involve:
• replacing a portion of the steel structural system with a less thermally conductive material, such as fiber-reinforced polymers (FRP)
• installing an FRP or stainless steel shim or fin plate
• coating the structural steel in a thermal barrier

Connecting these shims and FRP members to the steel structural system is challenging as no current design standard exists for these connections. Ultimately, this work attempts to answer the question: How can structural engineers contribute to sustainable design?

EXPRESS THE IMPACT OF THERMAL BREAKS ON BUILDING PERFORMANCE

EXPERIMENTAL PROGRAM – SHELF ANGLE

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CASES EXAMINED

Rooftop grillage post

Slab-supported shelf angle

Cantilever roof canopy beam

THERMAL MODELING RESULTS – SHELF ANGLE

Mitigation Strategy | Zone | Description | U-Value | ∆U
--- | --- | --- | --- | ---
Unmitigated | 1 | L6x4x3/8 | 0.142 | -
Unmitigated | 7 | L8x4x1/2 | 0.125 | -
FRP Shelf Angle | 1 | FRP L6x4x3/8 | 0.073 | -49%
FRP Shelf Angle | 7 | FRP L8x4x1 | 0.047 | -62%
FRP Shim | 1 | 2-1/8” shim, L4x4x3/8 | 0.074 | -48%
SS Fin Plate | 1 | WT4x20*, L8x4.5x9/16 | 0.11 | -23%
SS Fin Plate | 7 | WT4x20, L8x4.5x9/16 | 0.071 | -43%

*WT section is trimmed at the web

TAKEAWAY THOUGHT: thermal breaks in steel building cladding systems require both thermal and structural validation. Proposed details are promising; structural testing and modeling is currently underway.