

Assessing Overall Thermal Conductance Value of Low-Rise Residential Home Exterior Above-Grade Walls Using Infrared Thermography Methods

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Abstract : Infrared thermography is a non-destructive test method used to estimate surface temperatures based on the amount of electromagnetic energy radiated by building envelope components. These surface temperatures are indicators of various qualitative building envelope deficiencies such as locations and extent of heat loss, thermal bridging, damaged or missing thermal insulation, air leakage, and moisture presence in roof, floor, and wall assemblies. Although infrared thermography is commonly used for qualitative deficiency detection in buildings, this study assesses its use as a quantitative method to estimate the overall thermal conductance value (U-value) of the exterior above-grade walls of a study home. The overall U-value of exterior above-grade walls in a home provides useful insight into the energy consumption and thermal comfort of a home. Three methodologies from the literature were employed to estimate the overall U-value by equating conductive heat loss through the exterior above-grade walls to the sum of convective and radiant heat losses of the walls. Outdoor infrared thermography field measurements of the exterior above-grade wall surface and reflective temperatures and emissivity values for various components of the exterior above-grade wall assemblies were carried out during winter months at the study home using a basic thermal imager device. The overall U-values estimated from each methodology from the literature using the recorded field measurements were compared to the nominal exterior above-grade wall overall U-value calculated from materials and dimensions detailed in architectural drawings of the study home. The nominal overall U-value was validated through calendarization and weather normalization of utility bills for the study home as well as various estimated heat loss quantities from a HOT2000 computer model of the study home and other methods. Under ideal environmental conditions, the estimated overall U-values deviated from the nominal overall U-value between $\pm 2\%$ to $\pm 33\%$. This study suggests infrared thermography can estimate the overall U-value of exterior above-grade walls in low-rise residential homes with a fair amount of accuracy.

Keywords : emissivity, heat loss, infrared thermography, thermal conductance

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