Design values vs in-situ measurement: Thermal transmittance and the missing link in a Dublin context

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In recent years the need to 'retrofit' existing buildings in response to the long-term challenges of climate change and resource constraints has gained increasing prominence. The assumed thermal transmittance of external walls represents a significant source of uncertainty when estimating the energy performance of dwellings. Previous research as recent as 2011, has found that software programs for thermal transmittance tend to overestimate U-values (R-value) of traditional building elements. Moreover, current research recommends further research on the thermal properties of traditional building materials and construction components; improvements to the U-value calculations; and a standardised methodology for in-situ measurement of U-values. This research is a detailed study on the performance of external walls in Dublin, Ireland. It highlights the construction age of the current housing stock, common wall assemblies (for analysis / testing within research), and standard regulatory calculations. It also aims to evaluate transient hygrothermal simulations to highlight conflict with standard calculations and critical omitted climate factors. As a main aim, this research will evaluate in-situ thermal transmittance on 2-3 case studies identifying the gap between standard calculations, transient hygrothermal simulations and in-situ performance analysis. Existing dwellings based in a Dublin maritime climate were chosen for analysis. These wall assemblies were established and basic thermal transmittance calculations carried out in accordance with EN ISO 13788. The same wall assemblies were simulated using WUFI® Pro 5.3 in accordance with EN 15026:2007 and Ashrae 160P. The final step will be to assess the in-situ thermal performance of the same wall assemblies using thermal flux sensors in accordance with ISO 9869-1. The finding of this stage of the research suggests that orientation has a significant impact on the hygrothermal performance of an external cavity wall. Correspondingly, the orientation will have a significant impact on the thermal transmittance of the same wall assembly. Furthermore, the findings from the research identify and highlight the disparity between thermal transmittance from standard calculations and the gap between those and the simulations presented here. Preliminary calculations and simulations have been carried out which suggest inconsistency between the standard thermal transmission calculation and transient hygrothermal simulations by as much as 158%. The in-situ measurement of thermal transmittance can be an effective tool to be used for evaluating the real energy demand of a building, and for allowing the analysis of energy improvement strategies. This research will address a gap in knowledge where simulation and practical case study examples will exemplify and support the assessment of transient thermal transmittance as an accurate representation of the in-situ performance values. This research can form the basis for further research on retrofit of the Irish housing stock. Finally, the research will offer a source of information for researchers and designers who can explore the performance of external wall assemblies and allow for a difference in designed versus expected in-situ thermal performance values.

Key Words: Thermal transmission, Retrofit, Simulation, Hygrothermal, In-situ analysis