Outline of the research plan for the development of new generation of testing standards and improving modeling techniques using "Virtual Thermal Testing Facility - ViTTeF" Concept

BACKGROUND

Current fenestration thermal testing standards that are in use in North America have deficiencies that are potentially threatening integrity of the National Fenestration Rating Council (NFRC) rating and labeling system in their effort to rate all of fenestration products. NFRC standard 102-2001, which is largely based on ASTM C1199 and E1423 standards, is used for experimental validation of computer modeling results, which are based on simplified computer tools THERM and WINDOW (LBNL 2003). When new modeling methods are being developed, very often results are validated against careful experimental measurements. In an attempt to achieve good agreement, very often it is necessary to replicate experimental conditions as close as possible. However, this effort is often time consuming and expensive due to custom development of every model. In order to overcome this obstacle, novel concept for rapid generation of computer models of the experimental setup is proposed here. This concept is named Virtual Thermal Testing Facility, or ViTTeF. This outline describes steps and briefly discusses concepts for the research on improving existing fenestration thermal testing standards as well as the development of a ViTTeF concept.

OBJECTIVE

The objective of this project is to improve our understanding of the physical phenomena occurring during a fenestration thermal test, help us develop better testing standards based on this expanded knowledge and finally provide the tool that would lead to the development of a reliable computer model that would be used in place of physical testing in the future. In addition to the benefit of the refinement and improvement of the North American testing standards, this work will lead to the recommendations to improve ISO standards. Because of the substantial involvement of visiting Russian scientist, Dr. Aleksandr Fomichev in this project, it is expected that the results of this investigation and development of the new concept will lead to the improvements in Russian national standards dealing with thermal testing, as well.

SCOPE

Develop the concept of Virtual Thermal Testing Facility (ViTTeF), based on existing knowledge of the capabilities of computer modeling. Use LBNL IR Thermography Chamber for proof of concept and expand this concept to the hot-box apparatus. The candidate hot-box for this modeling is ORNL guarded hot-box apparatus. The ViTTeF is envisioned as a 2-D computer model of heat transfer (conduction, convection and radiation) of a representative portion of the thermal testing apparatus, where the test specimen would be modeled as a separate portion of the model, integrated into the rest of the hot-box model (see two accompanying documents for clarifications).

The model would be extended later on to the full 3-D CFD and heat transfer numerical model, as resources for full 3-D modeling become available (i.e., larger computer memory and space and computing power) and understanding of complex heat transfer and fluid flow phenomena becomes better understood.

The advantage of this concept is that once the geometry and physics of sample window and hot-box have been modeled and validated, the other model specimens can be “inserted” into the hot-box in much the same way that physical samples and/or surround panels are inserted and replaced in real hot boxes.

The following is a brief plan for accomplishing this scope:

- Finalize proof-of-concept and generate technical paper on ViTTeF concept
- Get AutoCAD drawings of ORNL Hot-Box (Andre Desjarlais/Willie duPont),
- Model 3-D conduction model of simplified geometry of the Hot-Box to understand “flanking” areas,
- Model 2-D conduction, radiation and convection heat transfer using the real geometry of the Hot-Box to better understand how to create Virtual Model of the testing apparatus,
- Utilize CTS as a sample specimen, and using its geometry and physical data, perform computer modeling of the integrated models of hot-box and CTS,
- Perform physical measurement of the CTS at ORNL,
- “Replace” CTS with the PFM01 and PFM02 windows and repeat computer modeling,
- Perform physical testing of PFM01 and PFM02. Modify test environment based on the lessons learned from the computer model, as appropriate.
- Refine ViTTeF based on the comparisons done for sample specimen (CTS) and PFM windows (PFM01, PFM02)
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