Session XII-A: Modeling and Simulation

Thursday, December 9, 2004
8:30 a.m. to 10:00 a.m.
Grand Ballroom – Beach

Session Chair:

Charlie Curcija
University of Massachusetts
MIE Department
160 Governor's Drive
Amherst, MA 01003-9265

Phone: 413-545-4454
Fax: 413-545-1027
Email: curcija@ceere.org

8:30 a.m. to 8:40 a.m.	Introduction Charlie Curcija
8:40 a.m. to 9:00 a.m.	*"Evaluation of the Interface Moisture Conductivity between Control Volumes—Comparison between Linear, Harmonic, and Integral Averaging"* Thomas Bednar
9:00 a.m. to 9:20 a.m.	*"Two-Step Procedure for Determining Three-Dimensional Conduction Z-Transfer Function Coefficients for Complex Building Envelope Assemblies"* Jan Kosny
9:20 a.m. to 9:40 a.m.	*"Probabilistic Analysis of Indoor Surface Hygrothermal Conditions Accounting for Thermal and Hygric Memory of the Building Component"* Kimmo Kurkinen
9:40 a.m. to 10:00 a.m.	*"The Whole Model Validation for HAM-Tools—Case Study: Hygrothermal Conditions in a Cold Attic under Different Ventilation Regimes"* Angela Kalagasidis

Evaluation of the Interface Moisture Conductivity between Control Volumes—Comparison between Linear, Harmonic, and Integral Averaging

Angela Sasic Kalagasidis and Carl-Eric Hagentoft – *Chalmers University of Technology*

Thomas Bednar – *University of Technology Vienna*

Advanced calculating models have become an essential tool in building physics practice for the prediction of thermal and hygric performance of building envelopes. Successful application of any simulation model is generally affected by the mathematical model on which it is based, the quality of the input data, and, finally, when sensitivity and efficiency of the calculations are to be investigated—the numerical method itself. Simulation of the rapid moisture transfer through a building envelope is a typical process that encounters numerical difficulties. The problem is mostly related to certain building materials, such as bricks, characterized by their low moisture capacity and high hydraulic conductivity in the moisture-saturated region. This paper investigates three numerical techniques for the estimation of the moisture transport coefficients during such processes. Two of them—the harmonic and the linear techniques—are widely used, whereas the integral one is not. It is shown that numerical difficulties can be overcome by choosing a suitable technique.

Two-Step Procedure for Determining Three-Dimensional Conduction Z-Transfer Function Coefficients for Complex Building Envelope Assemblies

Elisabeth Kossecka – *Polish Academy of Sciences*

Jan Kosny – *Oak Ridge National Laboratory*

A two-step method of derivation of conduction z-transfer function coefficients for three-dimensional wall assemblies is described in this paper. Results of the calculations are presented for clear walls listed in ASHRAE Research Project 1145-TRP and some other two-core masonry block wall assemblies. Overall resistances, three-dimensional response factors, and structural factors have been computed using the finite-difference computer code. The z-transfer function coefficients were then derived from sets of linear equations, which included relationships with the response factors and compatibility conditions. These equations were solved using a minimum error procedure. Very good agreement between heat fluxes calculated using three-dimensional response factors and three-dimensional z-transfer function coefficients was achieved.

Additionally, wall time constants, which are important for hot box test measurements, were developed from the asymptotic values of the response factors' ratios.

Probabilistic Analysis of Indoor Surface Hygrothermal Conditions Accounting for Thermal and Hygric Memory of the Building Component

Kimmo Kurkinen, Krystyna Pietrzyk, Eva-Lotta Wentzel, and Carl-Eric Hagentoft

Chalmers University of Technology

A new approach to address the memory effects of the building component is demonstrated in the paper. As an output of the analysis, the probability distribution for the surface temperature and relative humidity is given, which is interesting for the determination of both thermal comfort and the risk of mold formation. Three different wall constructions are used in the example.

The paper presents two calculation procedures. The first procedure is the probabilistic approximation based on the wall surface dynamic response (DTN model) to the external and internal climatic load. The probability distributions of moisture and thermal parameters, as well as a reliability analysis of the moisture performance of the walls, are carried out using FORM (first-order reliability method). The results are then compared with the results obtained from the second procedure. In this, a transient one-dimensional HAM model is used for the calculation of the hygrothermal surface conditions, followed by a statistical analysis of the output.

The Whole Model Validation for HAM-Tools—Case Study: Hygrothermal Conditions in a Cold Attic under Different Ventilation Regimes

Angela Sasic Kalagasidis – *Chalmers University of Technology*

HAM-Tools is a software library specially constructed for hygrothermal system analysis in building physics. The software is developed as a modular structure of standard building elements and systems using a graphical programming environment. Due to its modular structure and transparency, each of the existing components can be easily changed and adjusted to specific user demands. In order to asses the software's ability to predict the building hygrothermal response under given climatic and operating conditions, validation tests against measurements have been performed. As a case study, temperature and relative humidity of a cold ventilated attic space in real operating conditions was selected. Validation results are presented as a comparison between measurements and calculations. Parametric sensitivity analyses were performed and necessary adjustments for the missing input parameters have been fully documented. The code has shown a high degree of reliability, both in a qualitative and a quantitative way.