## *Session XIII-A: Material Properties*

**Thursday, December 9, 2004**
**10:30 a.m. to 12 noon**
**Grand Ballroom – Beach**

*Session Chair:*

Hartwig Kuenzel
Fraunhofer Institute of Building Science
IBP-Halzkirchen, Postfach 1152
Halzkirchen 1, 83602, Germany

Phone: 49-8024-64345
Fax: 49-8024-64366
Email: kuenzel@hoki.ibp.fhg.de

10:30 a.m. to 10:40 a.m. Introduction
Hartwig Kuenzel

10:40 a.m. to 11:00 a.m. *"Water Vapor Permeability and Thermal Conductivity as a Function of Temperature and Relative Humidity"*
Ilkka Valorvirta

11:00 a.m. to 11:20 a.m. *"Development of Water Retention Transfer Functions of Ceramic Bricks of Dresden Building Stock"*
Rudolf Plagge

11:20 a.m. to 11:40 a.m. *"Modeling of Moisture Transport in Wood with Hysteresis and Temperature-Dependent Sorption Characteristics"*
Carsten Rode

11:40 a.m. to 12:00 p.m. *"Development of Wall Assembly System Properties Used to Model Performance of Various Wall Claddings"*
Roland Serino

## Water Vapor Permeability and Thermal Conductivity as a Function of Temperature and Relative Humidity

Ilkka Valovirta and Juha Vinha – *Tampere University of Technology*

This paper deals with water vapor transmission properties and thermal conductivity at various temperatures and relative humidities, especially in Nordic climatic conditions. The paper presents measured data for mineral wool, cellulose, flax and sawdust insulation materials, gypsum boards, fiberboards, wood hardboard, oriented strandboard, plywood, wood, weatherization membranes, bitumen paper, and felt and building papers. Effects of increase of vapor permeability as a function of relative humidity, decrease of vapor permeability as a function of temperature, and increase of thermal conductivity as a function of temperature and relative humidity are discussed. In a Nordic climate, a sufficient water vapor resistance of the interior section of building shell and sufficient thermal insulation are required. On the other hand, sheathing must be permeable to water vapor. Changes in material property values can have a considerable effect on the performance of the shell structure.

## Development of Water Retention Transfer Functions of Ceramic Bricks of Dresden Building Stock

Rudolf Plagge, Heiko Fechner, and Peter Häupl – *Dresden University of Technology*

John Grunewald – *Dresden University of Technology and Syracuse University*

The building stock of Dresden consists of a large number of brick buildings constructed during the 20th century. Different type of bricks were sampled and their moisture storage function was measured using pressure plate apparatus and desiccators with different saturated salt solutions. A multivariate cluster analysis procedure was carried out to detect natural groupings within the data. Multi-modal water retention functions were applied to smooth and interpolate between the scattered data of the discovered clusters to provide a complete, unbroken, and consistent functional description. In total, four representative retention transfer functions could be found for the collection of the bricks of the Dresden building stock.

## Modeling of Moisture Transport in Wood with Hysteresis and Temperature-Dependent Sorption Characteristics

Carsten Rode and Christian Odin Clorius – *Technical University of Denmark*

Transient calculation models that predict moisture content in wood and other hygroscopic construction members employ the sorption curve of the materials to express the relationship between relative humidity of air and equilibrium moisture content. However, the sorption curves are somewhat temperature dependent, and they exhibit hysteresis, so the equilibrium state depends on the sorption history. Most transient moisture transport models neglect these facts. This paper will attempt to refine the current models by implementing a sorption "surface" spanned by relative humidity, temperature, and the resulting moisture content.

The paper mainly indicates that taking hysteresis into account will tend to reduce the effective moisture capacity of building materials for short-term moisture variations, while taking the influence of temperature on the sorption properties into account will tend to increase the apparent moisture capacity in practical situations where heating of a building element is normally ensued by its drying.

The paper will investigate the effect of considering moisture content dependency of the vapor permeability, sorption hysteresis, and temperature dependency of the sorption curves in an existing calculation model, which is used to predict the moisture conditions in solid wood constructions. This paper presents measurements of moisture content in almost 5-in.-thick roof elements of solid wood, which are located over an open stable for cattle. A previous comparison between measurement and prediction of the moisture content of the wood had indicated the possibility of using temperature-dependent sorption data as a way to improve the correspondence—particularly the question about the magnitude of the seasonal variations. The calculation results with the new model are presented alongside with experimental results and practical experiences of such constructions.

## Development of Wall Assembly System Properties Used to Model Performance of Various Wall Claddings

Achilles Karagiozis – *Oak Ridge National Laboratory*

Roland Serino – *Dryvit Systems Inc.*

Mikael Salonvaara – *VTT Building and Transport*

Different cladding systems have inherently different hygrothermal performance characteristics. This paper looks at comparative test evaluation methods and tools applicable for various claddings and climatic loads. The hygrothermal performance of an EIF system is evaluated to demonstrate the methodology for total hygrothermal performance characterization and subsystem performance, such as drainage and ventilation drying. A series of laboratory tests have been performed to develop system characteristic performance data by employing a moisture engineering framework. Results were developed to characterize the drainage of EIFS clad wall systems under realistic loading. The drying performance of these walls was then investigated as a function of exterior loading employing advanced hygrothermal modeling. Results of the tests also provided validation data to computer modeling. Hygrothermal modeling was employed to develop the criteria required for moisture design and to perform relative performance ranking of various wall claddings in a wall cladding selection program as a function of both interior and exterior environmental loading.