Session III-A: Indoor Environment I

Monday, December 6, 2004
3:30 p.m. to 5:00 p.m.
Grand Ballroom – Beach

Session Chair:
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3:30 p.m. to 3:40 p.m. Introduction
Mikael Salonvaara

3:40 p.m. to 4:00 p.m. "*Climate Stability of Historical Museums: Research of Temperature and Moisture Reaction in Areas Close to Outer Walls—Consequences Regarding the Building and the Exhibits"*
Hans-Peter Leimer

4:00 p.m. to 4:20 p.m. *"Indoor Air Humidity of Massive Buildings and Hygrothermal Surface Conditions"*
Henk Schellen

4:20 p.m. to 4:40 p.m. *"A New Look at Residential Interior Environmental Loads"*
Michael Aoki-Kramer

4:40 p.m. to 5:00 p.m. *"Hygroscopic Inertia as a Function of Transient Behavior of Covering Materials"*
Nuno Ramos

Climate Stability of Historical Museums: Research of Temperature and Moisture Reaction in Areas Close to Outer Walls—Consequences Regarding the Building and the Exhibits

H.-P. Leimer – *University of Applied Sciences*

J. Bode – *BBS Institute*

In the range of the modernization and restoration of the Herzog-Anton-Ulrich Museum of Brunswick, the differences between the climate near the exterior wall and that of the average room-climate were measured. In addition to that, the risk of damages at the building fabric caused by moisture and the conservative risk of the exhibits fixed at the inner side of the exterior walls were evaluated.

Regarding the mathematical description of the heat-transfer circumstances and flow circumstances at the area near the exterior walls, the determination of the convective heat-transfer coefficient at the boundary areas of wall and exhibit to the air gap is not clearly soluble. Usually the affinity theory can be used when having free convection circumstances.

In the above-mentioned case there is a thermally affected output stream at the cold wall as well as a forced convection that is due to the ventilation and heating system.

For this application, in particular regarding the airspeed and the gap's geometry, there are no authentic similarity models known. As a result, it is only possible to get an approximate appointment of the heat-transfer procedure by calculating. Temperature and moisture measurements on the objects' surfaces were carried out in addition to the theoretical analyses to evaluate the conservative and physical risk of damage regarding the precise case of a picture gallery. In addition to that, the heat and airflow in the range of the exhibits that are fixed at the inner side of the exterior wall have to be analyzed via numerical simulation.

Indoor Air Humidity of Massive Buildings and Hygrothermal Surface Conditions

Henk L. Schellen, Dionne Neilen, Jos (A.)W.M. van Schijndel, and Marcel A.P. van Aarle

Eindhoven University of Technology

The indoor air humidity of massive buildings is important for the preservation of the building and its valuable interior parts. Open air gas infrared heating, for example, produces a lot of vapor, which may lead to high indoor air relative humidities and condensation on cold exterior walls and glazing. Due to (air) heating under cold winter conditions, the relative humidity drops and this may lead to very low indoor air relative humidities for interior objects such as church organs, resulting in cracking of wooden parts and other problems of drying out. Humidification would be a solution, but it may lead to high relative humidities near cold exterior surfaces. A method was developed for a graphical representation of the near surface relative humidity by measuring the surface temperatures as a function of time by infrared thermography and simultaneously determining the mean vapor pressure of the air. From these measurements, mold germination on indoor surfaces can be predicted in an early state, making use of a representation in so-called hygrographic pictures.

A New Look at Residential Interior Environmental Loads

Michael Aoki-Kramer – *RDH Building Sciences Inc*

Achilles N. Karagiozis – *Oak Ridge National Laboratory*

When designing exterior wall systems for residential buildings, interior environmental loads are typically considered as constants, if considered at all. More advanced design and modeling tools may incorporate dynamic interior environmental conditions, i.e., scheduled hourly fluctuations in temperature and relative humidity, into the analysis of wall performance. IEA Annex 14 and 24 recommendations are one alternative for specifying daily interior moisture product rates for use in dynamic hygrothermal performance modeling studies. The use of interior environmental moisture production rates from the ASTM Handbook of Moisture Control or the proposed ASHRAE standard 160P on "Design Criteria for Moisture Control in Buildings" may produce substantially higher interior loads than those observed by measurements. There are two issues that must be examined: the use of appropriate interior calculation methods and the use of appropriate interior loads. In other words, are the IEA Annex 24, ASHRAE, or ASTM Handbook assumed rates of moisture production appropriate for all locations or should they vary?

In this paper, the authors report measured interior temperature and relative humidity in several units of multifamily housing and compare the measured moisture production rates to the rates suggested by other design sources. In general, measured moisture production rates in Seattle were found to be lower than the handbook design rates. Using measured interior moisture production rates versus calculated ones may produce distinct differences in hygrothermal performance modeling analysis of exterior wall systems. The modeled performance differences resulted in significantly different wall component recommendations depending on the interior moisture production rate chosen. The authors conclude that using a single handbook design moisture production rate and suggested interior calculation load for hygrothermal performance modeling analysis is not appropriate in all cases but, rather, that the standards should require hygrothermal analysis using at least two of three possible ranges of interior moisture production, i.e., low, medium, or high. The authors suggest that the choice of which range of moisture production rates to use should be based on the designer's investigation of how the building will be occupied and the type of HVAC system used.

Hygroscopic Inertia as a Function of Transient Behavior of Covering Materials

Nuno M. M. Ramos and Vasco Peixoto de Freitas – *Porto University*

This paper presents recent work on analysis of the importance of hygroscopic inertia in the hygrothermal behavior of buildings. The paper first discusses the role of hygroscopic materials in moderating the inside relative humidity variation in countries of mild climate of which Portugal is an example. Then laboratory tests, aimed at characterizing the behavior of covering materials in transient conditions, are presented, as well as some conclusions provided by these tests.