Session VI-A: Wall Systems I

Tuesday, December 7, 2004
1:30 p.m. to 3:00 p.m.
Grand Ballroom – Beach

Session Chair:

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1:30 p.m. to 1:40 p.m. Introduction
Kumar Kumaran

1:40 p.m. to 2:00 p.m. *"Moisture Transport by Convection in Lightweight Exterior Facades"*
Carsten Rode

2:00 p.m. to 2:20 p.m. *"The Airflow Characteristics of Ventilated Cavities in Screen-Type Enclosure Wall Systems (RP-1091)"*
Joseph Piñon

2:20 p.m. to 2:40 p.m. *"Field Studies of Ventilation Drying"*
Eric Burnett

2:40 p.m. to 3:00 p.m. *"Drying Rate of Timber-Framed External Wall Structures in Nordic Climate"*
Juha Vinha

Moisture Transport by Convection in Lightweight Exterior Facades

Charlotte Gudum – *Birch & Krogboe A/S*

Carsten Rode – *Technical University of Denmark*

This paper presents the experimental setup, a computer model, and simulation results of a recent Ph.D. project that focused on the effect of convection in lightweight exterior facades on moisture transport. First, the paper presents measurements of air velocity in the wall cavity by tracer gas and thermal anemometer. It is found that tracer gas can be used for air velocity measurement. Secondly a computer model is validated against measurements. Finally, using the computer model, a set of different yearly simulations with weather data from a design reference year were used to study the effect on cavity moisture levels of (1) insulation thickness, (2) presence or absence of vapor barrier, and (3) the degree of cavity ventilation.

The Airflow Characteristics of Ventilated Cavities in Screen-Type Enclosure Wall Systems (RP-1091)

Joseph P. Piñon, Danko Davidovic, Jelena Srebric, and Eric Burnett – *Pennsylvania State University*

Many wall systems in North America incorporate a drained and vented air cavity behind the cladding. One important function of this air cavity is to provide a chamber for convective airflow. This ventilation airflow, driven by wind pressure or natural buoyancy, or both, helps to remove moisture from the wall system and, therefore, to dry it. However, there is little conclusive research on the nature and quantity of the cavity airflow behind different screen-type claddings with different venting strategies and cavity depths.

This paper describes a series of experiments using an airflow chamber to investigate and quantify the airflow characteristics in ventilated wall cavities with different cavity depths, vent dimensions, and cladding surfaces, including Plexiglas, brick veneer, and vinyl siding. Vent and cavity depths were limited, for the most part, to sizes and types that are commonly used in residential construction. Realistic predictions of the nature and extent of airflow behind various ventilated cladding designs under specific certain realistic driving forces are given. CFD modeling has been used to obtain information about the nature of the airflow in ventilated cavities. An attempt has been made to provide wall enclosure designers with guidelines concerning ventilated wall cavity design. The results have also been compared to predictions of various analytical expressions for pressure loss through vents, ducts, and cracks.

Field Studies of Ventilation Drying

John F. Straube and Randy van Straaten – *University of Waterloo*

Eric Burnett – *Pennsylvania State University*

Many enclosure assemblies in many different climates have traditionally been ventilated with exterior air. The nature and magnitude of the benefits of providing a ventilated wall system have been debated, but little quantitative research has been conducted. This paper presents some of the results of a series of detailed ASHRAE-supported full-scale field test house studies that explored the role of ventilation and sheathing membranes in the drying of wood-framed walls. Several companion papers describe the technical background and the results of computer modeling and laboratory testing.

The studies involved five different 1.2 m wide and 2.4 m high wood-framed wall systems—three clad with brick and two with vinyl siding. Along with comprehensive boundary conditions (including driving rain), a total of over 20 sensors were used to monitor the moisture content, RH, and temperature within each wall system. Air velocity within the ventilation space of the brick veneer was also measured directly. A unique intra-wall wetting system was developed to uniformly and repeatedly wet the sheathing of the walls in a uniform manner. The walls were wetted three times at different times of the first year and their response-monitored. Changes were made to the size of the ventilation space in all walls, and a second year and three more wetting-drying cycles were imposed.

Results included: all walls allowed a very significant amount of drying, some of the walls exhibited no damage at all at the end of the experiment, drying rates varied significantly during different weather conditions, ventilation increased the drying potential of some walls, and the nature of the sheathing membrane influences the drying rate. It was also shown that solar-driven vapor diffusion acts to redistribute vapor from within the wall to the interior (where it did cause damage) and that ventilation reduces the magnitude of this flow. This reduction of inward drives due to ventilation had a larger effect for the absorptive brick cladding tested. The location of brick vents—both top and bottom—was clearly shown to be beneficial to drying. The vinyl siding profile tested allowed significant ventilation-induced drying, whether applied with or without furring.

Drying Rate of Timber-Framed External Wall Structures in Nordic Climate

Juha Vinha and Pasi Käkelä – *Tampere University of Technology*

This research looks into the moisture behavior of timber-framed external wall assemblies under Nordic climate conditions. The focus of this study was to measure drying rates of wall assemblies and to study the effects of different material layers on drying times from the viewpoint of water vapor diffusion of permeable walls (walls with an air barrier and no vapor barrier) and impermeable walls (walls with air and vapor barrier). Drying times have been estimated from laboratory test results. Laboratory tests were done with test equipment that allowed full-scale laboratory tests in real climate conditions. The main focus has been on relative humidity and temperature changes in the outer surface of the insulation layer (behind the sheathing) in different climatic conditions. Analysis was based on three criteria: limit value of mold growth (Viitanen 1996) during the autumn period, condensation during the winter period, and drying times during the spring period. It was noticed that water vapor resistance of the inner lining of the wall assembly has no significant effect on drying times during the spring period. In other words, permeable and impermeable walls have the same drying times if their other properties are identical. It can be generally noted that the water vapor resistance ratio between the inner and outer lining should be at least 5:1 in a Finnish climate. However, there are a lot of different variables that have an effect on this ratio (humidity excess of indoor air, absolute values of water vapor resistances, etc.).