Heat, air, moisture, and contaminant transport in built environment and its simulation technology

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Simulation for Heat, Air and Moisture Transfer Analysis

There are two types of humidity control: facility control and random control. The former is affected by dehumidification and humidification technology, and the latter is influenced by the moisture absorption and desorption of building materials and ventilation activities. If not properly controlled, the risk of microbial contamination increases. Since microbial growth in indoor spaces leads to health damage, humidity control and its flow design are important. Not only experiments or field measurements, but also the appropriate heat, air, and moisture environment by utilizing simulation technology are developed. This program are also used to calculate contaminant concentrations due to airflow.

Heat and Moisture Balance

$$\Gamma\frac{dX_r(t)}{dt}+\sum_{i=1}^{N}\alpha_{x_i}^{'}\cdot S_i\cdot\left(X_r-X_{surf_i}\right)+G\cdot\left(X_r-X_o\right)=W(t)$$

$$c\Gamma\frac{dT_r(t)}{dt}+\sum_{i=1}^{N}\alpha_i\cdot S_i\cdot\left(T_r-T_{surf_i}\right)+cG\cdot\left(T_r-T_o\right)=H(t)$$

Governing Equations of Heat and Mass Transfer in Wall Component

$$\left(\Phi_0\gamma'+\kappa\right)\frac{\partial X}{\partial t}-\upsilon\frac{\partial T}{\partial t}=\lambda_x^{'}\nabla^2X$$

$$-r\kappa\frac{\partial X}{\partial t}+\left(c\rho+r\upsilon\right)\frac{\partial T}{\partial t}=\lambda\nabla^2T$$

$$-\lambda_x^{'}\frac{\partial X}{\partial n}=\alpha_x^{'}\cdot\left(X_o-X\right)$$

$$-\lambda\frac{\partial T}{\partial n}=\alpha\cdot\left(T_o-T\right)$$

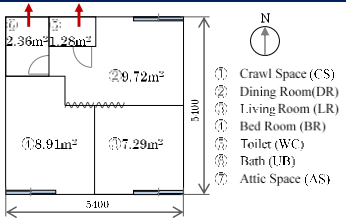
Multizone Air Flow Balance

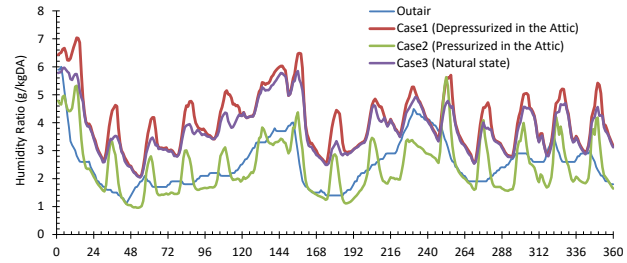
$$Q_{mj}=\alpha A_{mj}\cdot\sqrt{\frac{2}{\gamma_i}}\cdot\Delta p^{\frac{1}{n}}$$

$$\sum_{j=1}^{n}Q_{mj}=0$$

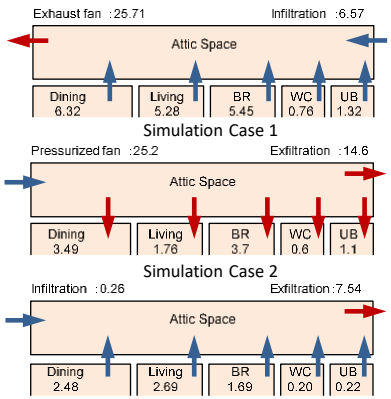
Ventilation for Improving Hygrothermal Condition of the Emergency Temporary Housing (ETH), Simulation Results

To avoid condensation in the attic space of TEH, by using Whole Building Heat, Air and Moisture transfer simulation. Pressurized in the attic space makes condensation risks small in these simulation cases.





Simulation Results of Humidity variation in the attic space (from 24th Jan. to 7th Feb.)

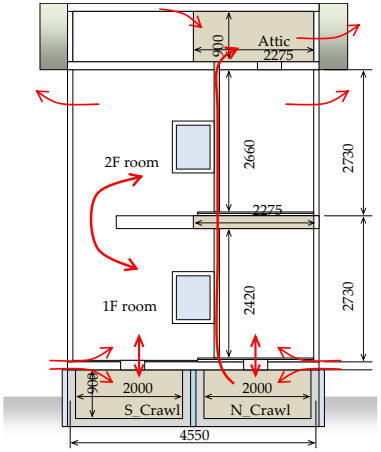


Unit of numbers in figure is kg/h
Crawl Space (CS), Dining Room (DR), Living Room (LR), Bedroom (BR), Toilet (WC), Bath (UB), Attic Space (AS)

Averaged Air flow volume (kg/h) and its vector around Attic Space

The Relationships Between the Indoor Air Pollution and the Air Quality in the Crawl space

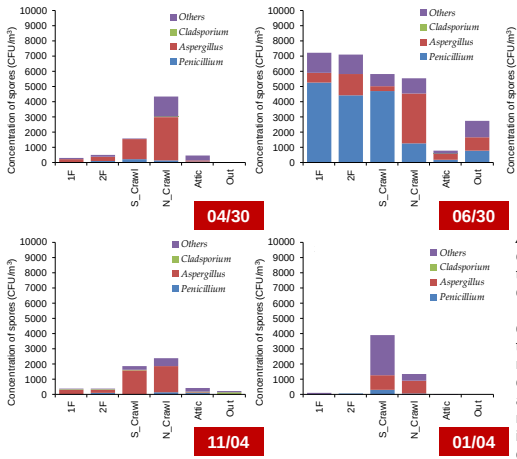
The High Moisture Content of the Fresh Concrete in the Crawl Space creates great risk that mold germination and proliferation. Moist air flow into living spaces through room-to-room infiltration, it increases the danger of Mold Damage in living areas. *Aspergillus* has a strong correlation with the surface moisture content of vertical concrete wall surfaces.



Sectional Plan of Experimental House and Possible Flow Paths

South west Elevation of Experimental house

Inside View of 1st Floor of Experimental house



Aspergillus and *Penicillium* have continued to be the most common in the crawl space. *Cladosporium* was observed only during the summer. The characteristic was the eventual decrease in number of molds. As time passes after construction and moisture generation from the concrete subsides, the quantity of airborne fungi decreases. The moisture management is most important in the early stage of completion .