RP1010

MONITORING AND MODELLING THE CSR LOW ENERGY HOUSE

Research Questions

How are the composite walls in the CSR house performing during a day, a month or a year in maintaining comfortable indoor temperature?

Figure 1: CSR house research centre in western Sydney

Methodology

Consider the wall system as part of thermal circuit with a periodic heat flow at outer surface…

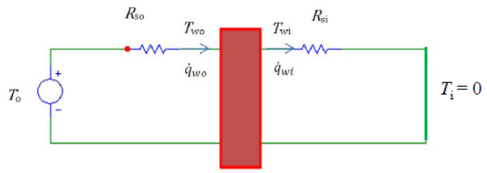

Figure 2: Simplified thermal circuit of the CSR house composite wall system

Assuming the outdoor periodic heat flow is varying in a simple sinusoidal mode, the surface temperature of the external wall $T_{wo} = T_o \cos(\omega t)$

The temperature profile T(x,t) in the wall can be expressed by:

$$T(x,t) = T_o e^{j\omega t}[A\cosh(\gamma x) + B\sinh(\gamma x)]$$

The core equation for solving the temperature of the wall is:

$$k\frac{\partial^2 T}{\partial x^2} = \rho c_p \frac{\partial T}{\partial x}$$

The characteristic – thermal transfer admittance Y_t can therefore be obtained using the following equation:

$$Y_t = \frac{T_o}{q_{wi}}$$

Results

In the CSR house, there are 7 different building materials for wall systems and four different composite wall types.

For each composite wall system, the thermal transfer admittance of the composite wall can be calculated and expressed as a function of time.

Take the CSR house Hebel™ composite wall system as an example:

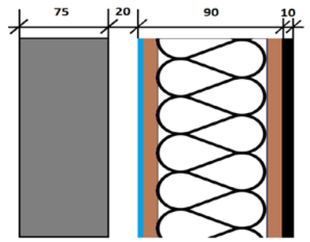

Figure 3: The Hebel™ wall system includes a 75mm Hebel™ concrete layer, a 20mm air gap, 90mm R2.7 glasswool insulation and a 10mm plasterboard.

Based on the thermal circuit model and thermal transfer admittance equation, we can obtain the transfer admittance

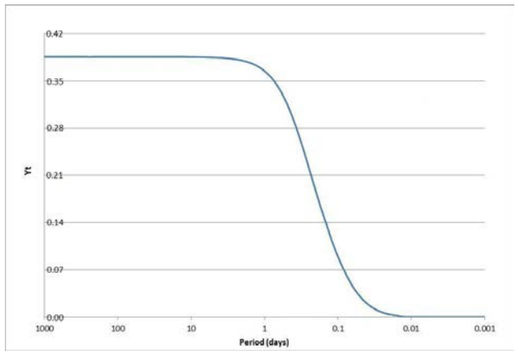

Figure 4: Transfer admittance Y_t as a function of period (days) for the Hebel™ composite wall system

This transfer admittance curve tells us that when the time period is more than a year, the transfer admittance of the Hebel™ wall will stabilised at U0.37. As the time period goes shorter, the effect of thermal mass in concrete will outweigh the effect of thermal resistance in resisting heat change.

Conclusion

With this model, we can get the effective U value or R value of any composite wall system as a function of time period. As it consider the effect of both thermal mass and resistance at the same time, the thermal transfer admittance can evaluate the building material's thermal performance in a more holistic way.

Future work

Designbuilder will be used to test the model and calculate the transfer admittance of walls.

By creating a test weather file with sinusoidal temperature variation, the surface temperature of different wall types will be analysed.

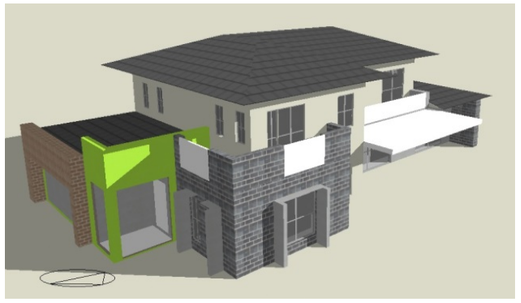

Figure 5: CSR house Designbuilder model

Anticipated impacts

This research aims to introduce a parameter to characterise the performance of the building material with a combined consideration of thermal resistance and thermal mass.

With this proposed model, the heat performance of composite wall systems can be easily quantified.

Further information

If you are interested in this project, please visit:

http://lowcarbonlivingcrc.com.au/research/program-1-integrated-building-systems/rp1010-monitoring-and-modelling-csr-low-energy-house

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