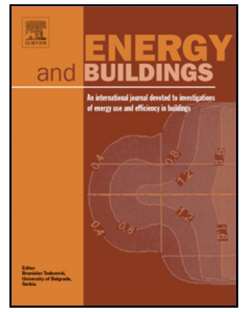
Accepted Manuscript



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PII: S0378-7788(17)31123-4
DOI: http://dx.doi.org/doi:10.1016/j.enbuild.2017.07.086
Reference: ENB 7826

To appear in: *ENB*

Received date: 30-3-2017
Revised date: 25-7-2017
Accepted date: 28-7-2017

Compact Facility for Testing Steady and Transient Thermal Performance of Building Walls

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Abstract

Energy efficiency retrofit of buildings represents a key effort in reducing EU energy demand by 20% by 2020. However, predictions tend to overestimate savings by large percentages. The shortfall in savings can be attributed to incorrect predictive techniques, comfort takeback along with other behavioural and workmanship variables. Common predictive techniques related to heat loss tend to be based on the U-value of the building envelope. This paper presents the design of a more straightforward and compact version of the traditional Hot-Box apparatus (measures U-value) which instead determines the thermal resistance of samples of building envelope. U-value includes the need to measure/predict the effective surface resistances. *In situ* surface resistances, which include radiation and convection, are difficult to predict and vary depending on climatic conditions, exposure levels, surface emissivities among many other influences. The design of the test facility eliminates the need to incorporate these surface behaviour variables. This paper details the replicable apparatus and test methodology. The results of testing a hollow block wall of typical construction using the rig is then presented. The determined R-value is found to be within 1% of calculated values and the thermal time constant also matches closely with the most accurate predictive estimates.

Keywords: Thermal resistance, Building Energy, Heat Transfer, Building Envelope, Walls, Transient, Steady

Nomenclature	
A	Surface Area (m^2)
c	Specific heat capacity (J/kgK)
R	Thermal Resistance (m^2K/W)
T	Temperature (K)
h	Heat transfer coefficient ($W/(m^2K)$)
L	Length (m)
$\dot{m}$	Mass flow rate (L/min)
q	Heat flux (W/m^2)
v	Wind speed (m/s)
w	Uncertainty (%)
Nu	Nusselt number
k	Thermal conductivity of air (W/(mK))
ε	Surface emissivity
σ	Stefan-Boltzmann constant ($W/(m^2K^4)$)
τ	Thermal time constant (hours)
Subscripts:	
a	Air
c	Convective
$combined$	Combined