Iterative dynamic model to estimate thermal resistance of wall subjected to a transient heat flux

António Tadeu*, Nuno Simoes†, Inês Simões††, Filipe Pedro†† and Leopold Škerget†††

* Department of Civil Engineering
University of Coimbra,
Pólo II, Rua Luís Reis Santos, 3030-788 Coimbra, Portugal
e-mail: tadeu@dec.uc.pt, web page: http://www.uc.pt/fctuc/dec

† Department of Civil Engineering
University of Coimbra,
Pólo II, Rua Luís Reis Santos, 3030-788 Coimbra, Portugal
e-mail: nasimoes@dec.uc.pt, web page: http://www.uc.pt/fctuc/dec

†† ITeCons
Rua Pedro Hispano, Pinhal de Marrocos, 3030-289 Coimbra, Portugal
e-mail: {mivsimoes, filipe.pedro}@itecons.uc.pt, web page: http://www.itecons.uc.pt

††† Faculty of Mechanical Engineering
University of Maribor
Smetanova ulica 17, 2000 Maribor, Slovenia
e-mail: leo@uni-mb.si, web page: http:// www.fs.uni-mb.si

ABSTRACT

This paper proposes and validates a numerical iterative model to evaluate the thermal resistance of multilayer systems (walls) when in a dynamic state. The proposed method is validated in two steps. First, the validation is performed numerically then, in the second step, it uses the temperature and heat flux values recorded during experimental tests performed in a hot box chamber. These validations involve comparing the obtained results with those expected, given the thermal properties of each material and thickness of each wall layer.

The paper first presents the analytical solution for simulating the heat transfer by conduction in the frequency domain, through the multilayer system. This is generated by imposing temperature on the external surfaces, when the thermal properties of the materials are known. The model is then modified by assuming the wall to be composed of a single layer with unknown thermal properties. The temperatures and heat fluxes, defined earlier by the analytical model and imposed on the external surfaces, lead to a non-linear system that can be solved for the unknown thermal properties. It is solved by implementing an iterative approach based on the Newton-Raphson method.

The proposed model solution is then validated by using temperatures and heat fluxes recorded during experimental tests in a hot box. The thermal resistance of different multilayer systems is estimated using the proposed iterative dynamic model and the results are compared with the expected ones, which enables us to show a good agreement between the two sets of results.

REFERENCES

[1] A. Tadeu, N. Simões and I. Simões, "Coupling BEM/TBEM and MFS for the simulation of transient conduction heat transfer", *International Journal for numerical Methods in Engineering*, Vol. **84**, pp. 179-213, (2010).

[2] International Organization for Standardization, "*ISO 6946: Building components and building elements - Thermal resistance and thermal transmittance - Calculation method*", (2007).

[3] C-E Hagentoft, *Intoduction to building physics*, Studentlitteratur, Lund, (2001).