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THE IMPACT OF TEMPERATURE VARIANCES ON THERMAL INERTIA FACTORS OF OPAQUE ELEMENTS OF THE BUILDING ENVELOPE

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EXTENDED ABSTRACT

This study presents an accurate model for the evaluation of the thermal inertia factors of building envelope opaque elements when temperature variances during the cooling period are considered. The calculation of these factors is essential for the estimation of the heat storage capabilities and heat losses through the building envelope. Thus, time lag, decrement factor and temperature fluctuations in the inner surface of the building envelope are determined for characteristic wall configurations and by employing a lumped thermal-network model that makes provision for the mechanisms of heat transfer.

The current analysis, which assesses the impact of temperature variances, is performed for the Greek region and more specifically for the urban environment of Thessaloniki. The meteorological information employed in this study have been obtained by the meteorological station, in the Aristotle University campus. Outdoor temperature variations correspond to the summer months (June, July and August), over the period of the last fifty-two years (1950 – 2001). The investigation concerns representative wall formations, which consist of masonry (brick), insulation and coatings on both surfaces. The insulation is placed as one or two layers on the outer, the inner or in the mid-centre brick-wall surfaces. Consequently, the examined wall configurations, based on the layer position and distribution, are six.

A dynamic thermal circuit model is used to simulate heat transfer by conduction through the wall and by considering convection boundary conditions under specific forcing functions on both surfaces. To accomplish this, the well-known analogies between the thermal and electrical laws are employed, leading to a thermal-circuit model. The one-dimensional model is applied as it has been proved to be a reasonable approximation since transverse heat flows are practically negligible. The differential equations describing the dynamic behaviour can be discretised leading to a set of algebraic equations with time-dependent coefficients and driving sources. The thermal circuit is analysed numerically by a computer program, which was developed for this purpose, using the non-linear nodal approach. During the solution procedure the dynamic behaviour of the thermal model is assessed in discrete time steps Δt. The modelling of the thermal behaviour employs a lumped capacitance, one-dimensional network model, in which distributed thermal resistances and capacitances are connected to each other via a number of nodes. The model contains all the essential features that characterize the discrete problem and its number of nodes is generally large enough to ensure a satisfactory accuracy.

Key words: Wall configurations, temperature variances, time lag, decrement factor, inner surface temperature swing, transient analysis, thermal-network model