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Conduction Transfer Functions for the Calculation of Heat Demands in Heavyweight Facade Systems

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Abstract : Better energy performance of the building envelope is one of the most important aspects of energy savings if the goals set by the European Union are to be achieved in the future. Dynamic heat transfer simulations are being used for the calculation of building energy consumption because they give more realistic energy demands compared to the stationary calculations that do not take the building's thermal mass into account. Software used for these dynamic simulation use methods that are based on the analytical models since numerical models are insufficient for longer periods. The analytical models used in this research fall in the category of the conduction transfer functions (CTFs). Two methods for calculating the CTFs covered by this research are the Laplace method and the State-Space method. The literature review showed that the main disadvantage of these methods is that they are inadequate for heavyweight façade elements and shorter time periods used for the calculation. The algorithms for both the Laplace and State-Space methods are implemented in Mathematica, and the results are compared to the results from EnergyPlus and TRNSYS since these software use similar algorithms for the calculation of the building's energy demand. This research aims to check the efficiency of the Laplace and the State-Space method for calculating the building's energy demand for heavyweight building elements and shorter sampling time, and it also gives the means for the improvement of the algorithms used by these methods. As the reference point for the boundary heat flux density, the finite difference method (FDM) is used. Even though the dynamic heat transfer simulations are superior to the calculation based on the stationary boundary conditions, they have their limitations and will give unsatisfactory results if not properly used.

Keywords : Laplace method, state-space method, conduction transfer functions, finite difference method
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