

INCLUSION-BASED BOUNDARY ELEMENT METHOD FOR DESIGN OF BUILDING ENVELOPES

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The energy efficiency of a building envelope can be improved by embedding phase change materials (PCM) due to their high latent heat. However, heat transfer in the PCM-embedded composite can be quite complex due to temperature-dependent thermal properties of paraffin-based PCMs and material mismatch between PCMs and the Matrix, especially in transient heat conduction cases. This research presents an novel numerical method to simulate the transient heat conduction through a concrete wall panel containing PCM using the Green's function. The pioneer work on simulation of PCM and heat equation applied finite element method (FEM), finite difference method (FDM). FDM discretize the time and space domain instead of taking derivatives, and it is usually applied to solve diffusion equations. However, the solutions of FDM are sensitive to time discretization and discontinuity issues. PCM capsules embedded in the domain of the building envelope serve as multiple inhomogeneities with heat source. To treat inhomogeneity problem, the PCM capsules need to be meshed to elements compatible to the matrix domain, which leads to large number of meshed elements. For inhomogeneity problem, Eshelby proposed equivalent inclusion method (EIM), filling inhomogeneities with the same material with the matrix and fictitious heat source, eigen gradient of temperature. The inclusion-based boundary element method (IBEM) combines EIM with boundary element method, which only requires to mesh convex surface. Upon experimental validation, the IBEM model is used for energy efficient building design and energy savings prediction.

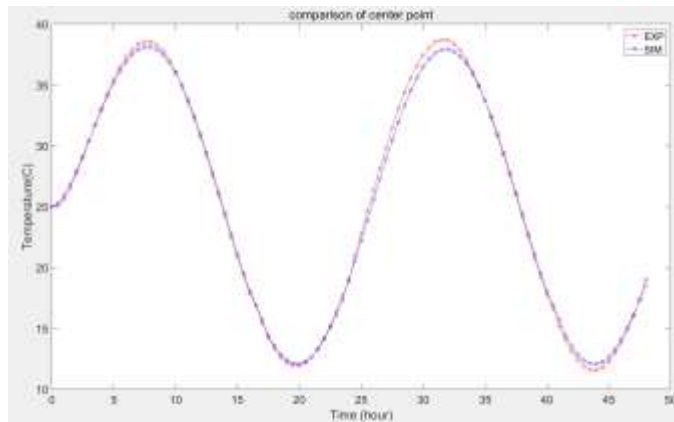


Figure.1 Comparison of experiment and simulation data

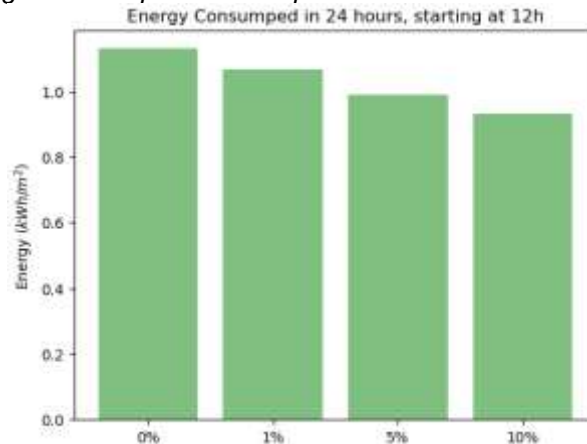


Figure.2 Energy saving with different volume fraction of PC