Numerical study on thermal resistance of PCMs incorporated in novel roof structures against energy loss	
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Abstract:
Incorporating Phase Change Materials (PCM) into building enclosures is one of the passive techniques to improve thermal comfort and reduce energy costs. The present study is dedicated to the assessment of various configurations of PCM incorporation in a roof structure in order to evaluate their impact on thermal resistance and consequent reduction in energy losses. Several arrangements of the PCM and brick are tested: small PCM blocks distributed through the structure, multiple long PCM blocks distributed horizontally or vertically, single PCM block occupying either the right half or the left half, and single PCM block occupying the top half or bottom half. The equations governing the flow and thermal transfer in the PCM, as well as heat transfer in the plaster and brick, are defined and derived in the non-dimensional form. The hydro-thermal behavior of the melting PCM is assessed in the different configurations and for two values of Rayleigh number. The results indicate that for low Ra, the highest thermal resistance is obtained when a single PCM block is located at the top of the cavity and separated from the hot source by brick. For high Ra, the maximum resistance is found when the PCM is placed in multiple vertical blocks. Putting the PCM in multiple horizontal blocks or in small blocks does not change the PCM melting when Ra is varied. In all cases, the fastest PCM melting is obtained when the PCM block is close to the hot source and is either in one single block or in multiple vertical blocks.