Influence of atrium roof geometries on the numerical predictions of fire tests under natural ventilation conditions

P. Ayala, A. Cantizano, C. Gutiérrez, G. Rein

Abstract— The use of computational fluid dynamics (CFD) as a tool for the design of smoke control systems and fire protection in large spaces has become more frequent as accuracy and computational speeds increase. In the present work Fire Dynamic Simulator (FDSv5) has been used to study two full-scale experiments conducted in Murcia (Spain) of 1.36 MW and 2.34 MW pool fires burning inside a 20 m cubic atrium under natural ventilation conditions. Different cartesian-grid approximations to the real geometry of the pyramidal roof have been investigated in order to assess the effect of stair stepping on the smoke layer and the temperature field. In general terms, good agreement between experiments and numerical simulations is found for all model roof geometries, especially far away from the fire source and the centreline. For example, at a height of 15 m, the temperature differences between all geometry approximations are lower than 10%. This shows that the cartesian-grid simplifications proposed here are a good choice and allow for saving some computational resources. In order to extend the results to different designs, the model has then been applied to different atrium geometries, study range of 16 varving the a area-to-height-squared ratio from 0.4 to 3.8. In addition, a comparison with simulation with a previous version of the code, FDSv4, shows that it predicts higher temperatures and slower ascends of the smoke layer than FDSv5, the difference being lower than 12% and 100 s respectively.

Index Terms— Atrium; Full scale fire tests; Smoke; CFD simulations; FDSv5; FDSv4

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