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Computer Simulation of Radon Distribution in Buildings

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Radon is an odourless, colourless, radioactive gas present in soils in various concentrations. Radon primarily penetrates into a building through leakage paths in the foundation. It can be brought into a house also with pumped water or in building materials. Radon decays through a series of decay products, which attach to particles suspended in the air or deposit onto surfaces in occupied zones. The decay products can be inhaled and deposited in the respiratory tract. The decay of radon and subsequent products is associated with emission of alpha or beta rays, which can cause the health risk. This risk can be decreased mostly by higher ventilation rates and/or by modifications in building constructions.

Once radon enters a building its distribution is mainly influenced by internal airflows between individual rooms. The intra-building airflow is driven by pressure differences resulting from different air temperatures (within a building and between a building and its exterior) and induced by airflow around a building (depending on wind velocity and direction). Volume flow rates of air and concentrations of radon for individual rooms are coherent. Thus by post-processing of the solved unsteady indoor air flows the concentrations of radon can be obtained for different rooms and time steps.

This paper deals with the numerical prediction of radon concentration distribution in buildings without mechanical ventilating system. Available computing tools for direct prediction of radon distribution in buildings are limited to steady state or quasi-steady state models, which do not consider all dynamic parameters influencing indoor airflows. For the presented project ESP-r was used to model and simulate an existing family house placed near Prague. ESP-r is a dynamic thermal simulation environment, which may be used to explore a range of issues (separately or in combination) including building fabric, airflow, ideal and detailed plant systems at time steps ranging from seconds to an hour. It attempts to simulate the real world as rigorously as possible at a level, which is consistent with current best practice in the international computer simulation community.

The results obtained from simulations are compared to radon concentration measurements, which were performed in the family house during two one-week periods in May and November 2000. The simulations and measurements show quite a good agreement for the period in May when indoor airflows are better defined. External air temperatures in this period were relatively high, the heating system was not in operation and several rooms in the house had opened windows during whole days. In contrast, it was observed that in November when the building was mostly tight closed, the heating system was working and indoor air flows were randomly influenced by occupants it was very difficult to define a model in compliance with the reality.

Future work should be focused on a case study of building with forced (mechanical) ventilating system inducing well-defined intra-building airflow. For such a case the simulation technique used in the present project should produced results having reasonable agreement with the reality.

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