Extended abstract: the full paper will published in the Journal of Building Physics

A Comparison of Measured and Simulated Air Pressure Conditions of a Detached House in a Cold Climate

Juha Jokisalo[1], Targo Kalamees, Jarek Kurnitski, Lari Eskola, and Kai Jokiranta are with the HVAC -Laboratory, Helsinki University of Technology, P.O. Box 4400, FIN-02015, TKK, Finland; and Juha Vinha is with the Institute of Structural Engineering, Tampere University of Technology, P.O. Box 600, 33101 Tampere, Finland.

ABSTRACT

This study discusses the evaluation of a multi-zone infiltration model of an existing two-storey detached house in the cold Finnish climate. This study was performed by comparing the simulated and measured pressure conditions of the building during a three-week test period in the heating season. The model allows the prediction of the effects of leakage distribution, airflows between rooms and floors, building leakage rate, pressure conditions, and climate on infiltration and energy use. The study shows that the model is able realistically to predict the air pressure conditions of a detached house in a cold climate and it is suitable for detailed infiltration and energy analyses.

INTRODUCTION

Infiltration, defined as uncontrolled airflow through a building envelope, depends on the air permeability of the building envelope and the air pressure difference between indoor and outdoor air across the building envelope. The pressure difference is caused by wind, the stack effect, and the ventilation system. The objective of the study is to perform an evaluation of the air pressure conditions predicted by a detailed multi-zone simulation model which includes leakage distribution and other important parameters.

METHODS

The object of the study is a detached house comprising two floors. Initial data of the simulation model were collected with extensive field measurements of the building and the following factors were measured:

- Ventilation
- Airtightness of the building envelope
- Air leakage distribution over all the facades and roof

[1] Corresponding author's e-mail: juha.jokisalo@tkk.fi

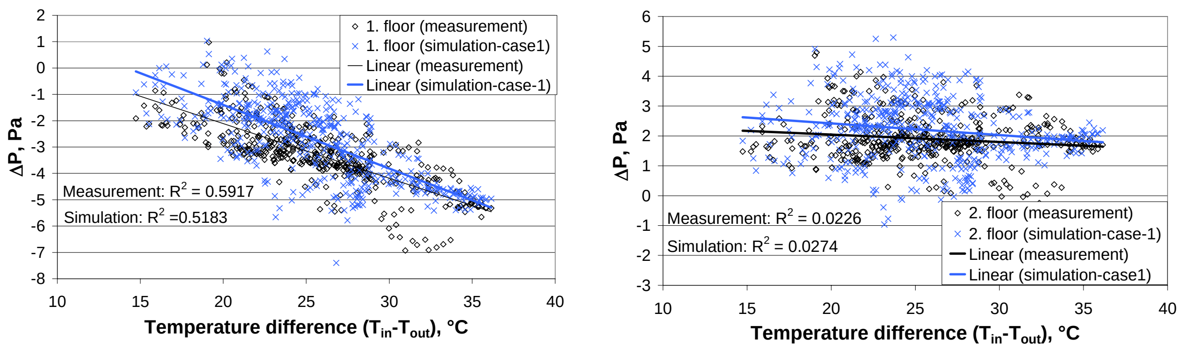
- Air pressure difference over the building envelope
- Indoor and outdoor temperature conditions

Distribution of the leakage openings was studied using a two-phase infrared camera imaging for the envelope of the building. The imaging was done inside the building in a normal and under-pressure conditions of 50 Pa. Three week's follow-up measurement of the pressure and thermal conditions was carried out in heating season.

The building model was done using IDA indoor Climate and Energy 3.0 (IDA-ICE) building simulation software. This software allows the modelling of a multi-zone building and provides simultaneous dynamic simulation of heat transfer and air flows.

RESULTS

The pressure difference is slightly negative on the average at the base floor and positive at the top floor according to the measurement and the simulation results during a three-week test period (see Figure 1). Both of the results show, that the pressure difference decreases with an increasing temperature difference between indoors and outdoors on the base floor, but the temperature dependence of the pressure difference is weak on the top floor. The different correlations between the air pressure and the temperature differences on the base and top floors are the result of different factors, such as the stack effect and the method of defrost protection.



a) b)

Figure 1. Measured and simulated pressure conditions of the detached house on the base (a) and top (b) floors during the test period. The pressure differences are shown as a function of the temperature difference between indoors and outdoors.

CONCLUSIONS

This evaluation exercise shows that the dynamic multi-zone simulation model that was studied, with specific features such as detailed leakage distribution and defrost protection of heat recovery, predicts the air pressure conditions of a detached house in sheltered wind conditions and a cold climate realistically. The simulated air pressure conditions of the building model are reasonable, even if the calculation of the wind-induced pressure conditions was greatly simplified, for example with approximate wind pressure coefficients and wind data that were taken from the closest airport's weather station. The study shows that this multi-zone model can be used for infiltration and energy analyses in the cold Finnish climate.