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Devlopment of a Practical Method to Quantify Infiltration Rate through Building Entrance

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Development of Practical Method to Quantify Infiltration Rate Through Building Entrance

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ABSTRACT

Infiltration through entrance doors, vestibules, cracks and other areas have a large impact in building energy consumption. It also has a significant impact on indoor air quality. There are only a few studies about air infiltration and air tightness in the literature. The purpose of this study is to develop practical methods to measure air infiltration rates through entrance doors. We have read research articles and identify several methods in the literature. Further investigation is required to help more accurately find infraction rate, crack size and location of cracks to help reduce air infiltration, energy costs, maintain comfortable indoor conditions and lower buildings' carbon footprint.

INTRODUCTION

Other than ventilation that we need to maintain acceptable indoor air quality, unwanted airflow through large openings such as windows and doors as well as cracks on the building envelop significantly affects building energy consumption, especially in winter. Energy loss due to infiltration because of cracks is a large part of building energy consumption: 33% of energy used in heating and cooling residential buildings and 40% of industrial business. Air infiltration also has a significant impact on indoor air quality because it allows outdoor particles, gaseous containment and moisture inside. There are only a few studies about air infiltration and air tightness. Most research that has been done only focuses on residential buildings and not commercial buildings because it has not been viewed as a major issue. Industrial buildings only meet the regulations which already don't have much data to being with because of few scientific findings. The little information and research done has left the energy standard of warehouse and production buildings lagging behind. Accurate quantification of air infiltration rates through building entrance doors allows reduction of energy consumption, improvement of indoor air quality and better understanding of physical phenomena around the entrance doors.

METHODS

Blower Door Method

- Pull or push out air to lower or increase air pressure inside allowing air infiltration rate to be measured by the pressure difference between the indoor and outdoor space.
- This method is disruptive to the occupant because a blow fan is mounted to a door and it takes lots of effort to set up and tear down.
- It can't find where infiltration enters from and does not measure infiltration in all parts of the building envelope.

Thermographic images

- It along with blower door helps locate the cracks inside the building and the size of them which can help calculate inflation more accurately leading to better building energy consumption.
- Thermographic images of a building help identify crack sizes and infiltration rates. Infrared thermography can be used with the blower door method to identify the locations of building cracks as shown in Figure 2.

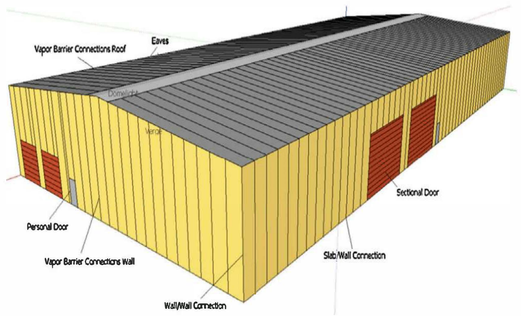

Figure 1. Relevant leakage of building component and connection of the sample building. (Adapted from 3)

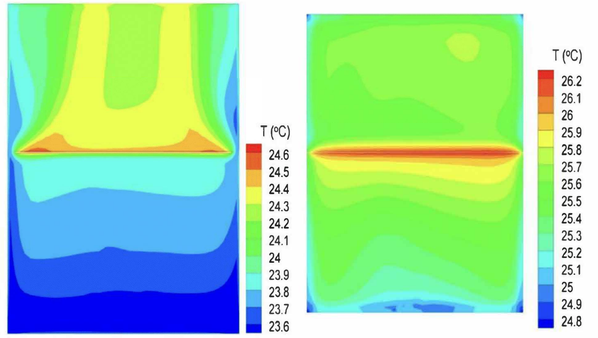

Figure 2. Temperature distribution on the wall with the crack: (left) outside surface and (right) inside surface. (Adapted from 2)

DISCUSSION

Further research is needed to effectively quantify the infiltration rates through building entrance doors. As key factors affecting infiltration rates are identified, a detailed plan for field measurements, including all the instruments should be established. Differences in the infiltration rates through different types of entrance doors and the existence of vestibules. Detailed strategies to measure all the factors that are closely related to the estimation of air infiltration through large openings are essential as well.

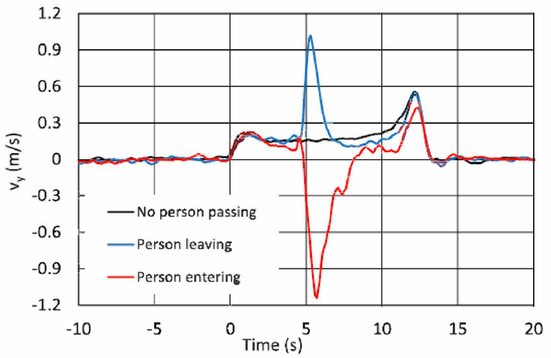

Figure 3. Comparison between velocity with and without a person passing. (Adapted from 4)

RESULTS

- Lie et al. (2018) proposed a novel technique to measure infiltration rates. The trial run in the building as shown in Figure 1 revealed that the proposed method only needed one person and a half day to complete the task. Additionally, compared to the conventional blower door method, the equipment used in this method is lightweight and simple to install.
- Using a thermographic image of a building envelope taken by an infrared camera and measuring the indoor/outdoor air velocity, temperature, and pressure helps identify crack size and air infiltration rate.
- Villafruela et al. (2016) found that the infiltration rates through the automated entrance doors of the retail stores and supermarkets ranged from 40 L/s to 5800 L/s compared to those of retail stores which only ranged from 100 L/s.m^2 to about 1100 L/s.m^2
- Figure 3 shows that the air velocities varies significantly when occupants enter or leave the door for the case that the velocity measured at the chest height. When the air velocity was measured at the head height, the airflow is outwards without entrance or leaving.

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