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Implication of Local Weather on Heat Transfer Rates by Infiltration

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ABSTRACT

The first law of thermodynamics, also known as "Law of Conservation of Energy", states that energy can neither be created nor destroyed; energy can only be transferred or changed from one form to another. The natural transfer of heat flows from a warmer environment to a colder environment. Infiltration through a building entrance door has major impacts on the indoor thermal environment, indoor air quality and energy performance. In our research, we measured differential pressure and air velocity across entrance doors. We also monitored the indoor and outdoor environments in the Environmental Building by collecting data using specialized instruments and sensors. After analyzing the measured data, we were able to calculate the heat transfer of the infiltration through the entrance doors. Finally, we were able to compare the heat transfer rates calculated from local weather and standard weather.

INTRODUCTION

The Architectural Design for a building has an effect on the day to day operations and functionality. This is especially true when it comes down to deciding what materials to choose for the building envelope, determining where to place the entrance doors & what types of entrance doors to use. These factors have a direct impact to the indoor thermal environment, indoor air quality & the building energy performance. For this project we conducted research on infiltration through the entrance doors in the Environmental Building. On a cold winter day, we measured local weather conditions, along with other environmental parameters in the Environmental building. With the measured data we were able to accurately calculate the airflow rates & quantify energy losses through the entrance doors. This poster presents the methods we developed & the significance of the weather sources in the calculation of heat transfer rates by natural air flow through building entrance.

RESULTS

Table 2 Heat loss calculated by two weather data sources in Environmental Building

Variable	Measured Weather		Standard Weather	
	Door 1	Door 2	Door 1	Door 2
Velocity (fpm)	109	139	350	351
Flow Rate (CFM)	2179	2756	6999	7017
Temp Difference (F)	9.8	9.6	11.3	11.6
Heat Loss (MBTU)	24	29	86	86

DISCUSSION

This is part of a long-term project to investigate the impact of infiltration through building entrance doors. This poster focuses on the influence of weather resources on the prediction of the infiltration through entrance doors. We have developed a method to accurately quantify infiltration rates and successfully estimate the heat losses due to the infiltration as shown in Table 2.

Table 2 shows that using the local measured weather is critical in the accurate prediction of heat losses through building entrance door. Standard weather data is widely used to predict physical phenomena taking place in buildings and their surroundings. The heat transfer rates of infiltration are solely dependent on the weather data since the energy equation is the function of an air flow rate and a temperature difference. The results indicate that if the standard weather data is continuously used to quantify heat loss through buildings entrance door will lead to the system being oversizing and the heat loss being overestimated. As infiltration may improve indoor air quality, this aspect should also be studied.

METHODS

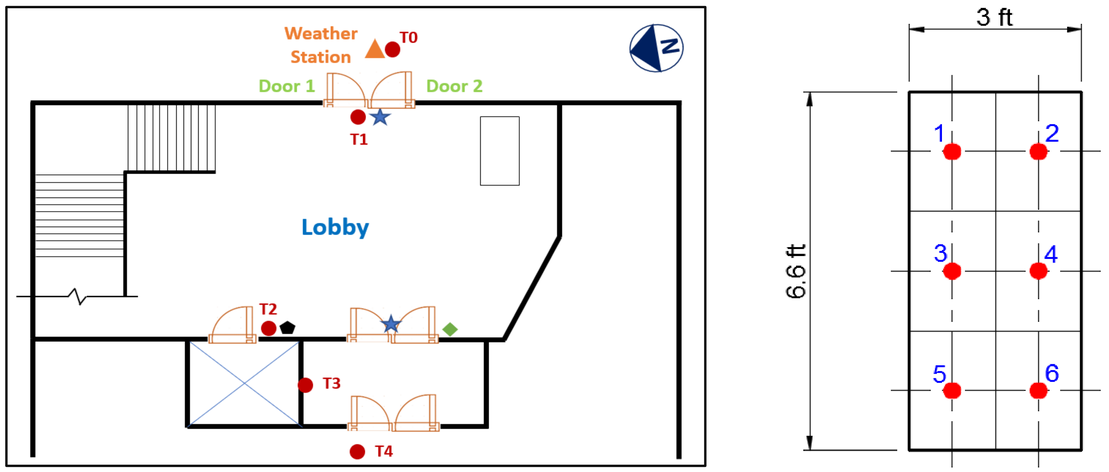

Figure 1 The measuring points on a building plan and the section of entrance doors

This differential pressure across the entrance doors in *in. wg.* can be expressed as

$$P_{diff} = P_h - P_l$$

where P_h is high-pressure side in *in. wg.* and P_l is low-pressure side in *in. wg.* The air flow rate in *CFM* across the entrance doors is expressed as

$$Q = AV$$

where *A* is the area of doors and *V* is the velocity of incoming air in *fps*. The energy equation is used to calculate the heat transfer rate of the natural airflow as

$$\dot{q} = 1.1Q\Delta t$$

where Δt is temperature difference in *°F* between outdoor air and indoor air.

Table 1 Measuring parameters and specification of the measuring instruments

Parameters	Instrument	Measuring Interval	Range	Accuracy	Resolution
OA Temp/RH	HOBO MX2301	1 min	-40-70°C	±0.2°C	0.04°C
Indoor Temp	HOBO U10	1 min	-20-70°C	±0.53°C	0.14°C
Door Opening	HOBO UX90-6M	1 sec	12m / 102°	-	-
Velocity	TSI Velometer	-	0-20 m/s	±5%	0.01 m/s
Wind Speed	HOBO U30	1 min	0-76m/s	±4%	0.5m/s
Wind Direction	HOBO U30	1 min	0-355°	±5°	1.4°

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