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# Measurement of air flow rate in a naturally ventilated double skin facade

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## 1 Introduction

Air flow rate in a naturally ventilated space is extremely difficult to measure due to the stochastic nature of the wind, and as a consequence non-uniform and dynamic flow conditions. Moreover, the air flow rate in a naturally ventilated cavity of a double skin façade may have significant variation in order of magnitude and occurrence of reverse flow.

This paper describes three different methods to measure the air flow in a full-scale outdoor test facility with a naturally ventilated double skin façade.

## 2 Methods

In the first method the air flow in the cavity is estimated on the basis of measured velocity profiles, which are measured in a number of horizontal planes equipped with 46 hot-sphere anemometers in total. The second method is represented by constant injection of $CO_2$ tracer gas in the lower part of the façade and measurement of the $CO_2$ – concentration in the upper part of the facade. In the third method a measured relation in the laboratory between pressure difference across the opening and the air flow rate is used to estimate the flow rate on the basis of continues measurement of the pressure difference between the surface pressure at the opening and inside pressure of the double skin façade.

## 3 Results

The airflow measured in the naturally ventilated cavity in external air curtain mode show reasonable agreement between the velocity profile and tracer gas method (Table 1).
The pressure difference method, in this case, shows poor results.

Table 1. Mean measured air flow in external air curtain mode.

| Method | Mean measured flow, $m^3/h$ |
|---|---|
| Tracer gas | 1011 |
| Velocity profile | 1007 |

Improved performance of the pressure method is observed when the double façade cavity is mechanically ventilated (preheating mode) and results show correspondence with the tracer gas method.

## 4 Conclusions

The tracer gas method as well as the velocity profile method are very sensitive to the flow direction in the cavity and can be applied within a number of limitations.

Due to the repeatedly changing shape of the velocity profile in the cavity, the number of measurement points within the velocity profile and measurement frequency is very essential for the measurement accuracy.

Partial success of the pressure difference method argues for further investigation as the method is very sensitive to the positioning of the surface pressure and reference measurement, to the fluctuations in wind direction and wind speed.

Although all three measurement methods are difficult to use under such dynamic air flow conditions, have sources of error and compared to laboratory conditions have relatively large uncertainties, the results show reasonable agreement and can be used for experimental validation of numerical models of natural ventilation air flow.