

# Measurement of Air Flow in a Naturally Ventilated Double-Skin Façade (DSF)

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# Air flow in a naturally ventilated DSF

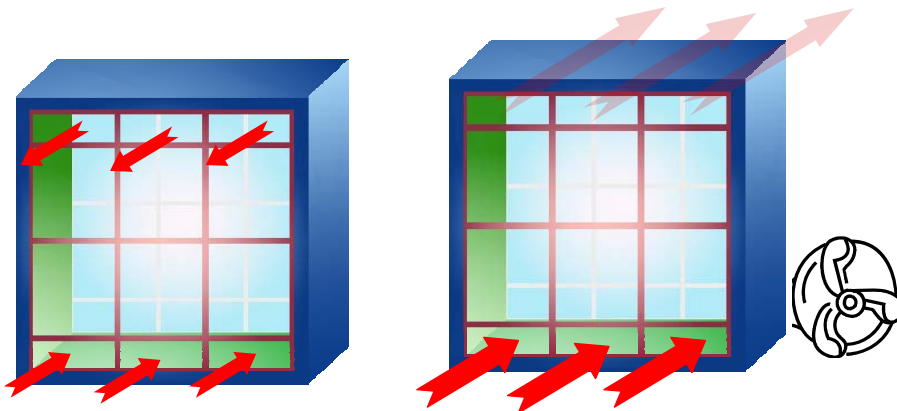
- Experimental methods for estimation of airflow in a naturally ventilated cavity
- Differences between air flow in a naturally ventilated cavity and traditionally ventilated domain
- Velocity profile method
- Tracer gas method
- Pressure difference method

# Outdoor test facility 'The Cube'



- Open flat country
- Windows facing South
- DSF internal dimensions:
  - height 5.5m
  - width 3.6m
  - depth 0.58m

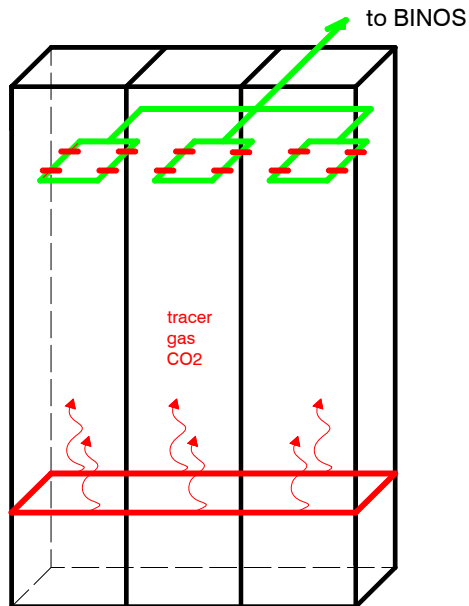
- Tested ventilation modes:
  - External air curtain
  - Preheating mode



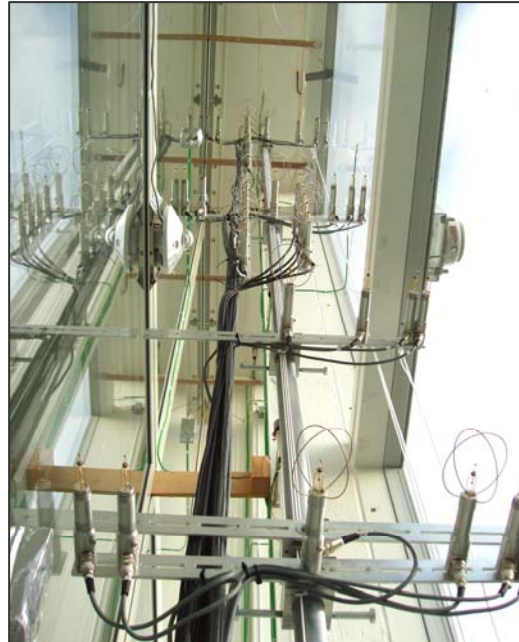
# The tracer gas method



- Constant injection of CO<sub>2</sub> tracer gas, apx. 5l/min
- 200 m<sup>3</sup> of tracer gas
- Difficulties to obtain good mixing and uniform concentration: wash-out effects and the reverse flow occurrences
- Signal delay



# The velocity profile method



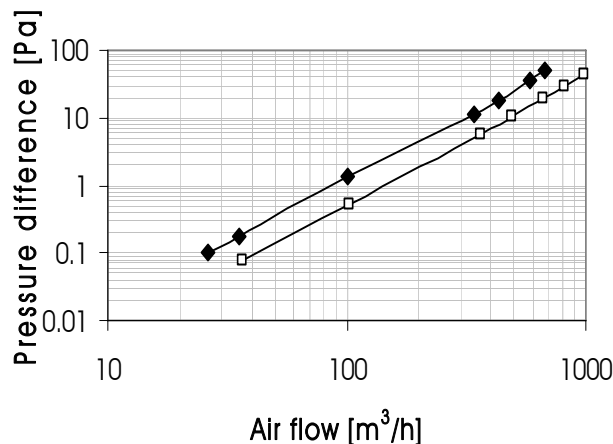
- High variations of the airflow compared to the traditionally ventilated domain
- A trade off between a number of installed anemometers and shape of the velocity profile
- Hot-spheres placed in 6 levels
- 10Hz sampling frequency
- Flow direction?
- Influence of solar radiation?



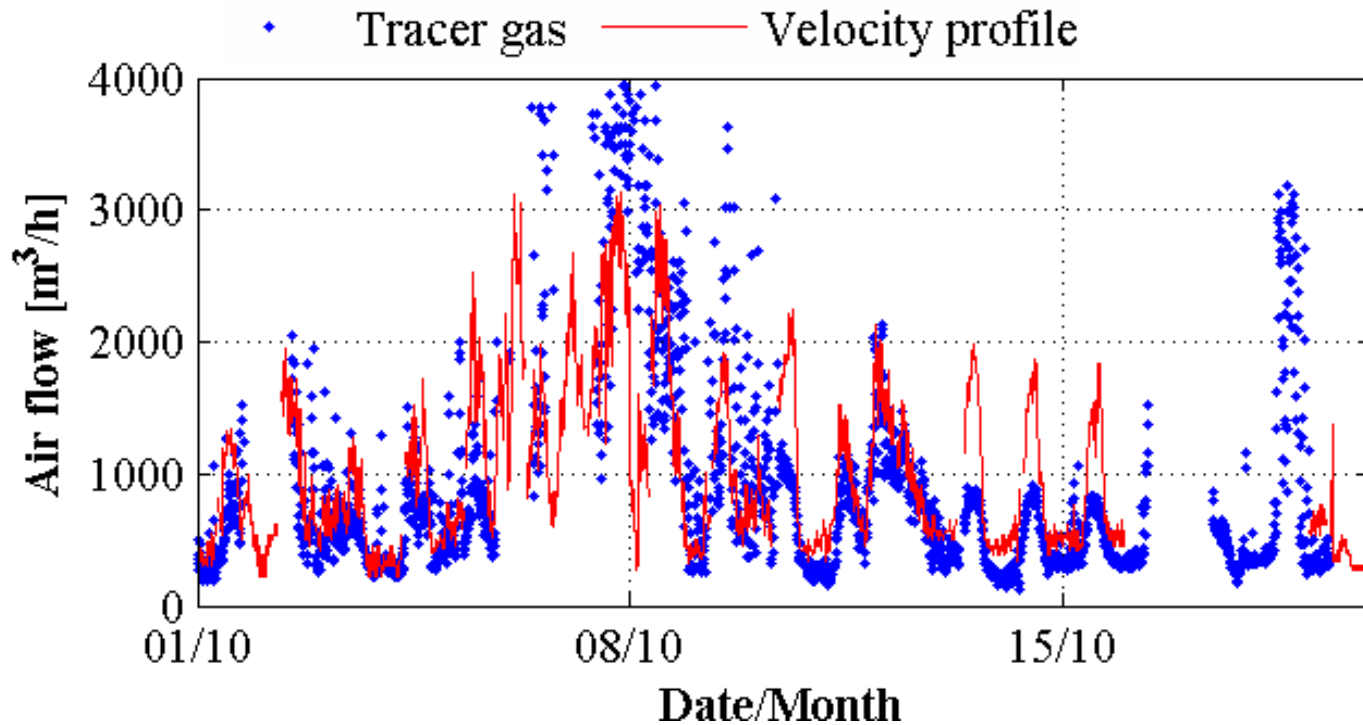
# The pressure difference method



- Stage of *opening calibration* aims to obtain a relation between the pressure difference and airflow
- Stage of *actual measurements*, where the pressure difference is measured and the airflow is calculated on the basis of laboratory obtained relation

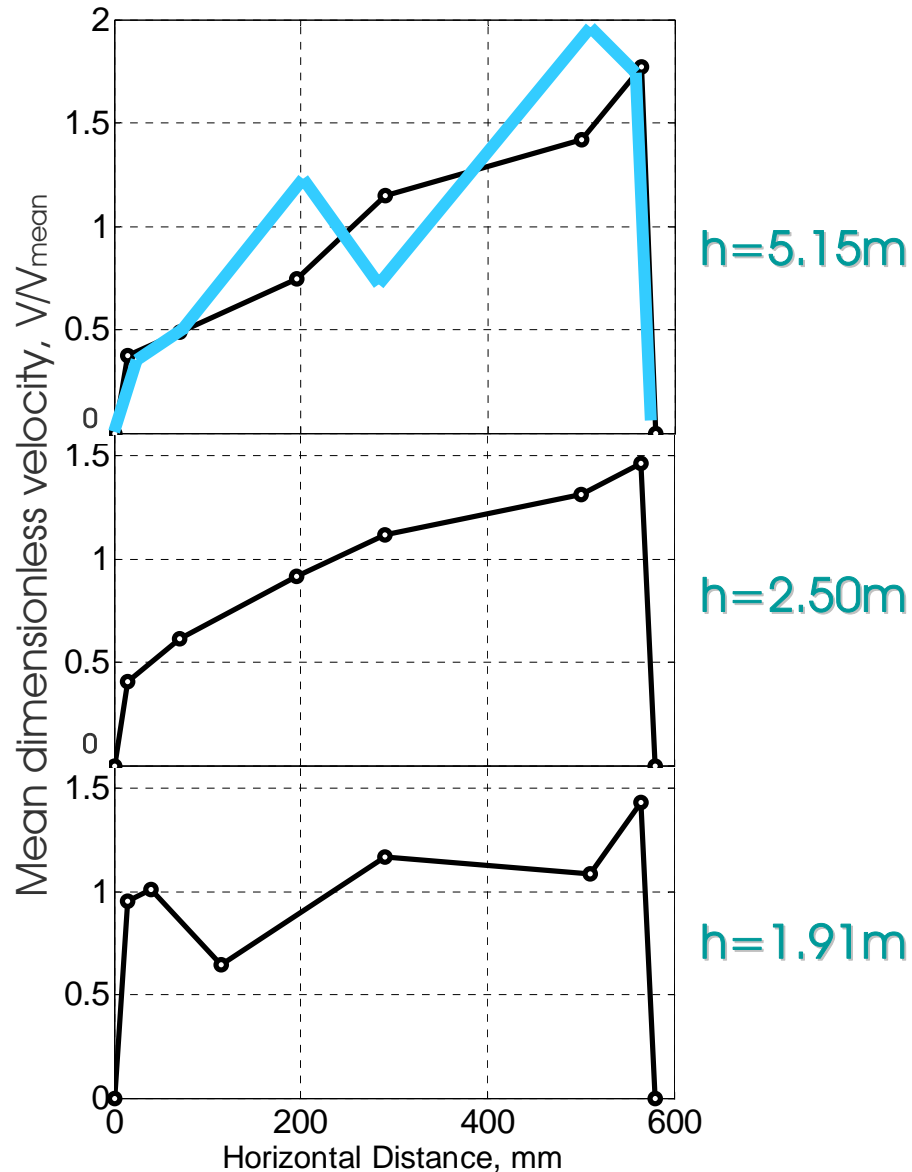


# Experimental results



Method	Air flow mean for the measurement period, $\text{m}^3/\text{h}$
Tracer gas	1011
Velocity profile	1007

# Experimental results



- Non-uniform and dynamic flow conditions
- Instant velocities in the range of 0-5m/s
- Boundary layer flow
- Two-directional flow, reverse flow



# Summary

- Sources of errors and uncertainties in the performed air flow estimations
  - Assumption of good mixing
  - Assumption of equal flow conditions in all 3 sections
  - Assumption of the laboratory flow conditions around the test facility
  - Reverse flow and wash-out effects, periods with the great dilution of the tracer gas, signal delay
  - Approximations in shape of the velocity profile
  - etc.
- No detection of the reverse flow
- No flow visualization

All presented methods have sources of error and compared to laboratory conditions have relatively large uncertainties. Although they provided a reasonable correspondence of the results