Quantifying the Performance of Natural Ventilation Windcatchers

Indoor Environment Quality in UK School Classrooms Ventilated By Natural Ventilation Windcatchers

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Talk Outline

- The EngD
- The Research Subject
- Research aim
- Research objectives
- Results: IEQ in classrooms
The Engineering Doctorate

- Conceived in response to industry and government concerns that a PhD did not prepare students for careers in industry
- In industry, for industry
- 4 year research degree
- Run jointly by Brunel and Surry Universities
- Theme of “Environmental Technologies”
- Sponsored by the EPSRC and Monodraught Ltd.
The Windcatcher

- Manufactured by Monodraught Ltd.
- Over 5500 Windcatchers installed in the UK
- Majority (70%) are used to ventilate school classrooms
The Windcatcher

- Fresh air in
- Stale air out
- Control dampers
- Ceiling diffuser

Monodraught
Research Aim

Quantify the performance of Monodraught Windcatchers used to ventilate UK school classrooms to ensure that future Windcatcher ventilation strategies provide sufficient ventilation to them.
Research Objectives

1. Quantify and understand the performance of a Windcatcher
   - Determine ventilation rates through a Windcatcher
   - Theoretically
   - Empirically

2. Develop a model to accurately predict flow rate through a Windcatcher system

3. Measure key performance in a number of case-study classrooms in UK schools
   - Temperature, relative humidity, CO₂, ventilation rate, sound pressure level.

4. Compare the measured and predicted data
   - Prove the model functions as a design tool
   - Improve ventilation rates in schools
The Schools

1. Seven Schools (designed and built after 2003)
2. Twenty four classrooms
3. Self contained rooms with a door
4. Most had manually opening windows (6 schools, 20 classrooms)
5. All ventilated by a single roof mounted Windcatcher free from
   a. Obvious shielding
   b. Obstacles
   c. Architectural features at roof level
6. Temperature controlled Windcatcher ventilation
   a. winter opening begins at 22°C (December to end of March)
   b. summer opening begins at 16°C (May to end of August`)
   c. During summer, dampers fully open at midnight for night cooling
7. No supplementary mechanical ventilation
The Schools
Results
Results

1. Data for weekday occupied hours (0900-1530hrs) only
2. IAQ measured for 1 week during summer and winter seasons
3. Max, min, mean average, standard deviation (where appropriate)
4. Compared against relevant standards
Results: Relative Humidity

Summer

Winter
Results: Internal Air Temperature

Summer

Winter
Results: Internal Air Temperature

![Graph showing internal air temperature results](image-url)
Results: Damper position

![Bar chart showing damper position frequency in summer and winter](chart.png)
Results: Night Cooling

7-fold increase in the rate of cooling after midnight

4-fold increase in the rate of cooling after midnight
Carbon dioxide measured in school classrooms ventilated by a Windcatcher

Summer

Winter
Carbon Dioxide Context

- Mean internal CO₂ concentration
- Occupied hours only
- Database of 1187 classrooms
- 287 NV
- 900 MV

Carbon Dioxide Context

- Mean internal CO$_2$ concentration
- Occupied hours only
- Database of 1187 classrooms
- 287 NV
- 900 MV

Carbon Dioxide Context: Winter

Mean CO$_2$ concentration of 1350ppm lower than:
• 58% of NV classrooms
• 22% MV classrooms
Carbon Dioxide Context: Summer

Mean CO$_2$ concentration of 682ppm lower than:
- 97% of NV classrooms
- 83% MV classrooms
Noise

![Graph showing sound pressure level for different school classrooms with windcatcher dampers open and closed.]

- **Yellow** represents Windcatcher dampers open.
- **Red** represents Windcatcher dampers closed.
Summary

1. Sufficient ventilation in classrooms in summer months
2. Windcatcher dampers always open in summer months
3. Windcatcher dampers predominantly closed in winter months
4. A temperature and carbon dioxide control strategy could improve IAQ in winter months
5. Evidence of night cooling attributable to Windcatcher
6. Measurements of ambient noise suggest conformity to BB93
Thanks for listening!