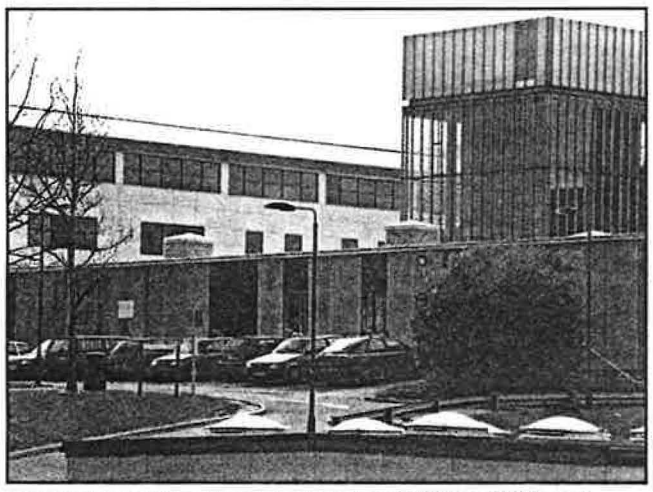
Testing out a natural remedy

Can natural-ventilation techniques really cope with the demands of hot summer days? That is the question that Monodraught's Terry Payne was seeking the answer to when he invited a BRE team to monitor an installation at the University of Hertfordshire.

Just how good is natural ventilation at helping to reduce uncomfortably high temperatures caused by internal heat gains from people, equipment, lighting and the effect of sunlight falling on the roof and façade of a building? It is equally easy to find enthusiastic exponents of the approach as well as more conservative people who prefer the more readily quantifiable solution of air conditioning to reduce internal temperatures.



Overnight cooling using the natural-ventilation abilities of Monodraught's Windcatchers at the University of Hertfordshire reduced the internal temperature of two lecture theatres by several degrees centigrade.

Tests

One of the major players in the business of natural ventilation is Monodraught, with its Windcatcher system. Indeed, it was as recently as our July issue that we ran a story about the installation of four Windcatchers to relieve overheating in two lecture theatres at the University of Hertfordhire. Since then, the installation has been subjected to tests by a team from the Building Research Establishment at nearby Garston.

Those tests were carried out over a period of four days in the middle of August and coincided with a period of very high temperatures — ranging up to 29.5°C. Unlike other Windcatcher systems that serve new buildings with design input from imaginative and adventurous architects and consulting engineers, the four units at the University of Hertfordshire were installed to remedy a history of severe overheating as an alternative approach to the prospects of incurring the high cost of air-conditioning or roof-top air-handling plant.

Monodraught's managing director Terry Payne tells us, 'I was concerned that at a BRE conference on natural ventilation that I attended the discussion was on prototype systems. I therefore arranged with BRE to look at the project at the University of Hertfordshire, less than 10 miles away. We were fortunate that the summer's generally indifferent weather improved tremendously, enabling the full potential capability of our Windcatcher system to be thoroughly evaluated.'

The area investigated had previously been used as the central computer rooms housing the university's main-frame computers. After the space had been converted into two lecture theatres with capacities of 120 and 140 people, it was soon discovered that the original air-conditioning system was far too powerful and noisy, and it was not possible to obtain sufficient turndown to achieve the required level of cooling. The floor grilles that are characteristic of such computer rooms represented a safety hazard and had to be covered, leaving the lecture theatres with no means of cooling, except a small outside door, there being no opening windows.

Improvement

It was the assistant mechanical engineer with the University, Adrian Harrington, who made the decision to install two 1 m-square Windcatchers in each lecture theatre following severe overheating during five consecutive summers. They were commissioned in mid June and are said to have quickly impressed both lecturers and students with the improvement they achieved.

The tests were carried out by BRE senior scientist Brian Webb and involved visual and non-visual measurements.

The visual measurements involved releasing a smoke trace at four positions at ceiling level. Smoke was released close to each of the four segments of the Windcatcher units to reveal the patterns of air movement, and a video recording was taken.

The non-visual measurements involved ascertaining ventilation rates using sulphur hexafluoride as a tracer gas. Tests were carried out with dampers open and closed to obtain a comparison between the background ventilation and that achieved by the Windcatchers.

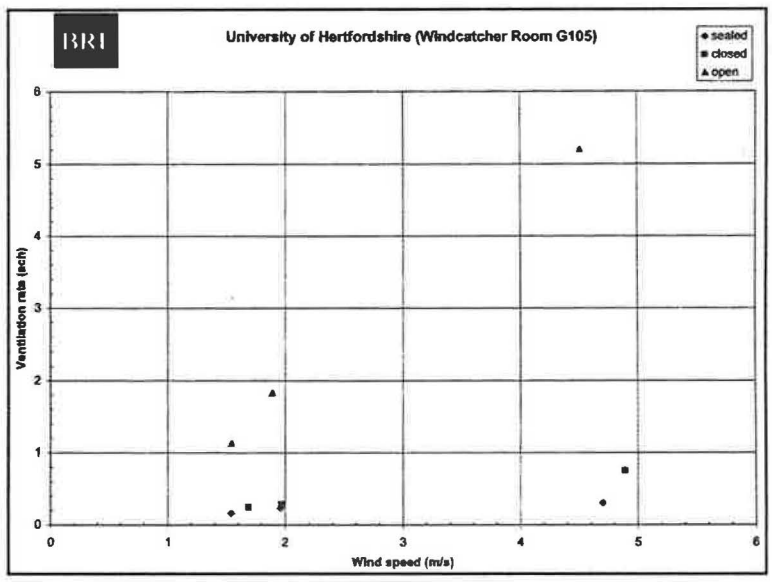
Potential

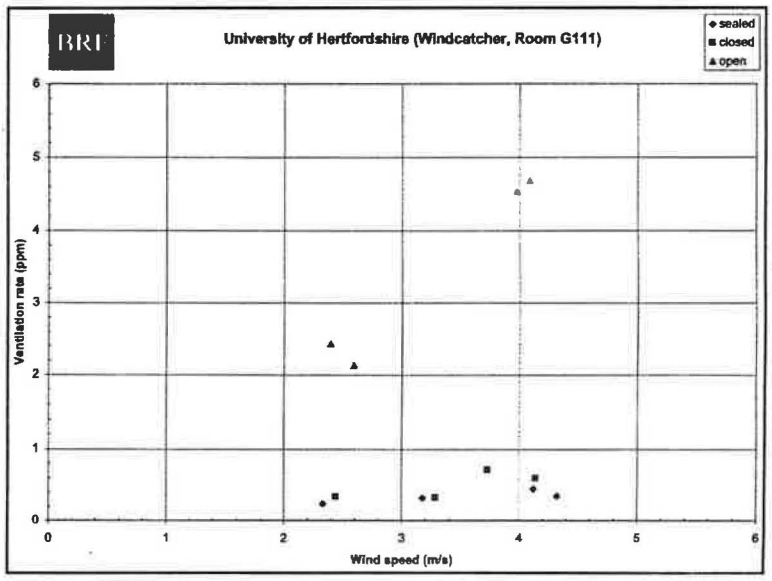
As the accompanying graphs show, the ventilation rate when the dampers were closed or sealed were low at all wind speeds — about half an air change an hour. It was when the dampers were fully open that the Windcatchers demonstrated their potential. In one lecture theatre over five air-changes an hour were achieved with a wind speed of 4.5 m/s.

"The installation has been subjected to tests by a team from the Building Research Establishment at nearby Garston"

The BRE team also looked at the ability of this natural-ventilation technique to provide free cooling overnight so as to reduce internal temperatures before the start of the following day.

The external temperature was recorded from 7 p.m. up to 9 a.m. the following morning. It fell steadily from about 20.5°C to 11.5°C at 6 a.m., after which it started to climb up to nearly 16°C.





Even during the hot spell in the middle of August windspeed alone provided sufficient driving force for Monodraught Windcatchers at the University of Hertfordshire to provide over five air changes an hour. These graphs are for two different lecture theatres and show the results of three sets of measurements: Windcatchers sealed ◆; dampers closed ■; dampers open ▲.

At the same time, the internal temperature in one lecture theatre was pulled down by 3.5 K and in the other by nearly 7 K. However, early morning sun caused the temperature in the latter theatre to climb by about 1.5 K after 7.30 a.m. — suggesting, perhaps, that 'night' cooling should be turned off shortly after sunrise.

It is during such periods of hot weather that the need for mechanical ventilation to help curb internal temperature rises is usually needed. However, as Brian Webb of BRE points out, the low temperature differential between inside and outside means that, on this particular site, there is very little stack effect, and windspeed was the main driving force. If the performance of a Windcatcher installation is adequate under such extreme summer conditions, the internal damper mechanism can provide the control required for the rest of the year.

The University of Hertfordshire has two Windcatchers in each lecture theatre. Each unit is 1 m square, and their installation merely involved penetrating the flat roof of each theatre.

Natural concepts

Whatever the wind direction, a constant flow of fresh air is provided into the building. This is achieved using two natural engineering concepts. Prevailing winds are encapsulated from any direction and directed down through the unit into the room below. A Windcatcher is divided into four quadrants, each of which can supply air or provide a means of extract, depending on wind direction.

The units are integrated into the university's building-management system. Intelligent, temperature-controlled modulating actuators automatically set the damper position to maintain optimum ventilation. A summer/winter switch provides night time cooling only during the summer months. At other times of the year, the dampers can be set to provide trickle ventilation and avoid cold draughts. Windcatchers can continue to operate when the rooms are not in use without requiring any energy to drive them, so these lecture theatres can remain fully ventilated, even during long holidays to keep the internal environment fresh and clean.

The University of Hertfordshire runs a building-services course, so it is a safe bet that students will have the opportunity to examine the abilities of natural ventilation for themselves.

Terry Payne is particularly pleased with the success of this project and the independent tests. He says. 'It is during the critical months and days of July and August that much criticism has been levelled at natural ventilation systems, but we have demonstrated that the unique design of the Windcatcher ensures an adequate air-change rate throughout the summer, not only providing a positive cooling effect but also introducing fresh, clean air which has previously been so lacking in these lecture rooms. We have now completed over 30 major contracts of Windcatcher systems.'

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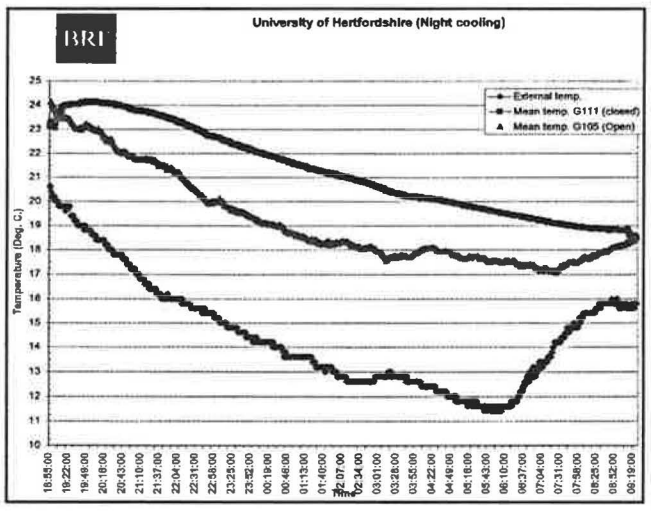

The effectiveness of Monodraught's Windcatchers in providing overnight cooling is shown by this comparison of the two lecture theatres. Top line is Windcatchers closed, centre is open units and bottom is external temperature.