A BSRIA Guide

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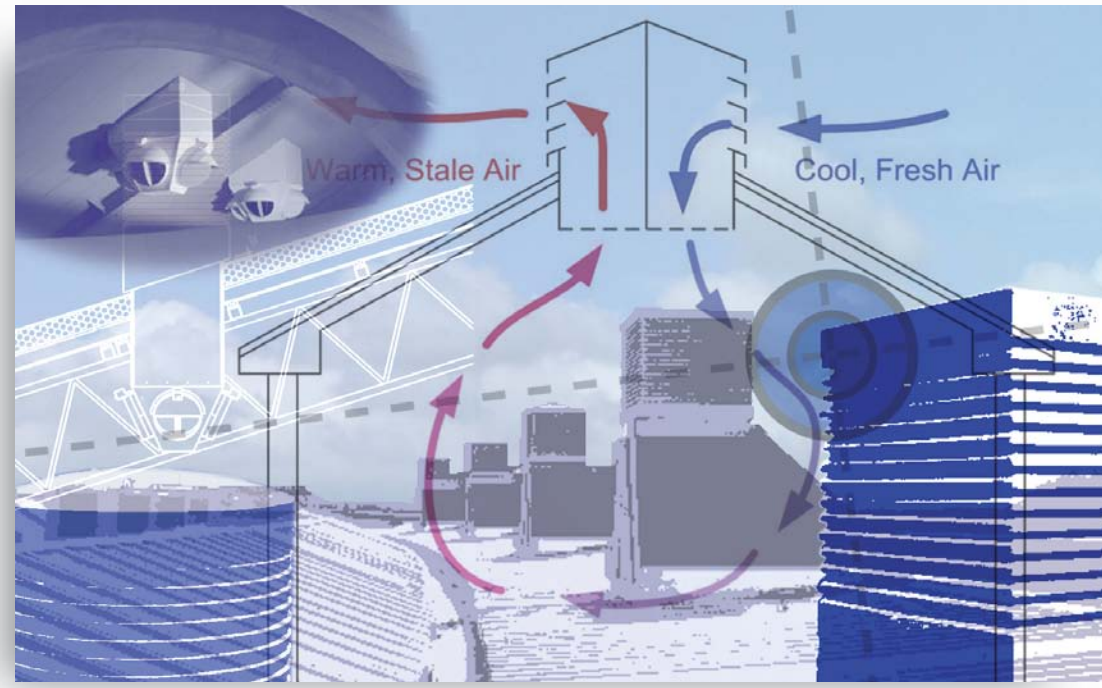
Wind-Driven Natural Ventilation Systems



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1.1 DESIGN CONSIDERATIONS

Roof-mounted natural ventilation offers a way of improving comfort conditions while reducing building carbon emissions. Applied correctly, natural ventilation will deliver good comfort conditions at low levels of energy consumption.

Buildings that are particularly suited to roof-mounted natural ventilation include educational buildings, health centres and libraries - the kind of buildings where air conditioning is not always practical or affordable. However, to realise all the environmental benefits, designers and clients need to appreciate the factors affecting the performance of these systems, as discussed in this publication.

Initial design issues

When natural ventilation is being considered during the early design stages, all aspects of the system - and its future operation - must be carefully assessed, and appropriate design information provided to ensure that the system can be specified correctly. As is the case with any design.

The roof-mounted ventilators described and analysed in this guide are characterised by having a combined supply and extract system. In this respect the ventilators may appear to be off the shelf – ostensibly fit-and-forget items very similar to other turnkey products that arrive on site in a sealed box, but they are not. In reality, roof-mounted ventilators - like most other building systems - depend on integrated design, professional installation and good management in operation to deliver good comfort conditions.

A review of a building and its uses should be carried out before natural ventilation is seriously considered as an option. This should not only consider key aspects such as suitable locations for ventilators, but also ask more searching questions about the building's operation and its future use. This should include analysis of how the building's use could change in the short to medium term.

Where possible the building's ability to cater for expansion of the natural ventilation system should also be studied, particularly if internal heat gains – from computers for example – are likely to increase. The variables most likely to compromise the performance of a natural ventilation system must be thoroughly explored.

Other key considerations for designers are alternative sources of ventilation and cooling. Designers need to assess the thermal performance of the building and the likely efficiency of the building's heating system–irrespective of whether it is new or existing. Heat gains should also be reduced by use of natural lighting and similarly uncomplicated energy efficiency practices. This will help reduce the building's cooling demands and make natural ventilation a more viable option compared with powered systems, such as air-conditioning.

Extra ventilation capacity, such as openable windows, can assist roof-mounted natural ventilation to deliver the required comfort conditions during the summer months when the system will be working near its peak. These openable elements in the fabric should generate cross-ventilation where possible. This will create a greater ventilation rate and thereby the more effective removal of hot, inside air.

1.2 SUCCESS FACTORS

Engineering

Only when the simpler technologies have been explored should designers consider reaching for more complex technologies to support natural ventilation. For example, technologies such as solar heating, automated controls and heat recovery can help reduce energy consumption even further.

While renewable forms of energy can offset the slight increase in heating required with natural ventilation, often at a low or zero carbon penalty, designers still need to think long and hard before regarding any wastage from a low energy system as being acceptable: the system may fall into disuse long before the building.

During the heating season and the mid-seasons, it is important to get an acceptable balance between indoor air quality and efficient heating. When left open inappropriately, ventilators of all kinds will let heat escape. On the other hand, ventilators that default to a closed position when they should be modulating will create a building that is hot and stuffy. Ventilation controls that are effective and easy for occupants to use will improve the risk of unnecessary heat loss and help maintain good indoor air quality.

It must be remembered that the internal layout of the space being ventilated will influence the effectiveness of the ventilators. High cabinets or desk dividers can disrupt the flow of air through the space. To allow free air movement, cabinets should be kept away from diffusion grilles and preferably located along walls.

Clients and designers need to understand the position of sedentary occupants in relation to the diffusion grilles of roof-mounted ventilators. People doing light office work and positioned for long periods beneath diffusion grilles may find airflows uncomfortable at least some of the time, an issue that emerged during the site visits undertaken during the research for this guide. The resulting discomfort must be alleviated quickly if occupants are to keep faith with the system.

Human

Research has shown that an otherwise technically capable ventilation system can get the thumbs-down from occupants. This is confusing for clients and designers alike, as a system may have been properly sized, it may have been well installed, and it may have technically good controls. In such instances, the root cause of occupant dissatisfaction may be more to do with human behaviour, and the relationship of individuals with innovative technology, than with any technical shortcoming.

Controls are often a pinch-point. Obvious problems are switches that are hidden or controls just out of reach. However, less obvious things can rapidly bring an entire ventilation system into disrepute, such as switches that are not labelled, or controls that are not visibly connected to anything.

Perception of poor performance will be as damaging as any technical glitch. Clients and designers need to appreciate these risks and design systems that users will find easy to use and understand. Best practice can be to allow a small amount of occupier control such as a manual override, but with the majority of the control being carried out automatically for optimum ventilation and cooling.

However, despite the virtues of manual control, designers should be wary of advancing arguments such as "the users will have to be trained to use the building". Occupants can indeed be trained, but that knowledge can rapidly diminish, particularly in buildings with a high turnover of occupants, such as in schools.

The answer is to design ventilation to be inherently robust. A system that puzzles the occupants or is difficult to use will prove fragile in operation, particularly when the occupants may be disinterested, the facilities management is lacking, or a change of use or expansion of the building begins to stretch the capacity of the ventilation system.

Despite its benefits, natural ventilation cannot be precisely controlled. In many buildings, coarse control will not pose a problem. In applications that require a stable environment, such as computer server rooms, natural ventilation is not a practical proposition.

Careful consideration of the factors regarding indoor air quality and temperature control should reduce the likelihood of some or all of the problems described above from occurring. With the right approach to design, roof-mounted natural ventilation systems can provide a very effective means of providing ventilation.

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Monodraught GRP 1000 mm square Windcatcher

EXAMPLE 1

Bisham School

Figure 28: Bisham school.

(Courtesy of Monodraught)

Project details

Location	Bisham, Buckinghamshire
Client	Bisham School Governors
Architect	Hook Whitehead Associates
Project type	New build (extension)
Building use	Education
Date building constructed	April 2001
Number of floors	1
Ventilator manufacturer	Monodraught Ltd
Ventilator model	GRP 800 mm square Windcatcher
Number of ventilators	2
Areas ventilated	Main assembly/sports hall
Date of installation	April 2001
Roof type	Tiled sloping roof with conventional hipped end-ridges
Position on roof	Near end-ridges
Occupancy	Up to 150 people
Floor area	140 m²
Floor to ceiling height	4 m
Volume to be ventilated	567 m³
Estimated heat gains	11·3 kW
Required ventilation rate	1·3 m³/s

Bisham School

Building and surroundings

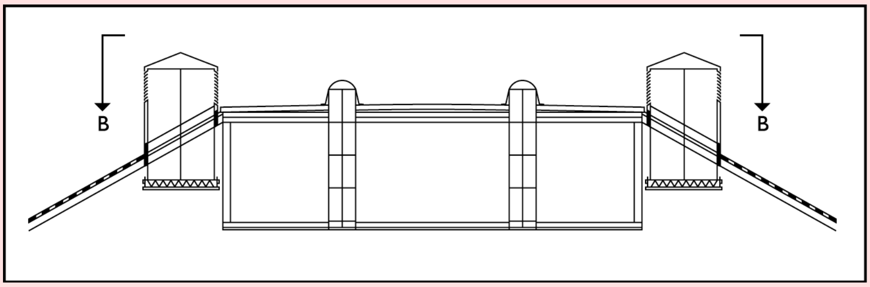
Bisham School in Buckinghamshire is one of the oldest schools in the UK, with its original buildings dating back to the 1700s. These were extended three times during the 1800s, and more recently in 1967. The most recent development occurred in 2001 with the building of a new school hall. This hall, used for assemblies and sports, included the installation of two Monodraught Windcatchers.

The school is relatively exposed, as it is surrounded by fields on three sides with the river on the fourth.

Installation

The two Windcatcher ventilators were installed on the roof of the school hall as shown in the figure below. Internally, the egg crate grille of the ventilator is mounted in a recessed area and higher than the lowest part of the ceiling.

Figure 29: A section through the roof of Bisham School showing the Monodraught Windcatcher installations



(Courtesy of Monodraught)

Ventilation control strategy

The ventilation is controlled by an electrically-operated wall-mounted positioner, which operates the volume control dampers. This is a manual control system where the users alter the percentage of damper opening by twisting the dial to the desired position. The controls are set to open the dampers to between 20-25% in the heating season to give a supply of fresh air to the hall.

Occupiers comments

The following comment obtained by BSRIA on the performance on the natural ventilation system in hot weather was provided by one occupier: “The units have been very useful during the hot summer this year. It was noticeably fresher and cooler in the hall during this time.” Another comment was made on the performance during cold weather: “Works well – in winter we usually leave the vents at about 20 – 25% to give some fresh air.” Another person commented: “The motors are quiet. We feel it works well in this environment.”