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# ENERGY-EFFICIENT BUILDING SYSTEMS

**Energy-efficient plant is only part of the plan to reduce carbon emissions by 20% by 2010 and by 60% by 2050. The systems in buildings that provide heating, cooling, lighting etc. must be designed to serve their purpose efficiently — and kept that way.**

# The energy-efficient approach to delivering comfort cooling

Chilled ceiling and beams deliver comfort cooling with 60 to 70% lower energy use than other systems, which is why **John Staunton** argues that this water-based approach cannot be ignored.

According to a 2001 policy brief on air conditioning by DEFRA, the energy consumption and associated carbon emissions resulting from air conditioning in the UK represented around 5% of the total carbon emissions from non-domestic buildings. However, there is still a substantial projected growth in air conditioning use, so it has a significant role to play in reducing a building's energy consumption.

## Energy consumption

Oversized plant and operation outside occupancy hours have a substantial impact on energy use and must be addressed, as does the inherent efficiency of the systems themselves. Comparing the peak power consumptions of different air-conditioning systems gives results from 50 to 70 W/m² for all-air, DX, VRF and fan-coil systems down to about 20 W/m² for chilled ceilings and chilled beams.

With today's pressures to reduce carbon emissions and energy usage, meeting amendments to the Building Regulations and achieving high building energy ratings, it is unsurprising that chilled ceilings and beams are emerging as a popular and energy efficient way to provide cooling.

Chilled ceilings and beams use chilled water to remove heat from the air in the space to be cooled. The water supply temperature can be as high as 14 to 17°C, which allows the use of cold water storage or free cooling from outside air for most of the year. As a result a much better energy performance is possible compared with systems requiring chilled water at a lower temperature. While not appropriate for every building, there is no reason why this technology cannot be applied to most new and refurbished office developments — as well as within other environments such as schools, universities, airports, hospitals and libraries.

Whether chilled ceilings or beams are chosen, such water-based systems are also very attractive in light of recent controversies over the aggressive effects of modern synthetic refrigerants used in air conditioning and the threat of Legionnaires' Disease. Greater occupant comfort is also achieved as they generate minimal air movement and avoid the obtrusive noise generated by mechanical

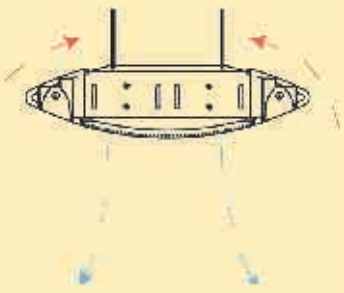

Fig. 1: Passive chilled beams rely on natural convection to cool room air and do not provide any fresh air.

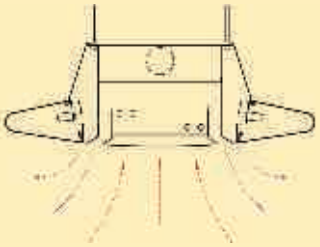

Fig. 2: By inducing room air and cooling it, the cooling capacity of active chilled beams is considerably higher than can be provided by cooled fresh air alone.

Integrated service modules from SAS are space saving and deliver air-conditioning more efficiently than fan-coil systems. This installation is at Imperial College in London.

alternatives. Chilled ceilings and beams also offer significant reductions in whole-life costs due to reduced maintenance requirements, bought about by fewer moving parts, and lower running costs.

## Thermal mass

Chilled beams offer the added benefit of opening up the concrete soffit so the thermal mass of the building can be exploited for cooling — a natural process that has a cooling potential of up to 25 W/m$^2$ according to the Concrete Centre. Beams, often specified as a design feature and enclosed in a metal casing, also offer all the fixed production, delivery and installation times you would expect from a prefabricated module — greatly reducing the risk of project overrun.

Chilled beams can be either 'active' and incorporate fresh air ventilation, or 'passive', which must be used in conjunction with separate air distribution systems, as with chilled ceilings. The decision on which to choose should be centred around the specific requirements of the building. The cooling load, minimum fresh-air volume and level of control required are key factors to consider, as is the water-supply system and the spacing of the units.

## Fresh air

The minimum level of fresh air per person recommended by CIBSE is 10 litres per second. This air will need to be delivered either by the active beam or an alternative air distribution system. However, you also need to ensure that as well as providing adequate ventilation, the air flow is sufficient to achieve the cooling required within the space. The most efficient system for the job will be the one that achieves the level of cooling required with the lowest volume of fresh air.

**"Chilled beams offer the added benefit of opening up the concrete soffit so the thermal mass of the building can be exploited for cooling — a natural process that has a cooling potential of up to 25 W/m²"**

Chilled ceilings use a combination of radiation and convection to achieve room cooling, while passive beams rely entirely on natural convection (Fig. 1). These systems are therefore sensitive to the location of the fresh-air supply and any heat sources, as well as any resistance to air flow. For this reason you may choose to install passive chilled beams at the perimeter of a building with a large percentage of glazing, as the thermal convection produced during the summer can enhance the cooling capacity of the beam, and a chilled ceiling throughout the rest of the building, where the cooling loads are lower.

## Induction

Active beams provide more control, as the induction of room air through the beam is managed by the flow of the fresh air supply (Fig. 2). Inducing more room air through the beam increases its cooling capacity. The induction ratio of a beam is the ratio of room air drawn through it to volume of fresh air introduced. A high induction ratio is often desirable but is not always required and should be determined by the requirements of the space. SAS active chilled beams can produce induction ratios up to 4:1.

Active chilled beams can achieve cooling outputs of up to 500 W per linear meter, passive beams can achieve cooling outputs of up to 300 W linear meter, and chilled ceilings can produce cooling outputs of 65 to 75 W/m$^2$.

This innovative approach to cooling cannot be ignored, especially as energy prices continue to rise.

MBS

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*[SAS International designs and makes chilled ceilings and both active and passive chilled beams. The performance of active chilled beams is independently tested by Krantz Products. SAS understands the importance of co-ordination between the architect and service engineer to ensure the correct balance between aesthetics and performance is achieved. www.sasint.co.uk]*