Chilled beams provide an alternative approach to cooling

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The long-promised, non-domestic Energy Performance Certificate (EPC) deadline has finally arrived. Now, non-dwellings over 10,000 sq m put on the market for sale or rent will now need an EPC assessment. By the end of 2008, it will be a legal requirement for all commercial buildings to have an EPC when they are built, sold or let. This, coupled with the amendments to Part L of the Building Regulations i.e., the requirement for a 28% reduction in CO_2 emissions for mechanically-cooled, non-domestic structures, is inevitably driving many changes in the market.

The application of high temperature water-based cooling systems are helping meet the challenge of balancing the requirements of regulations such as these with performance for occupant comfort.

Chilled beams and Integrated Service Modules (ISMs), also known as multi-service chilled beams, provide a quiet, energy –efficient and comfortable alternative to traditional cooling methods. The fact that they can be pre-fabricated off-site is another contributor to their growing popularity.

BSRIA reported last year that the market for chilled ceilings and beams has significantly in the last two years with further strong growth predicted for this year and next.

Utilising closed-circuit water-based systems as the heat transfer method, chilled beams feature a copper cooling element at its core. Aluminium heat-transfer fins are bonded to this element, thus increasing its surface area and cooling potential.

Suspended directly from the soffit, a beam is then either covered in stand-alone metal casing or installed above a suspended metal ceiling system that incorporates a large, open area for the air to pass through.

With operating temperatures of 14-17°C, chilled beams can use higher chilled water flow temperatures than other cooling systems. Thus, for large parts of the year this means that water at outdoor temperatures, evaporatively-cooled water or ground-sourced water can be used. This reduces the need for active refrigeration systems and potentially the size of the central plant.

Energy consumption is not the only advantage of chilled beams. Chilled beams contain no moving parts, such as fans and filters, resulting in reduced maintenance requirements and associated costs. They are therefore more reliable and less noisy. Greater occupant comfort is also achieved as minimal air movement is generated..

Such water-based systems are also considered environmentally attractive, particularly in the light of controversies over the effects of modern synthetic refrigerants used in air conditioning.

Passive or active

Chilled beams use convection to deliver the cooling. Chilled beams can

Chilled ceiling in Kings College

be either 'passive', which are used in conjunction with a separate air distribution system or 'active', incorporating fresh air ventilation.

Passive chilled beams work using natural convection to provide cooling. As the warmed air rises in an occupied space, it is drawn into the chilled beam/cooling element and chilled, before returning downwards to provide cooling to the space below. The higher the temperature differential between the air and the water, the greater the amount of air that passes over the chilled beam. This results in a higher amount of cooling provided, which is particularly important during peak summertime temperatures.

Active beams incorporate a ducted air supply. Active beams offer a greater amount of control, as the level of induction of 'hot room air' through the beam is managed by the flow of the fresh air supply. As the air induced through the beam is cooled, this process determines its cooling capacity.

The induction ratio of a beam measures the amount of room air drawn through it in relation to the volume of fresh air introduced. While a high induction ratio is often desirable it is not always required, and the level should be determined by the requirements of the space.

Passive chilled beams produce outputs in the region of 400 watts per metre length (W/m) and active chilled beams/ISMs outputs of 500 W/m. The spacing of the chilled beams depends on the width, height and design of the unit and the particular cooling requirements. The density of the beams/ISMs in the occupied space then determines the maximum cooling output of the system.

The decision on which option 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 utilised and the spacing of the units.

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

ISMs

Chilled beams can also incorporate other building services such as fire alarms and smoke detectors, sprinkler systems, voice, data and power cabling, speakers and public address systems, passive infra-red (PIR) sensors and importantly, lighting. When all of these items are combined in an architecturally designed metal casing, they are then referred to as Integrated Service Modules (ISMs) or Multi Service Chilled Beams (MSCBs).

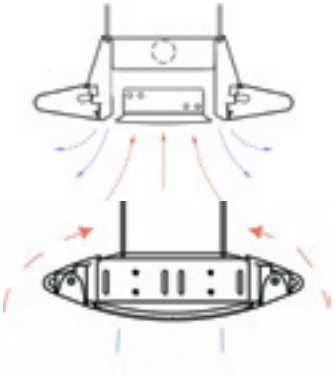
Also suspended from the soffit, common designs for ISMs involve flat, curved or faceted metal casings, and vary according to the project and building's needs.

The design plays a critical role in the performance, and mock-ups can be manufactured and independently-tested to ensure operational capabilities.

The off-site prefabrication of building services within ISMs, leads to on-site efficiencies in installation and a reduction in on-site wastage and storage requirements. In a recent BSRIA study, the installation of ISMs was considered to be 75% quicker than a traditional installation of fan coil units.

Design flexibility

Passive chilled beams and ISMs are most suitable for buildings with a sealed envelope that incorporate a fresh air distribution system. They are frequently used in conjunction with displacement ventilation systems.



Air flow around active (top) and passive (bottom) integrated service modulles

The design of active chilled beams and ISMs already incorporates fresh air distribution as part of the ducted air supply and a heating element can be incorporated into an active beam, removing the need for an additional heating system.

Chilled beams and ISMs also offer the added benefit of opening the concrete soffit up, allowing for thermal mass cooling. This is a natural process centred on the building's thermal mass, provided by exposed concrete slabs. It is increasingly being adopted as a sustainable low energy solution and works by utilising the natural properties of concrete which has a high specific heat capacity and conductivity.

This natural process has a cooling potential of up to 25W/m^2 according to the Concrete Centre. Utilisation of a building's thermal mass cooling potential can significantly reduce internal ambient temperatures.

Life cycle considerations

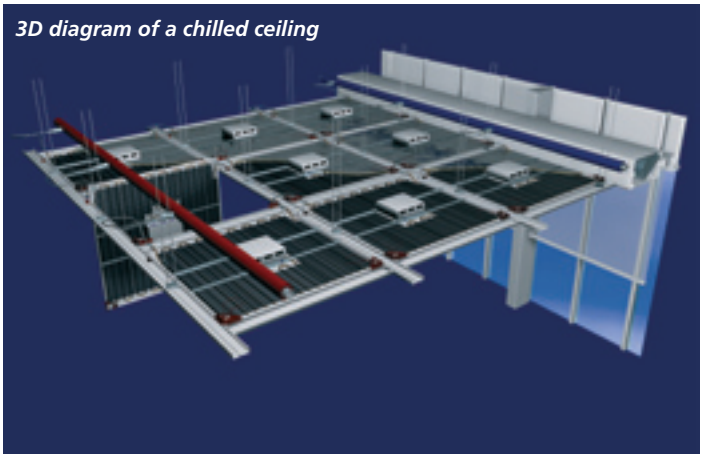
In a study by consultants Cyril Sweett (1) the whole-life costs of chilled ceilings and beams, fan-coil units, VRF and VAV systems in a new three-storey office development operating over a 25-year period were considered. It concluded that the chilled ceilings and beams option had the lowest life-cycle costs.

A solution that provides a flexible means of delivering excellent comfort control and low energy consumption, in a discreet way without the unsightly, space-demanding duct work associated with air conditioning is a highly attractive option. One that also adds to a building's 'sustainable credentials' is now increasingly demanded by end users, specifiers and architects. Passive and active chilled beams can help achieve good BREEAM, EPC and DEC ratings.

While not appropriate for every project 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.

Another application for install passive chilled beams is their installation at the perimeter of a building with a large percentage of glazing to offset solar gain. A radiant chilled ceiling could then be used to provide comfort cooling throughout the rest of the building, where the heat gains are lower. The recent refurbishment of Baskerville House in Birmingham incorporated a radiant chilled ceilings achieved a 'very good' BREEAM rating. It was also recognised by the BCO (British Council for Offices) when it won a prestigious 'refurbished / recycled workspace' region award.

Until recently, many buildings were not regarded as fully serviced unless they were air-conditioned by traditional methods. However, in today's climate where reducing carbon emissions and energy usage, meeting amendments to the building regulations and achieving good room comfort are all key considerations, it is unsurprising that alternative methods of providing such cooling within non-domestic environments are attracting the interest of the whole industry.



3D diagram of a chilled ceiling