The refurbishment of the London School of Hygiene and Tropical Medicine faced a number of challenges including restricted space

BEAMED EFFICIENCY

When a leading London college wanted to refurbish a grade-II listed site, cooling presented a major challenge because of space restrictions. But a chilled-beams solution provided the answer, writes **Paul Downie**

The London School of Hygiene and Tropical Medicine (LSHTM) is an internationally renowned postgraduate medical school; one of only a few in the world specialising in the study of public health and tropical medicine. Past discoveries have included the mode of transmission for malaria, the link between lung cancer and smoking and the treatment of sexually transmitted diseases, including HIV. Growth in student numbers has put huge pressures on the School's existing teaching and research space. Upgrading its building stock therefore became a priority. The School's main site is the Grade II-listed

SAS International

Cooling for the building is provided by chilled beams supplied by SAS International, which was part of the project team

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Keppel Street building, completed in 1929. It provides teaching and research accommodation for around 1,000 students. The development of its South Courtyard development was key to the improvement programme.

However, due to the constraints of the site and planning restrictions, there was no possibility of extending outwards or upwards. The original building can effectively be thought of as an upside-down capital A. The South Courtyard was an under-utilised open area that also housed two lecture theatres dating from 1957.

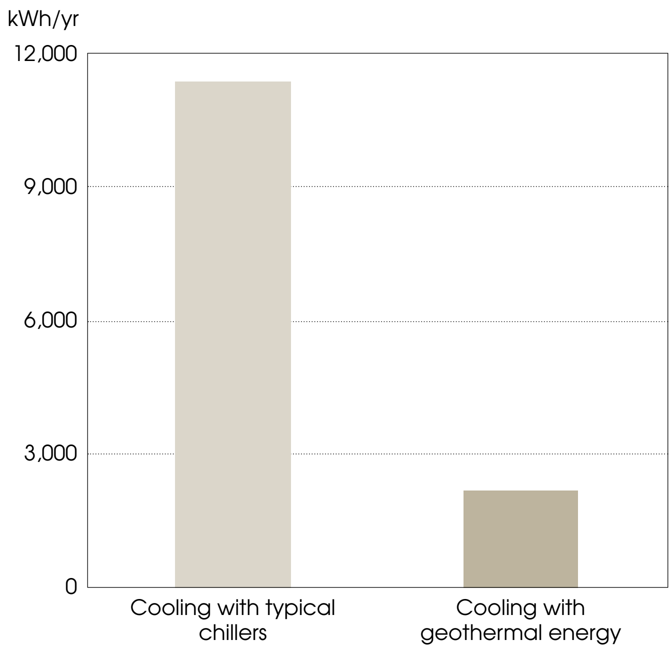
The new development rises five storeys above ground level in the former courtyard. Completed last year, the building was designed by Devereux Architects working with Downie consulting engineers. The challenge for the design team was to maintain the building's environment in a sustainable manner within the confines of an extremely restricted location. A detailed thermal building model was produced to assess the effects of the surrounding building on the new development, and vice versa. This established that significant cooling would be required to maintain comfortable conditions.

A number of primary cooling systems were considered, including traditional vapour compression refrigeration plant, but these either did not achieve the school's aspirations for sustainability or were not technically viable. 'Ground linked closed loop' systems were considered too restrictive to provide even a small percentage of the project's needs; and the limited roof space restricted the available scope for the inclusion of air source heat pumps.

With no way up and no way out, the design needed to consider an option that explored a deeper solution in the form of 'open loop heat transfer'. With a potentially abundant source of ground water at around 12C, it would be possible to cool the building efficiently using chilled beams.

Chilled beams have been in use in buildings for more than 20 years, and much is known about their reliability, very low maintenance needs, and design performance. For the refurbishment of the School, the key challenge was commissioning them in a way that would meet the client and architect's aspirations for a clean, efficient, modern, minimal aesthetic.

To achieve the required design capacity, active chilled beams (forced air movement) were employed with a catalogue design output of 140-160 W/sq m cooling output, depending on which technical data is used: most technical data relates to ideal installation scenarios and is usually produced in near-laboratory conditions. Passive units (using natural convection) will achieve up to 100 W/sq m and, if fully exposed to the space, approximately 80% convective cooling and 20% radiant cooling, as opposed to an active unit which is mainly convective. Active chilled beams will operate at an air pressure of up to 200 Pa; operating more than two units in series is not a good option due to high cumulative



Geothermal	kWh/year	$kgCO_2$/year
Cooling with typical chillers	11,350	4,800
Cooling with geothermal energy	2,200	900
Energy and CO_2 reduction	-9,150	-3,900
CO_2 reduction over baseline		-6.7%

Chilled beam comparison between open loop geothermal generator (8.9 kWe/kWth) and air cooled chiller (2.5kWe/kWth)

(Part L compliance calculations in accordance with the National Calculation Methodology, and using dynamic simulation with accredited software, IESve V6.0.2)

The 950 sq m area served by the chilled beams was modelled using commercial accredited software. When considering the yearly operational benefits of a chilled beam connected to an open loop geothermal system, compared with a chilled beam connected to a traditional air-cooled chiller with a seasonal efficiency of 2.5, the expectation for this system is clear – as shown here.

air pressure drop and the potential for noise due to higher air velocities in beams closest to the main distribution.

The planning required for incorporating chilled beams into a building design should not be underestimated, particularly when, as in this case, they are being used in conjunction with an exposed soffit; interconnecting pipework and ductwork are fully exposed and the units themselves will shield some of the beneficial thermal mass from the occupants below. Additionally the height – usually a minimum of 2.7 metres from the floor – and the relationship to occupants needs consideration in terms of maintaining appropriate comfort, and, of reducing the potential for close exposure to low temperatures above occupants heads.

Relative to a distributed system such as fan coils, the maintenance of a chilled beam system is less as it has fewer filters. However, water flow rates are usually low, which can result in dirt particles gravitating out and depositing in water coils, so the use of filters or particle separation with appropriate maintenance and flushing is essential.

Chilled beams can typically operate at a chilled water flow temperature of 15C, which in itself can achieve significant energy savings over a traditional system that requires refrigeration to supply water temperatures below 10C; but when connected to the open loop geothermal system, with a generator efficiency of 8.9 kWe/kWth, the benefits in terms of reduced CO2 emissions have been modelled as significant.

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The geothermal cooling system is 'demand-led' being controlled directly by measured occupancy levels. The floor templates are zoned into 14 occupied areas, six of which are cellularised offices and the remaining eight are open-plan spaces. Each zone is capable of independently controlling temperature and air flow through variable volume dampers and a two port valve cassette system. Occupant sensing is achieved through passive infra red sensors located throughout floor templates, which monitor occupancy levels and report, via a building management system, to variable volume secondary pumps. These react by increasing or reducing air and water volumes as required – thus optimising the energy consumed by the pump.

Photovoltaic cells incorporated into glazed modules act as solar shades to minimize solar gain to the building whilst generating electricity. Each module was specifically designed to create a glazed atrium forming the roof, spanning the existing and new building.

The technology was completed in 2010 as part of the two-year refurbishment project, and is in the process of having the monitoring system re-commissioned. Some initial test data is available, but further system commissioning is currently in process and further data will be made available during the operational period of the building. **CJ**

● **PAUL DOWNIE** is founder of Downie Consulting Engineers **www.downieconsult.com**