

<b>Project:</b>	<i>Breathing Space, Rotherham</i>
<b>Client:</b>	<i>Rotherham Primary Care Trust; Coalfields Regeneration Trust</i>
<b>Design Development Team:</b>	<i>Rotherham MBC Asset Management Service</i>
<b>Architect:</b>	<i>Howard Buckley</i>
<b>Structural Engineers:</b>	<i>Graham Lane, Mike Gibbons, Brian Lawrence</i>
<b>Natural Ventilation and Cooling:</b>	<i>BP Institute for Multi-Phase Flow at the University of Cambridge</i>

## **Background**

Designed literally to bring in a breath of fresh air to sufferers of COPD, Rotherham's new Breathing Space building combines modern architectural design with sustainable and healthy construction features. Central to the scheme is an atrium which is both naturally cooled and ventilated using the thermal mass of the building's undercroft. Breathing Space is located on a brown field site owned by the Rotherham Primary Care Trust (PCT), close to the centre of Rotherham.



Photo: Courtesy of Rotherham Metropolitan Borough Council

## **Architectural Design**

The main building comprises a three storey block containing the central atrium space with consultation and staff areas at ground floor and associated bedroom spaces and ancillary accommodation surrounding the atrium at first and second floor. There is a smaller single storey block to the front which contains the main entrance, reception and meeting rooms, kitchen, restaurant, toilets and a gym. The building occupies an overall footprint of around 1650m<sup>2</sup>. Externally, there is a landscaped garden with paths leading to sensory gardens, car parks and delivery areas.

The fusion of expert consultants for the architecture and design team has been reflected in the eclectic use of materials for construction including timber, unfired clay, lime plaster and concrete, with all these supported by steel at the heart of the building.

*Information compiled by the Steel Construction Institute*





Photo: Courtesy of Rotherham Metropolitan Borough Council

The structural steel frame supports 'Omnia' precast concrete flooring and atrium roof arches which were fabricated off site by Constructional Timber of Barnsley. There are five glulam frames linked by softwood purlins to create four birch faced ply shell roofs with integral north lights. The latter have opening sashes which operate via the building's computer management system to ventilate and cool the building. The roof is covered by a single ply Sarna membrane throughout. Sarna was used for its breathable qualities and its ability to be formed around the complex shape of the timber shell roofs.

A steel frame was chosen for speed of construction and for its ability to easily integrate with structural elements, for example the glulam roof and external walling. The steel structure provides straight-forward structural connections between these elements.

### **Environmental Design**

The design incorporates a number of sustainable principles and technologies:

- Natural ventilation and cooling
- Geothermal heating
- Solar hot water
- Breathable walls
- Minimal use of Volatile Organic Compounds (VOCs).

As the design team were new to some of these concepts, help was brought in from the University of Cambridge BP Institute for Multiphase Flow, which specialises in natural ventilation and natural cooling systems, and from Gaia Architects, who specialise in sustainable building construction and who also gave advice on the selection of materials.



Photo: Courtesy of Rotherham Metropolitan Borough Council

## **Natural Ventilation**

The focal point of the Breathing Space building is a central atrium which rises up through two stories and has four timber framed window pods on the roof. These are north facing in order to minimise solar gain, allow natural light into the space and to assist in the ventilation strategy. The atrium is ventilated through mechanically opening windows within the roof pods and a low level undercroft for summer cooling.

Advantage was taken of the gently sloping site to incorporate openings for fresh air inlets through the external wall via the undercroft to the atrium. The undercroft is 1.4 metres high and includes dense concrete blockwork which forms ducts for the incoming air. The system has been designed in conjunction with the University of Cambridge and works by mixing incoming and outgoing air in 'mixed downward ventilation mode'.

When the outside air is cooler than 18°C the high level windows open, allowing air in, which mixes with the departing exhaust air and falls as tempered fresh air. The windows are banked in four rows, each row having a temperature sensor. At ground level there are further temperature sensors along with two carbon dioxide sensors. These determine via a Building Energy Management System (BEMS) which and how far the roof level windows open to maximise air quality, minimise heat loss and the potential for draughts. The mixed mode principle has been modelled by the University, who are assisting in writing the software for the BEMS. The eight outside air dampers and ten chimney dampers will be closed in this mode.

When the outside air temperature is warmer than 18°C, the mechanical external louvres open to allow fresh air to enter under the building. This air is cooled and delivered to the atrium through ten low level ventilation chimneys. Six of these are without thermal mass block walls and provide intermediate cooling of the air as it passes under the building. The other four have thermal mass walls, which add additional surface area to pre-cool the incoming air naturally for periods up to 8 hours before it enters the atrium. The intermediate chimneys will be used when external temperatures are between 18 to 22°C and the others will be used when temperatures rise above 22°C.

An element of night-time flushing and cooling will also be used in the height of summer to pre-cool the building and recharge the thermal mass walls. Thus the use of natural ventilation and thermal mass for the atrium area removes the need for any additional cooling or mechanical ventilation and their associated costs.

## **Geothermal heating**

Heating is provided by a closed loop geothermal heatpump system incorporating 24 boreholes, each 100m deep, which generates 150kW of low pressure hot water heating at a temperature of 45°C. This is supplied through a traditional underfloor heating system, each area having local thermostatic control.

### **How the Geothermal heating system works**

Water circulating in the earth loop is colder than the surrounding ground, which is typically at a constant temperature between 8 and 13°C. It absorbs heat from the ground and carries it to the heat exchanger in the heat pump. Here refrigerant absorbs the heat from the water, which is then re-circulated through the earth loop to pick up more energy.

The refrigerant gas containing the heat from the water travels from the heat exchanger to the compressor. Here its temperature rises, magnifying the heat gained from the ground. The superheated refrigerant then travels to a second heat exchanger, where it gives up some of its heat to secondary heating water which feeds the underfloor heating system. This water is then pumped around the building at a flow temperature of 45<sup>0</sup>C, returning at approx 35<sup>0</sup>C.

After the refrigerant has releases its heat energy to the secondary heating water, it then flows through a throttling valve allowing it to decompress and then to the earth loop heat exchanger to start the cycle again.

The efficiency of a heat pump can vary, as the temperature it has to raise the secondary water to has a large bearing on the efficiency achievable. An efficient Ground Sourced heat pump can be reasonably expected to achieve 300-400% efficiency.

### **Solar Hot Water**

The hot water for the building is supplemented by two 4m<sup>2</sup> solar panels attached to an A-frame mounted on the dining room roof. The panels pre-heat the cold water supply before it enters the gas fired boilers, thus reducing the amount of gas required. The solar panel has a sensor which detects the panel temperature and the domestic hot water (DHW) storage vessel has a similar sensor. When a difference in temperature between these of 6<sup>0</sup>C or greater is detected, the pump is enabled and the solar panel begins to pre-heat the water.

### **Breathing walls**

To prevent fluctuations in humidity, which exacerbate the condition of the patients being treated at Breathing Space, the walls within the Atrium and the bedrooms are constructed of unfired clay blocks and lime plaster coated with a hygroscopic paint. This allows them to act as a sponge, absorbing moisture when the relative humidity rises and giving it back when it falls. Short-term variations in humidity are thus moderated.

Although the term "breathing" implies airflow, this is not necessarily the case. This simply means that a material is both open to vapour diffusion and is hygroscopic. In essence, this combination of properties allows a significant amount of water vapour (and other gases) to be adsorbed and released quickly, thereby regulating the room climate and indoor air quality.