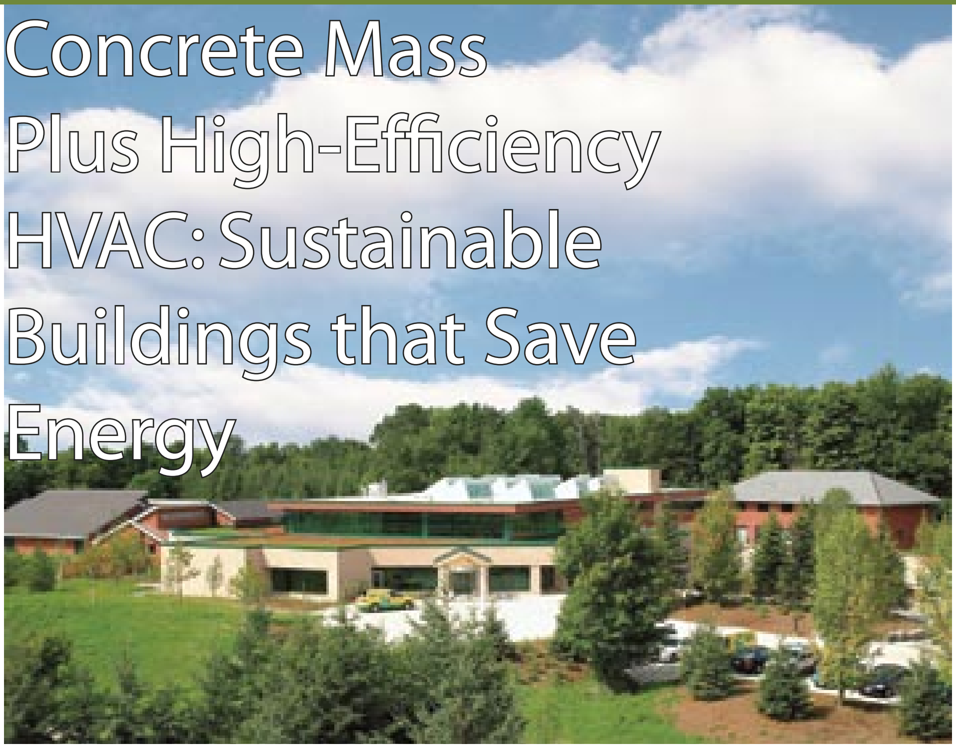
Concrete Mass Plus High-Efficiency HVAC: Sustainable Buildings that Save Energy



By John Leckie

Energy prices are soaring once again, with no end in sight. Analysts predict that energy bills will continue to climb and there is a strong possibility of chronic power shortages in the not-too-distant future. What can builders do to stave off the growing costs and uncertainty?

Perhaps it is time to take a hint from how the institutional building sector has gained massive reductions in energy use and greenhouse gas emissions for buildings. Following the institutional model of using concrete combined with high-efficiency heating and cooling systems, a building owner can cut energy costs by 50 per cent or more. This sustainable building solution offers Canadians an innovative way to apply proven practices to control their operating costs and keep increasing energy costs at bay.

Savings translate into profit for owners, since such buildings can command premium rents. Sustainable, or green, buildings are healthier buildings, with better air quality and fewer moisture and mould problems, bringing benefits to both tenants and owners.

European studies have shown that employee productivity goes up by 20 percent in sustainable, healthy buildings. With personnel and payroll making up the largest proportion of corporate costs, that 20 percent can make a major impact and most companies would be willing to pay more for a building that can deliver such benefits, for its workers and for the corporation.

In contrast to other areas for potential energy and cost savings, such as transportation, energy use and greenhouse gas emissions can be massively cut in new buildings with no major lifestyle changes and a relatively miniscule incremental cost (in the area of two percent of total building cost). As a result, the building owner has the opportunity to reap increased revenue because the building becomes more desirable and healthy for potential tenants and/or employees. In the case of public buildings—schools, libraries, office buildings—the energy savings are a boon for beleaguered taxpayers. The costs of heating and cooling and otherwise maintaining these buildings go down, stretching the tax dollar much further.

One of the best examples of a building realizing the mass savings in energy usage is the Earth Rangers Centre in Woodbridge, Ontario, north of Toronto. This 5,800-square-metre, structural mass concrete building is located in the Kortright Centre for Conservation. It was designed to deliver energy savings about 58 per cent above the Model National Energy Code by using lower lighting power density and radiant space conditioning. Not only did it meet this target when it was constructed—helping it earn a gold rating in the LEED (Leadership in Energy and Environmental Design) certification system in 2006—but, through tinkering to attune building operations and indoor/outdoor climates, close to another 30 percent has been trimmed from the energy use that remained.

The goal was to make the building the most energy-

efficient education and health facility in Canada. To achieve that, a considerable amount of concrete was used in the design. Concrete underground ventilation tunnels and a double foundation wall use the ground to temper the temperature of incoming outdoor air for ventilating the building. Rainwater and treated sanitary wastewater are captured in a 310,000-litre cast-in-place reservoir for reuse in the building. Exposed structural concrete slabs containing embedded polyethylene tubing provide 100 per cent of the space cooling and heating and act as thermal storage during the heating and cooling seasons.

The building**,** planned by Bautech Developments, designed by M Architecture, energy modeled by Transsolar and built by Internorth, has several other features that helped it attain its LEED rating, including pervious parking pavers, landscaping with native plants, a green roof and low-flow plumbing fixtures. It uses Greenguard-certified furniture, low-emission materials and displacement ventilation. Its second floor windows have forest silhouette decals to prevent bird strikes.

Graham Seaman, the building's facilities manager, says the building was one of the first to be constructed in accordance with a total energy model that called for all the design features to contribute to overall efficiency. The largest contribution to energy savings is made by the combination of the building's earth tubes and enthalpy wheel (a rotary air-to-air heat exchanger), which pre-heat or pre-cool the 100 per cent fresh air supply to the building, reducing natural gas consumption in the winter and chiller demand in the summer.

Most of the fine-tuning of the building is done by computer. While the building operations people are always looking for ways to tweak the system to reduce energy use further, it requires no more attention that any conscientious building operator would put into a building, Seaman says.

Concrete thermal mass has thermal storage capacity. During the summer, the ceilings can be cooled at night with off-peak, relatively cheap energy and the occupants arrive in the morning to a cool, comfortable building that needs much less cooling capacity, since the cooled surfaces are able to absorb daytime heat gains.

During the daytime, peak period energy is very expensive and utilities are finding it more difficult to meet demand; this feature, therefore, offsets both cost and supply considerations. The thermal mass also works during the winter, the radiant surfaces release consistent and comfortable heat all day long. By combing the concrete thermal mass, earth tubes and enthalpay wheel, space heating costs are significantly reduced. The concrete thermal mass is slow reacting to temperature changes and therefore creates a comfortable steady interior temperature

Another building that illustrates the savings that can be achieved is the Charles E. Fipke Centre for Innovative Research, located on the University of British Columbia's Okanagan campus in Kelowna, B.C. This 68,000-square-foot building, housing lecture halls, classrooms and wet and dry labs, has earned five Green Globes, issued by the second of Canada's two green building rating systems (LEED being the other). The centre, designed by Kasian Architecture Interior Design and Planning Ltd. and built by UBC Properties Trust, used a wind tower for air exchange, a groundwater energy system for winter heating and summer cooling and a number of other innovations to earn the Green Globes.

"Not only is the building naturally heated and cooled, it's also a naturally ventilated building," says architect André Kroeger of Kasian.

"The wind tower on the building means people will have 100 percent fresh air all the time."

UBC's Okanagan campus has developed a campus-wide geo-exchange system that pumps groundwater from beneath the campus, uses the water to heat or cool buildings and then returns the water to the ground. The school plans to have every building on campus connected to the system in the next few years.

Construction of the Fipke Centre began in 2006 and completion is expected in May of this year.

The decision to build a sustainable building should be based on the projected life-cycle cost of the building. That is not as easy as it might sound because, at the moment, there is no accepted standard for life-cycle costing. There is a clear need to put something in place that will allow building owners to compare apples and apples in their life-cycle calculations.

If the decision is made to go with a green building, a third-party certifier should be used. For North America, it could be LEED or Green Globe, or another rating system, but it is important that the performance of the building be measured against some standard to verify it is actually delivering what it was intended to deliver.

An important addition to the LEED Canada system is its Durable Buildings addition. Durability is not covered by the National Building Code, so this added requirement takes further steps to guard against the types of moisture problems that caused the leaky condo crisis in British Columbia. The third-party investigation of the building will identify durability improvements that could be made and areas where careful attention to detail is required to prevent problems.

As we move towards more and more sustainable nnovation, any additional expenditure to develop a green building will be reduced. When the top three building sectors—Commercial, Government and University/College—adopt sustainability standards across the country and transfer the knowledge gained, especially to young Canadians, we will have a sustainable future.This will be good news for building owners, as the energy savings, increased rents and increased value of the buildings over their lifetime will repay these costs many times over. The owner gains security against increasing energy costs and the satisfaction of having contributed to sustainable solutions to improve the environment.

Last year, the Cement Association of Canada released Version 2.0 of its *Guide to Sustainable Design with Concrete*, showing designers how they can innovate to achieve sustainable building solutions. The free guide includes practical information on the use of thermal mass and a durable building envelope to create a quality, sustainable building, one capable of using the characteristics of the material to reduce energy costs and also capable of lasting through the design life of the building.

It seems like a natural step to look to green buildings to reduce energy costs and greenhouse gas emissions. With savings of 50 percent or more readily available, why aren't at least all public buildings everywhere in Canada going this route? In the long run, it can only benefit us all.