For professional engineers in private practice

DECEMBER 2013

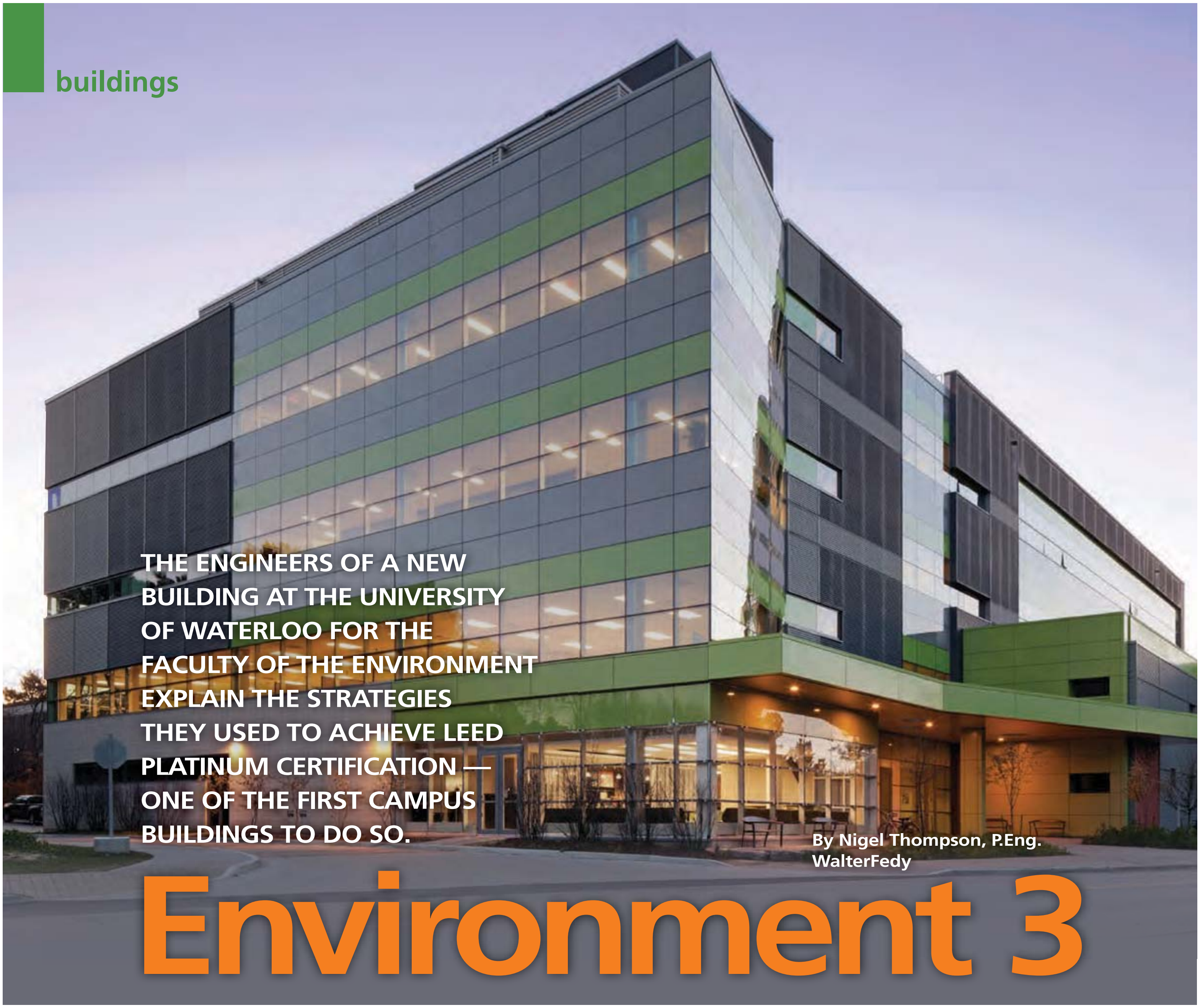
CANADIAN CONSULTING engineer

ENVIRONMENT 3
University of Waterloo

GROWTH SPURT
Toronto's New Skyscrapers

UNDER PRESSURE
Liability and Engineers

www.canadianconsultingengineer.com



THE ENGINEERS OF A NEW BUILDING AT THE UNIVERSITY OF WATERLOO FOR THE FACULTY OF THE ENVIRONMENT EXPLAIN THE STRATEGIES THEY USED TO ACHIEVE LEED PLATINUM CERTIFICATION — ONE OF THE FIRST CAMPUS BUILDINGS TO DO SO.

By Nigel Thompson, P.Eng.
WalterFedy

Environment 3

A-Frame Photography

For its third building on campus, the Faculty of the Environment at the University of Waterloo wanted one of the most environmentally responsible buildings on a university campus in Canada.

Design on Environment 3 (EV3) had started in October 2009 based upon LEED silver expectations, but soon afterwards the faculty raised the expectation to LEED Platinum. Our design had to be both green and innovative, while still meeting the request-for-proposal requirements. The building also had to be constructed within the original time frame in order to receive government funding.

In the end, a total of 53 LEED credits were achieved; 52 credits were required for LEED Platinum status. In December 2012, EV3 became the first structure to earn this top green building certification on an Ontario university campus, and only the second on a campus in Canada.

Located close to two other Environment buildings in the southwest area of the campus, the $23-million, four-storey, 5,295-m^2 building was completed in 2011 by a design-build team of Cooper Construction, Pearce McCluskey Architects, and WalterFedy. WalterFedy were the civil, structural, mechanical, electrical and LEED consulting engineers. The building has a 150-seat auditorium, cafe and four-storey atrium on the ground floor, and a studio, seminar rooms, common areas and two courtyards on the upper floors.

Using run-off water from the roof

The site strategy emphasized water reuse and management, a reduction in the heat island effect, and the creation of natural habitat for wildlife. To achieve these goals, the site includes constructed wetlands, cisterns, green roof-storage, permeable pavers, catchbasin goss traps, and deep sumps in the stormwater treatment train. Cisterns

Eye Fly Aerial Photography

A-Frame Photography

A-Frame Photography

Far left: main entrance. Above: aerial view of the Faculty of Environment complex in the southwest corner of the campus; the four-storey EV3 Building straddles EV2, an existing two-storey structure in the foreground. Inset above right: columns support the new building over the old. Left: living wall in the main atrium acts as a prefliter for return air from classrooms.

totalling 87 cubic metres collect 100% of the site run-off during a 25-mm storm event and provide on-site storage to attenuate peak flows during larger storm events.

Inside the building, rainwater run-off captured in cisterns below ground is distributed for non-potable uses such as in low-flow toilets, urinals, hose bibs, and to provide make-up water for a living wall in the atrium. As a result, the potable water consumption of EV3 is 87% less than the LEED reference building. A 280-m^2 green roof further reduces stormwater runoff by capturing precipitation in the soil matrix.

Building over a building

A major obstacle for the expansion was the limited space available, so the design locates a major portion of the building expansion directly over an existing faculty building, EV2, which dates from 1981. This decision made sense from the perspective of environmental responsibility, but created significant engineering challenges.

A north access road was realigned so that a new four-storey building could be constructed with a floor area of approximately 2,895 m^2. The additional 2,400 m^2 is provided by extending the third and fourth floors of the new structure over the top of EV2. The south end of the two extended floors is supported on four columns located 1 metre south of EV2.

EV2's two-storey, reinforced concrete structure was not designed for additional floors, so the upper two floors of EV3 had to be designed to span over the existing building. In order to achieve this, we designed two 10-metre-deep trusses (two storeys high) to span the 46.7 m over the top of the existing building. Located at each side of the building addition, these trusses in turn support five 5-m deep by 30-m long trusses located within the fourth floor, onto which the third

continued on page 14

 continued from page 13

A-Frame Photography

Left: fourth floor corridor; visible is one of the five trusses that span over the existing two storey building below.

floor structure is hung. Diagonal truss members are visible within the fourth floor space at certain locations, and various members of the two main support trusses can be seen through the vision glass on each side of the building.

The existing reinforced concrete roof of the EV2 building was not strong enough to support the snow drift pile-up resulting from the two-storey structure of EV3 above, so a new flat steel roof was built 1 metre above the existing concrete roof of EV2, with posts located over the concrete columns below. This solution caused the least disruption to the occupants and also served to support the green roof.

To support the large column loads of the two-storey structure spanning the existing building we had to explore various options owing to the soil conditions and close proximity (1 metre) off the existing building. Along with Cooper Construction, we finally opted to use continuous flight auger piles (CFA piles). The CFA piles are 600 mm in diameter and provide relatively high resistance, which results in the least amount of piles and, accordingly, the smallest possible pile caps. Under the four most heavily loaded columns, the pile caps measure 9.25 m x 1.35 m x 1.37 m, with 9 piles at each location.

Low-temperature and low flow air supply

The university required us to feed all the primary mechanical systems for EV3 from the campus's central energy plant, which supplies steam, chilled water and softened water. Using the central plant was a disadvantage from the point of view of acquiring LEED points since the efficiencies of the central plant equipment are not very high, and there was no opportunity to install a modern high efficiency plant for EV3 for heating and cooling. The remaining systems therefore had to be as efficient as possible.

Building ventilation and cooling is provided by two central air-handling units. These have low-temperature supply air (48°F) and low flow characteristics, features which reduce the fan energy requirements, reduce air distribution material costs (they need smaller ductwork since they move less air), and improve humidity control in summer. The air distribution systems are variable flow with a low pressure drop to reduce fan energy further. Carbon dioxide levels are monitored throughout to provide demand control of the ventilation systems, which reduces the need to bring in outside air into spaces when they are not occupied at their design density levels.

We developed an energy simulation model which calculated that EV3's design energy cost was 45% less than the LEED reference building, thanks to the above strategies.

A unique feature of the building's ventilation system is the two-storey living wall in the main atrium. The wall acts as a pre-filter for the return air from the classroom air-handling unit.

One of the added environmental benefits of obtaining LEED Platinum was that the university was required to make a commitment to remove their last chiller on campus that contains CFCs within five years.

Electrical services for old and new

To merit the "measurement and verification" LEED credit, all branch electrical power and lighting circuits have a separate digital meter connected to the building automation system. All the mechanical services into the building and all mechanical equipment electrical loads are also sub-metered. This information is used to display the real-time energy consumption of EV3, and the faculty is using the information as part of its studies.

Because EV3 is joined to the existing EV2 building, their services had to be interconnected. The load analysis had to consider both buildings, and the required interconnections and shutdowns had to be coordinated to minimize disruptions to the building operations. The campus 13.8 kV primary supply loop serving the area had to be re-worked to accommodate the new EV3 substation installation.

After the building was completed the University had a photovoltaic system installed on the roof that generates 67,000 kWh per year.

Lighting orchestration

For the general lighting in EV3 we selected 28-watt T5 lamping, along with direct/indirect style lighting fixtures in offices, meeting rooms, studio spaces, the lecture hall, and corridors. Compact fluorescent downlights accent select areas. Lighting fixtures within offices, meeting rooms, and the lecture hall were provided with addressable, dimmable ballasts and linked to the building lighting control system.

The four-storey atrium space is lit with linear wall mounted fixtures installed at the second floor that include both down-light and up-light components. At the living wall, which requires 1000 Lux maintained on the entire wall for a 12-hour duration daily, 400W metal halide fixtures mounted on 1-m extension arms are installed at the midway point and above the top of the wall. These lights have a separate control system to allow them to operate independently from the building lighting.

The lighting control system provides local user control in individual spaces throughout the building. The management hub and dedicated system server for this system are installed in the penthouse and distributed controllers are provided for each area. **CCE**

Nigel Thompson P.Eng. is a structural engineer and partner at WalterFedy in Kitchener, Ont. He was the project manager on the EV3 project.

Owner: *University of Waterloo, Faculty of Environment*
Design-build: *Cooper Construction; Pearce McCluskey Architects; WalterFedy (civil, structural, mechanical, electrical, LEED) (Scott Oliver P.Eng., Nigel Thompson, P.Eng., Ed Fowler, P.Eng., David Buck P.Eng., Kevin Henry P.Eng.)*
Other key players: *Conestogo Mechanical (mechanical subcontractor); Electricomm (electrical subcontractor)*