Case Study
ONTARIO CAST-IN-PLACE CONCRETE DEVELOPMENT COUNCIL
Volume 14, Issue 1



ENVIRONMENTAL SCIENCE & CHEMISTRY BUILDING

2017 ONTARIO CONCRETE AWARD WINNING PROJECT FOR SUSTAINABLE CONCRETE CONSTRUCTION

As befits a new building for the study of environmental sciences and chemistry, this facility is strongly rooted in sustainable design solutions and is LEED Gold certified. This project is a showpiece for integrating the requirements of a modern and dynamic post-secondary academic campus plan and meets institutional objectives for stringent sustainable design targets.

This 110,000 square-foot, cast in place concrete structure building connects laboratories and academic offices around a sky-lit forum and crossroads designed to encourage collaboration and exchange facilitated by gathering spaces in wide corridors, meeting rooms and white boards throughout for spontaneous scenarios.

Laboratories have often been relegated to building interiors, the effect of this environment without the benefit of daylight or views on occupants is less than ideal. This facility locates laboratories above ground and in full view of the outdoors. To achieve an optimal balance between energy efficiency and daylight, the envelope features a mixture of cladding systems including high performance curtainwall, unique bird friendly fritted glazing and punched windows.

As an active research and teaching laboratory with nearly 120 fume hoods distributed in various labs throughout the laboratory wing, ventilation and make-up air posed a significant challenge. To improve energy efficiency, six precast concrete earth tubes were designed in different configurations to help temper incoming fresh air drawn from the adjacent courtyard before introducing it into the building in the office wing, then using a cascade effect as makeup air for the lab wing. The custom earth tubes that twist and bend beneath the courtyard have a 6′ clear interior dimension and were designed for quick installation for this fast-track project.

One of the earth tubes is translucent below the entrance vestibule, where an information kiosk explains the technology. A glass screen and floor opening permit students to see the earth in action; wind deflectors and coloured LEDs are integrated to illustrate the air movement within the tube.

OWNER
University of Toronto Scarborough

ARCHITECT OF RECORD
Diamond Schmitt Architects

ENGINEER OF RECORD
Read Jones Christoffersen Ltd.

GENERAL CONTRACTORS
EllisDon Corporation

FORMING CONTRACTOR
- Avenue Building Corporation
- UCC Group Inc.

MATERIAL SUPPLIERS
- St Marys CBM
- DECAST Ltd.

ADDITIONAL PARTICIPANTS
- Aluma Systems Inc.
- BASF Canada Inc.
- Carpenters and Allied Workers Local 27
- Footprint
- Harris Rebar
- Ironworkers Local 721
- Janet Rosenberg and Studio Inc.
- LIUNA Local 506
- Rebar Enterprises Inc.
- Smith + Anderson
- WSP Canada Inc.

LOCATION
Scarborough, Ontario

COMPLETION
January 29, 2016

BUDGET
$52.75 M

QUICK PROJECT FACTS

Project Type:
- Teaching and Research Laboratory

Building Area:
- 10,219 m^2 (110,000 sq ft)

Concrete Volume:
- 6,380 m^3

Maximum Concrete Thickness:
- 1,500 mm transfer beam at 2nd floor slab

General Dimensions:
- 9.6 m x 10.2 m structural bay at research lab
- 6.4 m x 10.2 m structural bay at Ground Floor teaching lab

Span Length:
- Largest Span Dimension: 10.2 m

OCCDC

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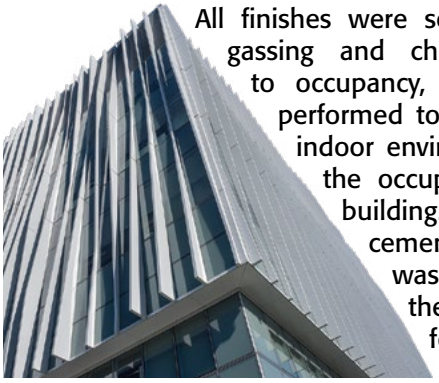
To optimize the efficiency of this system, a computational fluid dynamic (CFD) analysis was performed on the proposed design, and identified opportunities for improvement, specifically adding baffles and modifying their spacing throughout the concrete tubes to reduce stratification, control static pressure, and achieve a uniform distribution across all six tubes. Based on the results of this analysis the modeled heat transfer effectiveness of these tubes increased from 29-32% to 51-56%.

The structural grid of the lab wing allows for flexibility over all five levels of the building and the numerous lab benching layouts and configurations required by the functional program and room data sheets. This modular design approach together with demountable lab benching system is essential to allow the building to easily respond to the ever-changing nature of research and teaching methodologies. The majority of the labs feature the concrete structure as exposed ceilings and columns.

Interesting features within the laboratory wing include a high strength explosion proof concrete bunker structure at chemical storage area and the integration of structural concrete with non ferrous stainless steel rebar to achieve a non magnetic and stiff structure to house the Nuclear Magnetic Resonance Imaging machine, which is extremely sensitive to vibration and magnetic fields.



All finishes were selected to minimize off-gassing and chemical emissions. Prior to occupancy, a series of tests were performed to verify the quality of the indoor environment and ensure that the occupants received a healthy building. Concrete made using cement replacement additives was specified to reduce the overall environmental footprint of the materials used in the building.

The ESC building is not only a research and teaching hub, but also acts as an educational tool and showpiece for green building technologies. While conventional buildings tend to enclose mechanical and electrical support services behind walls or above a ceiling, here they are left exposed to showcase the complex network of air distribution, support services, sensors, and infrastructure.

One of the concrete earth tubes is visible below the entrance vestibule, where an information kiosk explains the technology. A glass screen and floor opening permit students to see the earth tube in action; wind deflectors and coloured LEDs are integrated to illustrate the air movement within the tube and emphasize the heating and cooling these tubes extract from the latent energy of the soil. The ventilation intakes are visible in the adjacent courtyard and highlighted with custom screens and hoods.

The roof of the building was designed to be PV-ready, including additional structural support and electrical conduit for a future renewable energy system. This offers the flexibility of gradually transitioning away from fossil fuel sources to a more renewable blend. Additionally, a ground source heat pump system, that utilizes 64 boreholes 150 metres deep that were drilled below the building prior to excavation, is operated using electricity.

Provided that this electricity is supplied from the future PV array, this will allow for both heating and cooling from renewable sources.

The Environmental Science and Chemistry Building conveys new thinking in laboratory design – open, transparent, flexible and adaptable, while providing a safe and secure work environment for students and researchers.

In 2000, the Ontario Cast-In-Place Concrete Development Council (OCCDC) was formed to aid the owner/developer, architect/engineer and design-build contractor in the decision-making process of choosing the best construction material for the framing system of new cast-in-place structures.

OCCDC promotes the benefits of reinforced concrete as the construction material of choice based upon the following advantages:

- fast-track construction
- costs savings
- structural advantages
- environmental considerations
- local economy benefits

The Members of the OCCDC include (alphabetical order):

- Aluma Systems Inc.
- Carpenters District Council of Ontario
- Concrete Forming Association of Ontario
- Ironworkers District Council of Ontario
- LIUNA—Ontario Provincial District Council
- Ontario Formwork Association
- PERI Formwork Systems Inc.
- Ready Mixed Concrete Association of Ontario
- Reinforcing Steel Institute of Canada

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