case study
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Ontario Cast-In-Place Concrete Development Council
OCCDC

The Canadian War Museum

The concept of 'Regeneration' embodies the sequences of devastation, survival, rebirth, adaptation and life. In times of war, nature – comprising the land and the human spirit nurtured thereon – is ravaged and seemingly destroyed. Miraculously and somehow inevitably, however, nature survives and regenerates as the power of life prevails. It is this process of regeneration and healing that nourishes and rekindles human hope, faith and courage.

This is the design concept for the new Canadian War Museum in Ottawa. The building (more of an expressive landscape) emerges gently from the bank of the Ottawa River, saluting the City and Parliament. Draped mostly with a blanket of grass on its rooftop, the museum opened on May 8th of 2005.

Due to its expressive power, concrete was chosen to be the predominant building material for the Canadian War Museum. Concrete was used as both the structure and the finish for the building, making use of its unique dramatic qualities and practical characteristics.

The building is structured with tilting planes that intersect with one another; some at dramatic angles and some that are barely visible. Raw concrete walls emerge sharply from sloped floors at 3° to 31° angle. *The sloping and colliding planes express the tension and upheaval of war, and are a physical representation of the devastation of place. A gradual process of regeneration is implied in the interplay of planes that resolve into interior spaces of memory, contemplation and spirituality.*

The exposed concrete is unrefined and the form joints were deliberately made rough. The surfaces express how the concrete itself was formed, revealing three patterns: the Memorial Pattern, the Random Plywood Pattern and the Vertical Board Pattern.

Formwork contractors, Bellai Brothers, were specifically requested to implement a "controlled imperfection" in the assembly of the formwork to take full advantage of the effects of the concrete.

To create the Vertical Board Pattern, rough sawn boards of random widths, lengths and thicknesses spaced with varying gaps insured that the concrete would ooze out between boards. With the Random Plywood Pattern, the contractors were instructed to find old and discarded plywood from previously used formwork,

Owner:	Canadian Museum of Civilization Corporation
Architects:	A joint venture of: • Moriyama & Teshima Architects • Griffiths Rankin Cook Architects
Engineer:	Adjeleian Allen Rubeli Ltd.
Structural Engineer:	Adjeleian Allen Rubeli Ltd.
Building Envelope Engineer:	Halsall Associates Limited
Project Managers:	Gespro / Genivar
Construction Manager:	PCL Constructors Canada Inc.
Forming Contractor:	Bellai Brothers Construction Ltd.
Reinforcing Steel:	AGF Raymond Rebar Inc.
Concrete Supplier:	Essroc Italcementi Group
Formwork Supplier:	Aluma Systems Inc.

Additional Participants:

- Carpenters Local 93
- LIUNA Local 527
- Ironworkers Local 765

Project Facts:

- Open on May 8, 2005
- 7.5 hectares (18.5 acres) in size
- Total gross floor area is 40,860 m^2 (204,500 ft^2)
- $115 million in construction cost
- 2 years to complete
- 32,000 m^3 (1.1 million ft^3) of concrete used
- 3,750 tonnes of rebar used
- 10,672 m^2 (115,000 ft^2) of grass-covered area on roof

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cut it up and arrange it into random sizes and shapes for the new formwork. Missing knotholes and rough edges were encouraged. Fly-ash was added to the mix design to darken the concrete as well as to embellish its texture and express the 'rawness' of war.

The Memorial Pattern used in the "Hall of Remembrance" was to be smooth, clean and organized: a contrast to the other two patterns. *In the Hall of Remembrance, the chaos, tension and anguish of war are to be left outside; while the inside triumphed with tranquility, calm and reflection.*

Not only was concrete the perfect material to provide architectural expression, it also provided energy efficiency for the new Museum. A poured concrete rain-screen on the exterior provided an overall energy conserving mass.

The use of recycled fly ash in the concrete mix (approximately 14%) gives the exposed concrete wall surfaces the desired motley, distressed and war-torn appearance, while also saving on capital costs.

The main lobby is a column-free space 18 to 22 metres wide and about 75 metres long. At the north and south ends of this space the roof not only supports a grass roof, but also pedestrian walkways, walls and gardens. To achieve these spans, the lobby structure is comprised of a series of post-tension, cast-in-place concrete beams, 2,200 mm deep and from 600 to 1,500 mm wide, with spans varying from 18 to 27 metres. The details had to provide for post-tensioning in two directions and had to carefully locate sliding bearings. The balance of the roof that supports the soil for the green roof system is comprised of 300 mm slab and 280 mm deep drop panels with columns on the 9 x 9 metre grid.

The main exhibition floor on level two has to support equipment of various sizes and weights, including tanks of about 60 tonnes. The design live load is 22 kPa. The floor structure is comprised of a 315 mm concrete slab, 260 mm deep drop panels and 400 mm deep capitals on circular columns.

The sloped walls presented a challenge to the formwork contractor who had to devise diagonal braces to support the walls after the formwork was stripped. Without the braces the walls would not be stable until the slab above had been constructed to restrain the top of the wall. The extensive steel buttresses and tension cables used became works of art unto themselves.

2005 Ontario Concrete Award winning project for Architectural Merit

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 incude (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 Ontario

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