SUSTAINABLE CONCRETE CONSTRUCTION

BURLINGTON PERFORMING ARTS CENTRE

2013 Ontario Concrete Awards

PROJECT CREDITS

OWNER
City of Burlington

ARCHITECT OF RECORD
Diamond Schmitt Architects

ENGINEER OF RECORD
CH2M Hill

GENERAL CONTRACTOR
Bird Construction

MATERIAL SUPPLIER
Hamilton Ready Mix Ltd.

ADDITIONAL PARTICIPANTS

- Aluma Systems Inc.
- Carpenters Local 18
- Crossey Engineering Ltd.
- C&T Reinforcing Steel
- Curran McCabe Ravindran Ross Inc.
- DTAH Architects Limited
- Enermodal Engineering Limited
- Fisher Dachs Associates
- Ironworkers Local 736
- Jaffe Holden Acoustics
- Leber Rubes
- LIUNA Local 837
- MHPM Project Managers Inc.
- Shai Gil
- Swan & Associates Inc.
- Valdor Engineering Inc.

PROJECT FACTS

LOCATION Burlington, Ontario

COMPLETION December 2011

BUDGET $29.1M

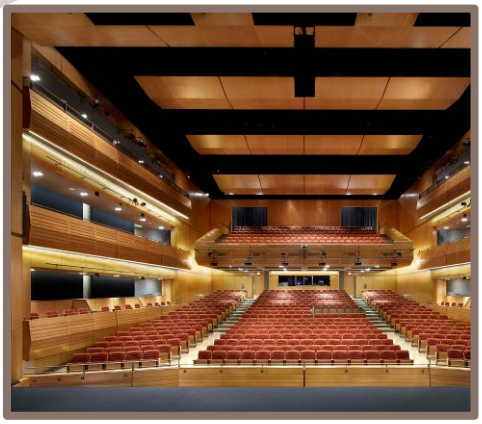
VOLUME

- 3,800 m^3 concrete
- Slag content in the concrete was used in order to make use of industrial by-products and reduce quarrying

QUICK PROJECT FACTS

- LEED Gold
- 90.5% of construction waste was recycled
- 60% savings in actual energy costs after 2 years of operation
- 33.64% Regional content





Concrete volume is enough to cover 4.75 footfall fields with 6" of concrete

The Burlington Performing Arts Centre is currently one of two theatres or performance centres in North America to achieve LEED Gold, and the first in Ontario to reach that goal. The extensive use of cast-in-place concrete was a significant factor in the sustainability aims of the project. Secondly, the use of concrete in the Performing Arts Centre has contributed to excellent acoustics and the intimate feel of the audience spaces. In addition, the use of textured concrete provides a robust contrast to the finer grained wood-lined interior of the main auditorium and creates a strong sense of craftsmanship and durability.

Sustainability

Concrete provides durability to the public spaces, which is a sustainable goal. Concrete contributed directly and indirectly to Energy and Atmosphere, Materials and Resources, Indoor Air Quality as well as Innovation and Design Process elements of our LEED Gold application.

Energy and Atmosphere

Energy efficient design was achieved with thermal and lighting controls and monitoring, efficient air handling systems employing heat recovery, use of natural daylight, provision of exterior views, lighting fixture selection and exterior envelope design. A third party energy model indicated that the new facility would achieve significant reductions in energy use from provincial standards and metrics. The owner has committed to energy use tracking after occupancy.

Concrete provides thermal mass that contributes to heat retention in winter and cooling in summer, and thereby reduces the energy load of heating and cooling equipment. Secondly, double cast-in-place concrete foundation walls with an insulated core removes thermal bridging at the base of the building. The double foundation wall provides direct bearing for masonry onto foundations without the use of steel shelf angles close to grade and corrosive ice removing chemicals. Importantly, the double foundation wall detail creates continuity of the plane of insulation below grade to reduce one of the largest areas of heat loss in winter and heat gain in summer.

Materials and Resources

Concrete played a major role in material re-use and recycling. High slag content was used in the massive concrete walls that provide acoustic separation around the Main Theatre. Use of slag extends curing time and was carefully monitored during construction in colder months. The colour of the resulting concrete pours was initially a concern, but remained consistent in the interior surfaces. Sound resource management was achieved by the reuse of slag as an industrial by-product and contributed to the reduction of new limestone quarrying.

Innovation and Design Process

Use of slag in the concrete was an innovative use of industrial by-products that contributed to the Recycled Materials Exceptional Performance element of our LEED Gold submission.

Other strategies for the LEED submission include sustainable site development, remediated contaminated soils, storm water management, reduced heat island effect and reduced light pollution.

Concrete contributed to an innovative solution to remove soil contamination. The solution was developed at the edge of the site and around the building foundations.

Groundwater contaminated with petroleum product from an abandoned service station was found to leach into the site from under an adjacent regional sewer. An underground concrete dam was constructed to block passage of contamination. The dam also provided support to an underground column of activated carbon that absorbs the contaminants and prevents further seepage to Lake Ontario nearby. The concrete foundation walls and slab-on-grade at basement level were used to support membranes to prevent ingress of the contaminants into the building. A single point of entry of the weeping tile system in the foundation leads into a filtered interceptor that collects residual oil-based material.

Concrete Design Considerations

The concrete and wood-lined 730 seat Main Theatre features the outstanding acoustics required by major symphony orchestras and the level of intimacy expected for drama. The Main Theatre is designed for exemplary sightlines and provides the technical infrastructure for the most demanding performances.

A separate Studio Theatre provides a smaller intimate setting for an audience of 221 on the main level and 40 at a mezzanine level for cabaret, stand-up comedy or experimental theatre.

Both venues open onto a large glazed public Lobby and Galleria that also open onto west and east entrances, an outside public plaza, and a more private terrace.

The concrete 'shell' of the Main Theatre and Stage Tower supports the long span beams over the two large volume spaces, while bracing the steel frame structure for the surrounding spaces. This 'shell' also separates the performance space from outside noise and variations in light levels of the outside environment. The concrete 'shell' also contributes to the interior finish of the space that lends character and a sense of quality to the interior.

Acoustic Separation and Noise Mitigation

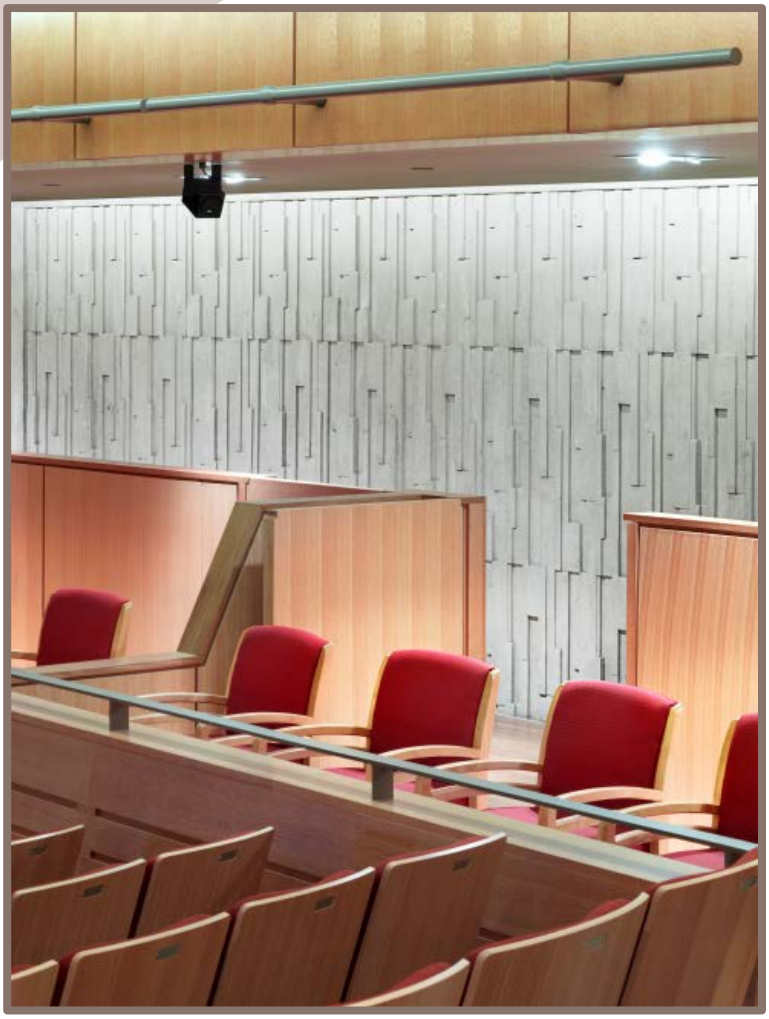
Concrete was key to providing the level of acoustic separation that was desired.

Concrete inhibits outside noise from entering the performance space in a continuous membrane. The 300 mm thick cast-in-place concrete walls and concrete and steel composite deck roof surrounding the 17 metre high Main Theatre and 22 metre high Stage Tower is the greatest factor in providing acoustic separation and achieving the goal of a low Noise Criterion (NC) rating of NC-20.

A challenge of theatre design is to accommodate very large quantities of ventilation air, service penetrations, service entrances and entrances for performers and audience without compromise to acoustic separation. Furthermore, supply air ducts are large so that the velocity of air is greatly reduced before entering the space to reduce air turbulence-generated sound.

Mechanical systems are located adjacent to the mass concrete enclosure of the Main Theatre and Stage Tower and do not have direct contact with the enclosure. By isolating service equipment, no equipment-generated vibration and noise will find a way inside the performance space. The design problem seemed impossible - seal a room to prevent outside noise from entering, but cut large openings to allow passage of air and people into that room.

Detail design carefully considers all penetrations of the



massive concrete 'shell' including flexible vibration isolation, distance between noise source and 'shell' penetrations and insulated silencers. The concrete creates a solid and stable surface to mount acoustic isolation attachments firmly. Ultimately, concrete ensures that noise reduction standards are met.

Flexible Acoustics

Managing interior sound in performing arts centres to accommodate both voice and instrumental performances is more complex than in single-use venues. Reverberation times of 0.8 seconds (ideal for speech) and 1.8 to 2.0 seconds or greater (ideal for choral music) suggest that a room have two or more characteristics to create legible, rich sound.

The surface characteristics of the Burlington centre can be altered by increasing or decreasing the amount of exposed concrete in order to 'tune' the room for voice or instrumental performance.

Variable acoustics are provided for by changing the surface characteristics of the Main Theatre enclosure. The Main Theatre and Stage Tower are enclosed by a massive cast-in-place concrete 'shell'. Some of the surfaces flanking the

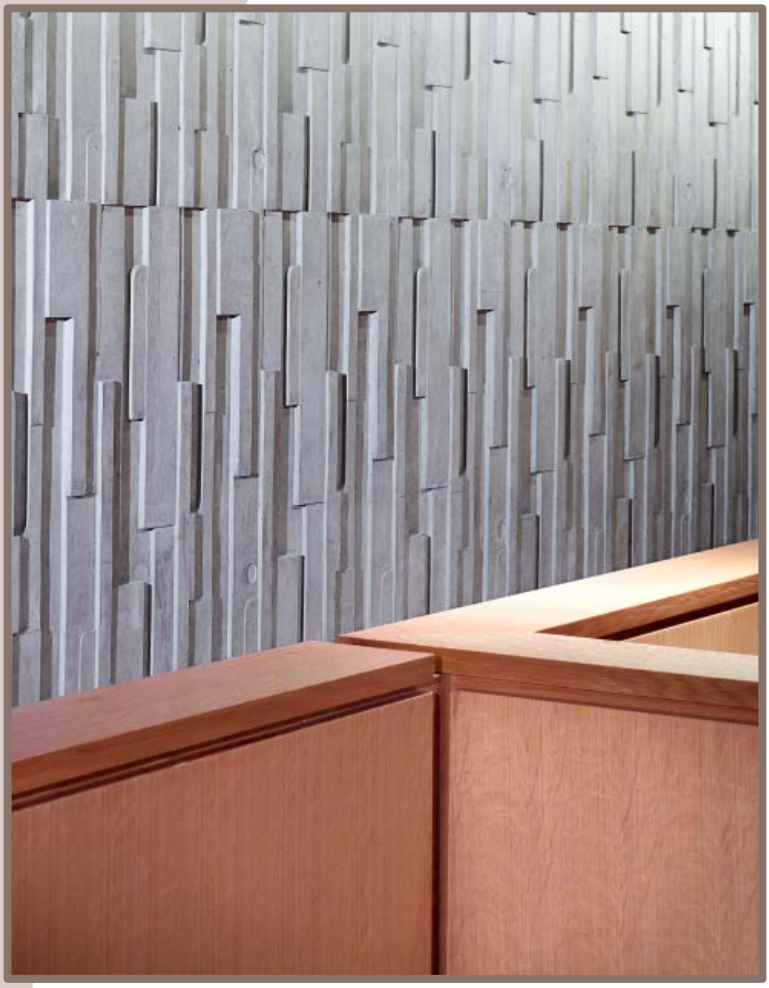
Main Theatre have the underlying concrete 'shell' exposed to view behind wood paneling. The two materials create a strong contrast in texture and colour as well as different surface qualities effecting acoustics. The concrete 'shell' is further exposed in the Stage Tower and the upper levels of the Main Theatre to provide a solid, non-vibrating surface that contributes to the acoustic 'tone' of the room.

Special forms cast into the concrete walls of the Main Theatre provide a diffusive shape that helps to blend sound. During the concrete pour, 24 form liner Reckli panels were installed on the long sides of the room. The panels provide a 'bas-relief' pattern in the concrete with different angles and depths which reflect sound into a variety of directions to create the reflective sound and warm acoustics. The faceted concrete surfaces reduce sound focal points and diffuse or enhance sound before it reaches the audience.

Adjustable drapery raised or lowered to expose or cover the underlying concrete surfaces is used to adjust sound absorption and 'tune' the Main Theatre for various performance acoustic requirements.

Intimacy

Patterned concrete creates different intensities of light and shadow around the audience. The detail and contrast between cast-in-place concrete and wood paneling create a richness and interest to the surroundings.



The intimacy or 'feel' of the Main Theatre rely equally on the detailed facets formed into the concrete which reflect light and create warmth of colour and light. The reflected light and recessed shadows contrast with the blonds and reds of clear finished oak paneling to advance and bring the audience visually closer to each other. The result, along with acoustic clarity is a sense of closeness of audience to the performer and stage even though the seating is spacious and the audience chamber has volume. Concrete plays a key role in the composition.

Durability

There is an economy in the use of concrete as a structural element in the Burlington Performing Arts Centre. The materials are readily available in the near vicinity, as are skilled trades' people. Concrete exposed or hidden from view provides a structural 'shell' that surrounds the Main Theatre and Stage Tower at its centre and braces the steel framing system around this centre. It is a solid armature that provides bracing and stability, reduces vibration and noise, and provides solid attachment at points of contact.

In back-of-house areas, exposed concrete and concrete block provide very durable, low maintenance surfaces that easily handle the frequent movement of wardrobe racks, props and deliveries.

Craftsmanship

Exposed concrete in the Burlington Performing Arts Centre helped to celebrate craft and human touch in its making. The walls were not parged or rendered after placing and stripping. After careful but minimal cleaning, each nail head, pencil line, butt-joint and tie-form is left visible and forms a record of the very skilled trades that worked on it with care, to level and plumb. The mark that the trades people left on the flat or 'bas relief' walls of cast-in-place concrete are an expression of solidity, confidence and pride in the core of the Burlington Performing Arts Centre that speaks for the entire community.