ST. JOSEPH SEMINARY

ST. JOSEPH SEMINARY, EDMONTON, ALBERTA

THE CATHOLIC CHURCH THINKS IN HUNDREDS OF YEARS

ST. JOSEPH SEMINARY

Edmonton has been home to St. Joseph Seminary since 1927, when the school was opened officially by Archbishop H. J. O'Leary. As the seminary expanded over the years, it moved several times to larger and more modern buildings. Most recently, the northwest extension of Anthony Henday Drive required that the seminary move to a new home on the Catholic Campus at 84th Street and 100th Avenue in Edmonton. That extraordinarily beautiful site sits at the crest of the North Saskatchewan River bank overlooking downtown Edmonton.

Rev. Richard Smith, Archbishop of Edmonton today, made one remarkably influential statement at the outset of the new St. Joseph Seminary project in 2007: "The Catholic Church thinks in hundreds of years." That one simple declaration helped shape the entire design, guiding the project team to create a beautiful seminary with a sense of permanence, a modern rendition of traditional church architecture with timeless elegance.

STRUCTURAL ENGINEERING AND ARCHITECTURE ARE CALLED TOGETHER

With the Archbishop's statement as a guiding light, the design team set out to construct a building with a sense of timeless permanence, reinterpreting traditional forms of church architecture—arches, buttresses, and side aisles—with modern materials. In traditional church design the structure and the architecture are inseparable, both created simultaneously by the vision of a single master builder. From the outset, the design team took a highly collaborative approach to the design process, attempting to act in unison as a single master builder made up of many professional experts.

At the heart of the seminary, visually and spiritually, is the new chapel, a sanctuary created entirely with cast-in-place fair-faced visually exposed concrete. The concrete gives the space a character, warmth, beauty and permanence that could not possibly be duplicated by any other construction material. Chalk-white, self-consolidating concrete cast in a single massive pour, the chapel walls are 450 millimetres thick, 11 metres high, and have a visually exposed area of over 700 square metres. The story of the engineering and construction methodology required to construct the chapel successfully is remarkable.

To achieve seamless integration of structural engineering and architecture in the chapel, the structural engineer led the design team through an extensive project management and risk control plan. Through the construction manager, the concrete supply and formwork contractors were engaged early in the design phase to provide technical input.

The risks of casting nearly 350 cubic metres of a highly customized concrete mix—without construction joints—while achieving the highest possible levels of architectural finish are daunting. The entire project team—structural engineer, architect, interior designer, construction manager, formwork contractor, formwork supplier and concrete supplier—all worked together for more than 18 months to develop a methodology that proved wonderfully successful.

Literally every detail of the chapel was painstakingly thought out in advance: the size and location of every form tie; the type, size and orientation of every sheet of formply; the development of specialized formwork details to create sharp 90° exterior corners without chamfers; special structural reinforcing for crack control; and countless test batches to confirm the best colour, texture and porosity of the concrete. Portions of the formwork were even lined with fabric to create a concrete that has an amazingly soft and tactile appearance.

Functionally, the massive yet elegant concrete walls of the chapel act not only as the finished interior surface, they also serve to provide protection from the noise and vibration of the outside world, to regulate temperature through their thermal mass, to provide a long reverberation time for enhanced acoustical performance of the pipe organ, and to act as a simple white backdrop for coloured light filtering through seven historic stained glass windows.

ST. JOSEPH SEMINARY, EDMONTON, ALBERTA

The project team believes the chapel at St. Joseph Seminary is one of the finest examples of architecturally exposed cast-in-place concrete in North America. Without doubt, it was the most challenging—and most successful—experience that anyone on project has ever encountered for designing, planning, testing, casting and protecting beautiful concrete.

Structural steel also plays a vital role in the reinterpretation of traditional church architecture. Daylight in the narthex emphasizes intricately detailed structural steel, and steel arches on the aisles reinterpret the flying buttresses of traditional cathedral architecture. Within the chapel, artistically sculptured structural steel gives support to gracefully curved walls that hint at the wings of a dove and act as a backdrop for the altar. Outside, the 15 metre glazed bell tower supports a structural steel cross 7 metres high, creating a beacon for the Catholic Campus that can be seen for miles across the river valley.

The structural engineer also coordinated closely with the other engineering disciplines to create truly integrated building systems. For example, the columns of the bell tower act as ducts carrying warm air to the windows, eliminating the need for radiant heating that would be visually unappealing. Similarly, the girts around the narthex provide lateral stability to the exterior columns, support the floor-to-ceiling glazing, and conceal the radiant heating pipes. The radiant heating pipes are placed within the upper portion of the girt, which was designed to promote air flow and thereby prevent condensation on the windows on extremely cold days.

Within the chapel, the rear wall is all glass, featuring seven more historic stained glass windows. This wall is framed elegantly with columns that appear extremely slender—so slender, in fact, that they are hung from the roof so that they act in tension for improved stability. The graceful and delicate appearance of the structural steel framing contrasts with the permanence of the concrete walls, and both steel and concrete are commanded by the beauty of the stained glass itself.

CONCLUSION

The quality of design, detailing, fabrication and construction for St. Joseph Seminary unsurpassed and recalls the craftsmanship of times of old. Responding to the Archbishop's declaration that "The Catholic Church thinks in hundreds of years," the design team has provided a sense of beauty and permanence that can endure for centuries.

Today the project stands complete, on budget, with a construction cost of $33.5 million dollars. St. Joseph Seminary is currently on track to achieve the owner's target of a LEED Silver designation with the Canada Green Building Council.

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DIALOG

The Archbishop of Edmonton made one remarkably influential statement at the outset of the new St. Joseph Seminary project in 2007: *"The Catholic Church thinks in hundreds of years."* That one simple declaration helped shape the entire design, guiding the project team to create a beautiful seminary with a sense of permanence, a modern rendition of traditional church architecture with timeless elegance.

STRUCTURAL ENGINEERING AND ARCHITECTURE ARE CALLED TOGETHER

With the Archbishop's statement as a guiding light, the design team set out to construct a building with a sense of timeless permanence, reinterpreting traditional forms of church architecture—arches, buttresses, and side aisles—with modern materials. In traditional church design the structure and the architecture are inseparable, both created simultaneously by the vision of a single master builder. From the outset, the design team took a highly collaborative approach to the design process, attempting to act in unison as a single master builder made up of many professional experts.

At the heart of the seminary, visually and spiritually, is the new chapel, a sanctuary created entirely with cast-in-place fair-faced visually exposed concrete. The concrete gives the space a character, warmth, beauty and permanence that could not possibly be duplicated by any other construction material.

Structural steel also plays a vital role in the reinterpretation. Daylight in the narthex emphasizes intricately detailed structural steel, and steel arches on the aisles reinterpret the flying buttresses of traditional cathedral architecture. Within the chapel, artistically sculptured structural steel gives support to gracefully curved walls that hint at the wings of a dove and act as a backdrop for the altar. Outside, the 15 metre glazed bell tower supports a structural steel cross 7 metres high, creating a beacon for the Catholic Campus that can be seen for miles across the river valley.

THE CHAPEL

The chapel is at the centre of daily life at the seminary. Constructed of chalk-white self-consolidating concrete cast in a single massive pour, its walls are 450 millimetres thick, 11 metres high, and have a visually exposed area of over 700 square metres.

Built with some of the most strict appearance controls imaginable, the interior surface of the chapel wall is the final visually exposed finish–created without sandblasting, sack-rubbing or any other cosmetic treatment. The result is a stunning space that beautifully portrays the simplicity and elegance of concrete, framing seven historic stained glass windows made in France in the 1950s that were salvaged from the old St. Joseph Seminary campus in north Edmonton. Seven more windows are framed in structural steel around the entrance to the chapel.

Literally every detail of the chapel was painstakingly thought out in advance: the size and location of every form tie; the type, size and orientation of every sheet of formply; the development of specialized formwork details to create sharp 90° exterior corners without chamfers; special structural reinforcing for crack control; and countless test batches to confirm the best colour, texture and porosity of the concrete. Ultimately, the decision was made to cast the entire chapel as a single pour to eliminate construction joints entirely. Portions of the formwork were even lined with fabric to create a concrete that has an amazingly soft and tactile appearance.

Functionally, the massive yet elegant concrete walls of the chapel act not only as the finished interior surface, they also serve to provide protection from the noise and vibration of the outside world, to regulate temperature through their thermal mass, to provide a long reverberation time for enhanced acoustical performance of the pipe organ, and to act as a simple white backdrop for coloured light filtering through the stained glass windows.

The strength of the concrete is no less important than its appearance, as the walls of the chapel also act structurally. In addition to its structural reinforcing, extreme care was given to crack control reinforcing so that no cracks would be visible to the naked eye. Form and function are one.

Awaiting the first glimpse of the completed chapel concrete was exciting and nerve-wracking for the entire project team. As the formwork was stripped away, the entire project team waited with nervous anticipation to see the finished product: What if something had gone wrong inside the form? Will it be as beautiful as hoped? Will the extensive risk-control plan really work?

What the formwork revealed was even more beautiful than expected, a testament to the incredible cooperation and hard work of everyone on the entire project team. Thanks to craftsmanship in concrete, the chapel at St. Joseph Seminary has quickly become a testament to faith that will serve and inspire for centuries to come.

The project team believes the chapel at St. Joseph Seminary is one of the finest examples of architecturally exposed cast-in-place concrete in North America. Without doubt, it was the most challenging—and most successful—experience that anyone on project has ever encountered for designing, planning, testing, casting and protecting beautiful concrete.

CHAPEL CONSTRUCTION: PROJECT MANAGEMENT AND RISK CONTROL

To achieve seamless integration of structural engineering and architecture in the chapel, the structural engineer led the design team through an extensive project management and risk control plan. Through the Construction Manager, Dawson Wallace, the concrete supply and formwork contractors were engaged early in the design phase to provide technical input.

The risks of casting nearly 350 cubic metres of a highly customized concrete mix—without construction joints—while achieving the highest possible levels of architectural finish are daunting. The entire project team—structural engineer, architect, interior designer, construction manager, formwork contractor, formwork supplier and concrete supplier—all worked together for more than 18 months to develop a methodology that proved wonderfully successful.

Beginning in early 2008, a series of special project meetings were organized by the structural engineer specifically dedicated to the architecturally exposed concrete on the project. From the earliest stages, the design and construction management teams invited specialized concrete subtrades to participate in the design process. That teamwork ultimately ensured the success of the chapel construction.

The following subsections give some indication of the level of complexity and coordination involved with construction of the chapel, which is 30 metres long, 16 metres wide, 11 metres high, and 450 millimetres thick. The east end of chapel behind the altar is semicircular in plan, with a radius of 8 metres.

CONCRETE MIX DESIGN

Extensive concrete trial batch tests were conducted in cooperation with the concrete supplier, Lafarge North America, to determine a mix with the best colour, texture and porosity of the concrete. Self-consolidating concrete was selected to minimize the need for vibration and essentially eliminate honeycombing and bugholes, and to provide a quality of texture resolution to accept linen formliner.

After studying many possible mixes that satisfied the structural and technical requirements, a batch was selected by the architect containing both white cement and titanium dioxide colorant. After the target colour was chosen, four more laboratory trials were performed to create a self-consolidated mix with the appropriate performance, flow, viscosity and colour.

FORMWORK CONSIDERATIONS DURING DESIGN

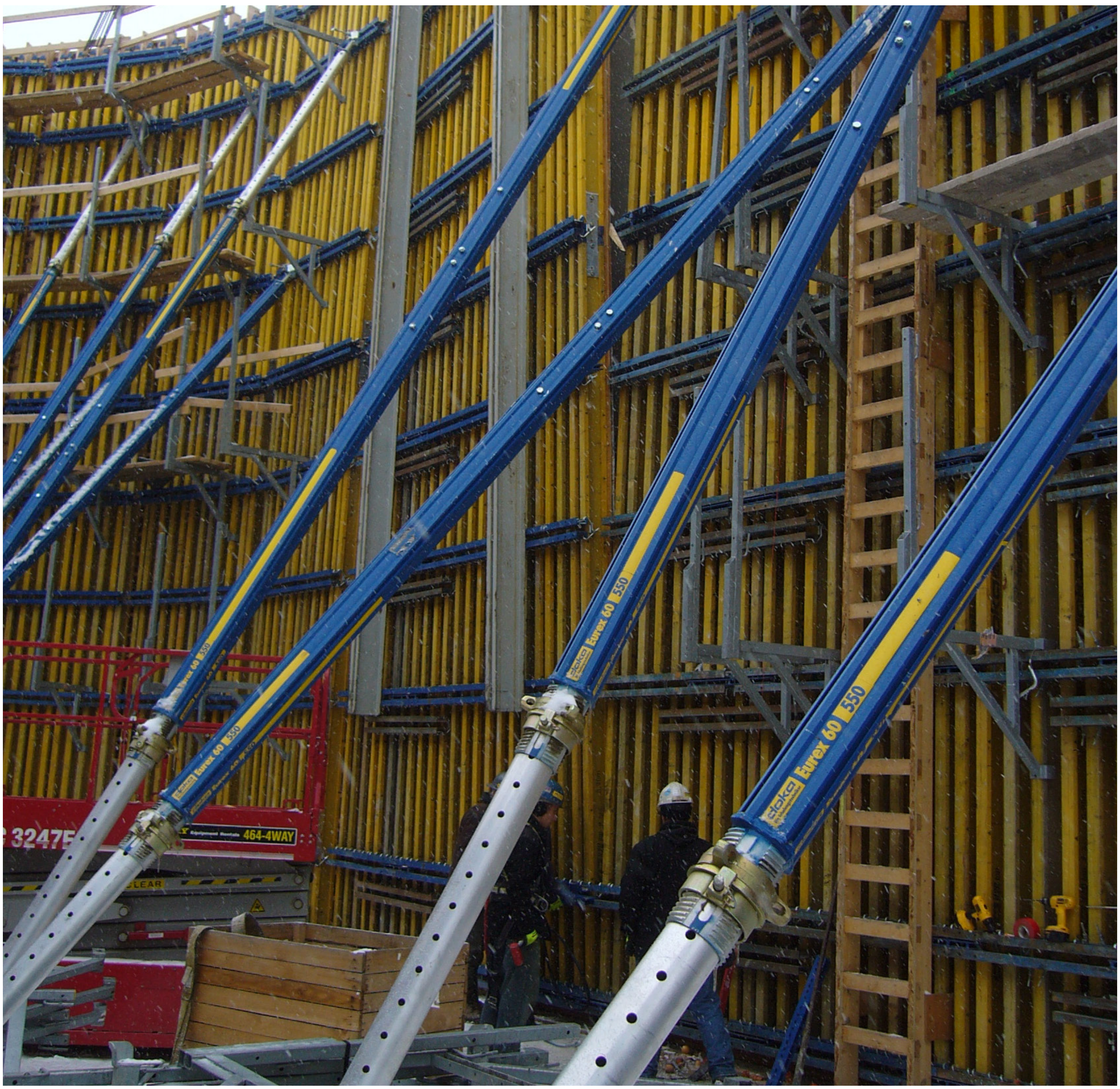
A highly customized concrete mix to achieve a visually beautiful finished product is worthless without formwork of equal quality.

Self-consolidating concrete is extremely flowable and develops lateral pressures on formwork nearly equal to full hydrostatic pressure. The formwork supplier, DOKA, originally proposed to design the formwork assuming full concrete head pressure. However, with the desire to eliminate construction joints, it would have been impossible to cast 11 metres of height using this approach: far too many form ties would have been required, ruining the final appearance.

To manage formwork pressures, the structural engineers worked with Lafarge who developed a form pressure model specifically for the special white self-consolidating concrete mix. Pressure decay curves from the models allowed the team to develop an optimal maximum pour rate of 2 metres per hour. The number of form ties was minimized by taking into account the pressure decay curves. Ties 20mm in diameter were selected to minimize the number required, without becoming so large as to be visually unappealing. After construction of the wall, cone holes at ties were filled in with concrete plugs specially cast with the same mix to match the wall colour.

Knowing the formwork pressure decay curves and the tie size and spacing, attention was turned to achieving a super-flat, smooth wall with a minimum of visual blemishes. In consultation with the formwork supplier, the design team reviewed many formply options and eventually selected High Density Overlay (HDO) plywood to provide the highest quality surface finish. The hardness of HDO plywood reduces the risk of plywood face damage during construction. Every form panel joint and every form tie were detailed on the design drawings. All formply was sealed with polyurethane to make certain that surface moisture differences would not result in colour variations, especially along panel edges.

Formwork whalers were spaced at 150 mm on centre to limit formply deflection under concrete pressure. Formply at inside corners of concrete was mitred to avoid plywood edge pattern on finished concrete surface, and specialized formwork details were developed to create chip-free 90° exterior corners without chamfers. Portions of the formwork even lined with fabric to create concrete that has an amazingly soft and inviting appearance.



STRUCTURAL REINFORCING

The structural engineer needed to manage the risk of vertical cracks developing in the continuously cast walls as a result of horizontal shrinkage of the concrete. Options considered included post-tensioning the walls and the addition of shrinkage-compensating admixture in the concrete mix. Ultimately, the complexities associated with post-tensioning made it impractical, and the added cost of shrinkage compensating admixture was judged unnecessary. The approach chosen was to provide additional skin reinforcing for the concrete consisting of 15M @ 200 each way, each face, in addition to reinforcing required for structural strength. That skin reinforcing has served to control cracks to sizes not easily visible to the naked eye.

Reinforcing was chaired and tied only to the outside face of the wall so that no wire or chairs would be visible on the interior concrete surface. The inside face of the formwork was erected first, allowing rebar to be tied in place before "buttoning up" the outside form. During rebar placement, the formply on the inside face of the wall was protected from accidental damage by full height woven geotextile fabric.

CONSTRUCTION SEQUENCE AND RISK CONTROL

Many options were considered for possible construction joint locations, but none could achieve the desired seamless appearance. Ultimately, the design and construction teams decided to cast the entire wall in a single pour. Using a single pour not only eliminated joints, but also helped to ensure colour consistency throughout the wall surface.

The design team required the construction manager to build three wall segment mock-ups at 1:1 scale to confirm variables such as mix performance, formwork details, form coating, form liner, and release agent. Adjustments to the mix and formwork construction details were tweaked and improved with each successive mock-up. Approaches for tying and chairing the reinforcing only to the outside face of the wall were developed, allowing the exposed face completely free of wire or chairs. The mock-ups were also used to develop and test effective repair methods in case form damage or concrete damage occurred on the actual wall. The mock-ups were also designed with sustainability in mind: they are now permanent features on the Seminary site, acting today as site signs and garden walls rather than being discarded at the end of the testing process.

In advance of chapel wall construction, extensive co-ordination meetings were held to ensure that all parties were well versed in the detailed plans for the pour. Extremely detailed shop drawings for all formwork components were prepared and reviewed in great detail. Detailed architectural and structural engineering reviews of all formwork were made in advance of placing concrete. The forms were disassembled and improvements were made several times before they were accepted.

To ensure a steady supply of consistent concrete, Lafarge dedicated an entire batch plant production specifically for the chapel, eliminating the risk of cross-contamination of colour from other mixes. Aggregate and cement were stockpiled in advance to ensure consistency of colour and texture. Each batch produced was exactly the same size (5.5 cubic metres) to decrease risk of colour or texture variation. Extra trucks were held on standby in case of mechanical malfunction, batch rejection, or serious traffic delays.

The wall was cast on October 1, 2009. The weather forecast was monitored closely to ensure that rain or cold temperatures would not adversely affect the pour. A backup pour date had been arranged in case of threatening weather. Concrete was placed simultaneously by four concrete pump trucks, ensuring a uniform rate of concrete placement around the perimeter of the chapel. A fifth pump was set up on standby in case of failure of one of the primary pumps, but was not required.

To ensure safety and confirm that actual conditions met the predicted pressure decay curves, Lafarge installed pressure transducers on the formwork. Measurements confirmed that pressures were maintained below the maximum rating of the formwork, and correlated well with the predicted pressure decay curves. The specialized personnel and equipment required for the monitoring work were brought in from Vancouver.

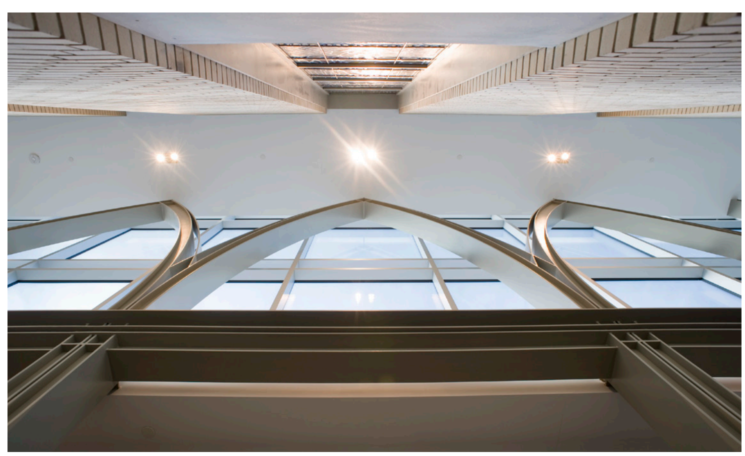
Despite the use of self-consolidating concrete, a risk existed that air pockets might become entrapped beneath the large openings for the stained glass windows. Wall-mounted vibrators bolted to the formwork were placed around the entire perimeter of the chapel and were used intermittently until the concrete reached a height of 3 metres, well above the bottom of the openings.

Following concrete placement, the formwork was left in place for approximately 72 hours before being “cracked” to loosen it and reduce the risk of the forms becoming permanently adhered to the concrete. Forms remained in place for two weeks to protect the concrete from excessive drying and cold weather, ensuring excellent curing and reducing the risk of shrinkage cracking. After formwork removal, protective plywood sheets were used to avoid accidental damage during the balance of the construction work on site. The level of detail in the project specifications even included a prohibition on the use of pens and markers on the site that might accidentally mar the finished concrete surface.

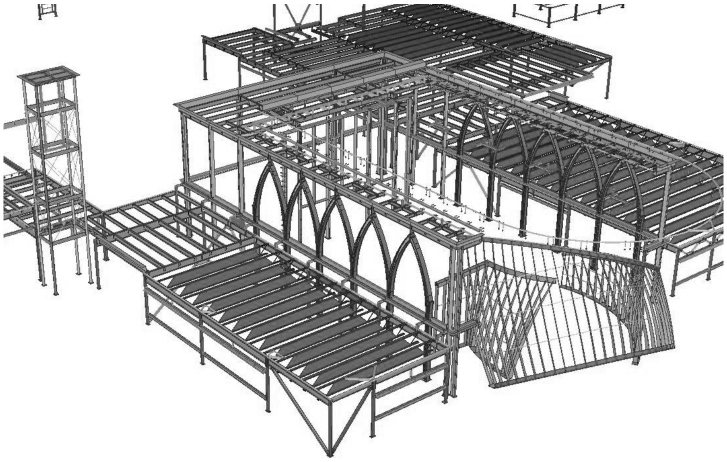
The only finishing applied to the concrete was a silane/siloxane anti-graffiti coating, not to protect the concrete from graffiti, but to allow fingerprints and soot from candles to be wiped off!

ANGELS ARE IN THE DETAILS

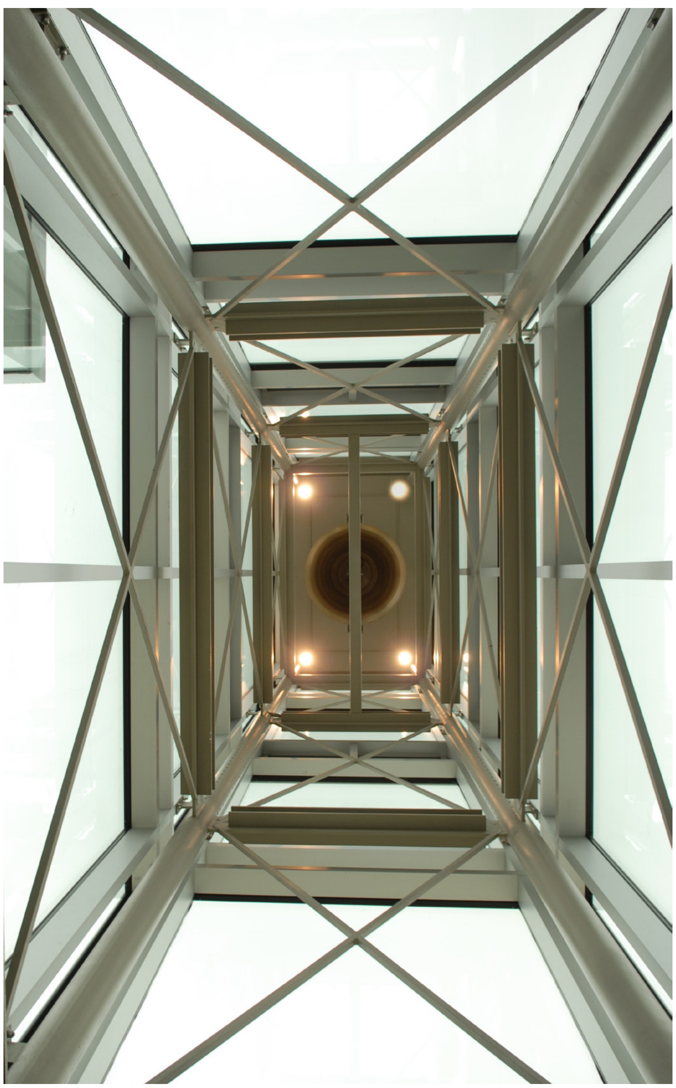
All steelwork in and around the chapel is as artistic as it is structural, meeting or exceeding Architecturally Exposed Structural Steel (AESS) Level 4. The arches are completely custom shapes built up as from tailor-cut steel plates. Throughout the design, detailing, fabrication, and erection stages, careful attention to permissible locations for welding of the built-up shapes makes them appear almost seamless. Prior to fabrication, mock-ups of the columns—first half-scale, then full-scale—were built to confirm that the arches would be constructible and meet the stringent artistic appearance requirements. A great success, the steel provides a light and modern reinterpretation of what traditionally would have been made from stone, making a showcase of the simple beauty of the material. Shadows cast by the arches on the plain concrete backdrop enliven the aisles on sunny days.

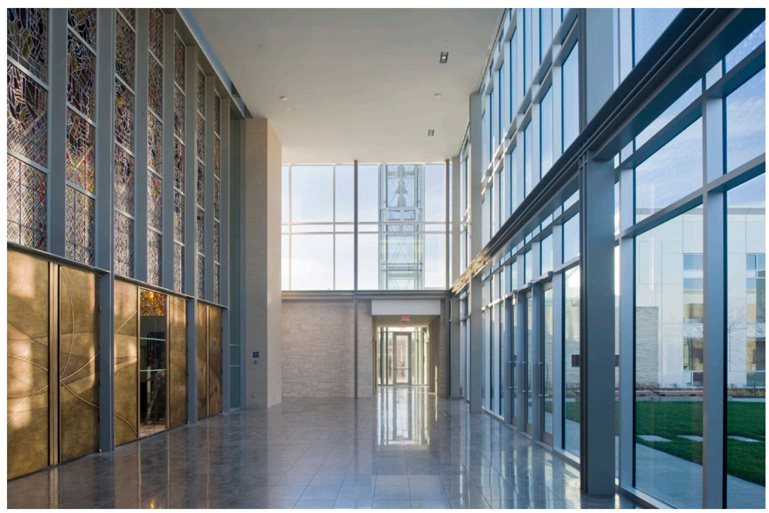


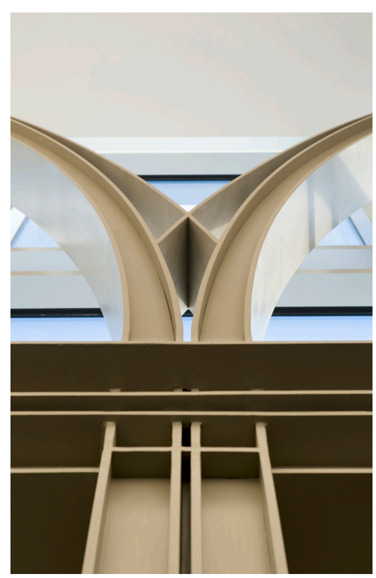
The curving walls that serve as a background to the altar were designed as free-form shapes using three-dimensional computer modelling. These walls serve to provide a sense of being wrapped within the altar, while also providing important acoustical dampening to the chapel. The electronic model was transferred to the detailer so that shop drawings could be created directly without detailed print drawings. The wall was created using a series of plasma-cut plates joined together with plates top and bottom. This frame was then filled in with plywood and covered in acoustic plaster. Structural steel was chosen as the backbone of these walls because of its strength, adaptability, and light weight.

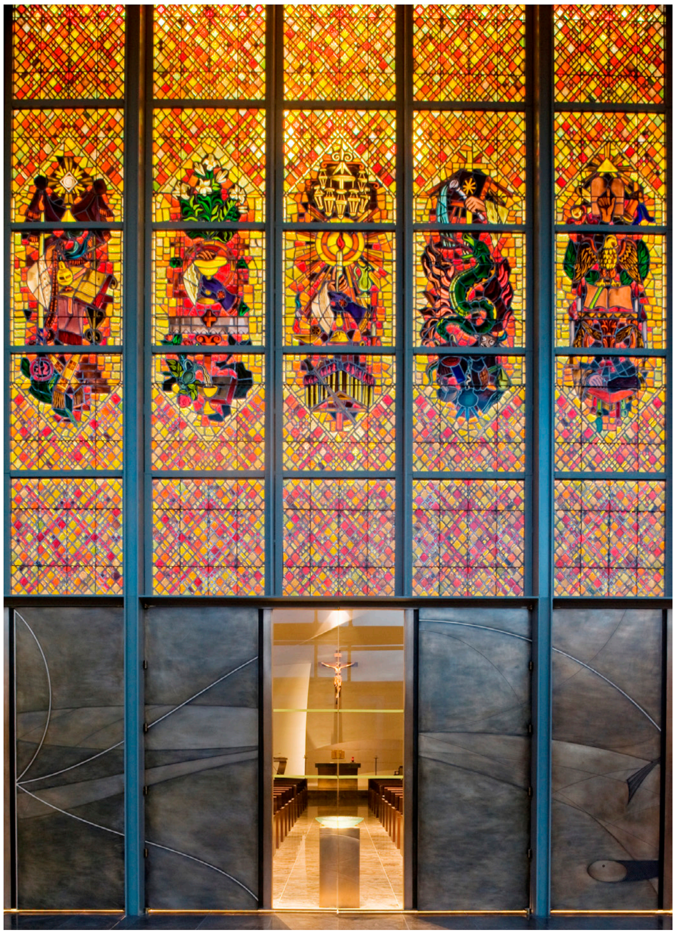


The structural engineer also coordinated closely with the other engineering disciplines to create truly integrated building systems. For example, the columns of the bell tower act as ducts carrying warm air to the windows, eliminating the need for radiant heating that would be visually unappealing. Similarly, the girts around the narthex provide lateral stability to the exterior columns, support the floor-to-ceiling glazing, and conceal the radiant heating pipes. The radiant heating pipes are placed within the upper portion of the girt, which was designed to promote air flow and thereby prevent condensation on the windows on extremely cold days. The return line is hidden within the lower portion of the girt, which has removable panels on one side to allow maintenance access. The arch columns also incorporate integration of the electrical systems, with conduits hidden within the custom hollow shape for lighting and other power systems.









Within the chapel, the rear wall is all glass, featuring the remaining seven historic stained glass panels (recall that the other seven are framed by the concrete walls). This wall is framed elegantly with columns that appear extremely slender—so slender, in fact, that they are hung from the roof so that they act in tension for improved stability. The graceful and delicate appearance of the structural steel framing contrasts with the permanence of the concrete walls, and both steel and concrete are commanded by the beauty of the stained glass itself.

CONCLUSION

The quality of design, detailing, fabrication and construction for St. Joseph Seminary is unsurpassed and recalls the craftsmanship of times of old. Responding to the Archbishop's declaration that "The Catholic Church thinks in hundreds of years," the design team has provided a sense of beauty and permanence that can endure for centuries. The vision provided by the Archbishop empowered the design team to draw upon the traditions of stone cathedrals from a bygone era, reinterpreting traditional church architecture with modern techniques. Schedule and cost, while important on the project, were not as vital when viewed through the lens of centuries. Providing a space for worship that will serve and inspire exceptionally for generations of seminarians was the primary responsibility of the project team.

Today the project stands complete, on budget, with a construction cost of $33.5 million dollars. St. Joseph Seminary is currently on track to achieve the owner's target of a LEED Silver designation with the Canada Green Building Council.

ST. JOSEPH SEMINARY – PROJECT CREDITS

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DIALOG

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Concrete Product Supplier
Lafarge North America

Rebar Supply and Install
Sherwood Steel

Steel Detailer
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