Notre Dame Cathedral
Ottawa, Ontario

Plaster Conservation at Notre Dame Cathedral

Report compiled by

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INTRODUCTION

HPCS assembled a team of 18 technicians to undertake the work. Rod Stewart directed the team. Site supervision and organisation was by Eric Stewart. The team members are pictured below.

From left to right: Shawn Selway, Christopher Layton Thomas, Deirdre Poole, Karen Scott, Jeremy Kerr, Amelia Stewart, Andrew Russell, Clarence Zebruk, Shawn Erskine

Absent from the photograph: Elizabeth Saikali, Mike Sainchuk, Muriel Morris, Jason Beaudet, Phil Ebbrell, Francis Ebbrell, Alex Barber, Rod Stewart, Eric Stewart

Subconsultants and special suppliers to HPCS on the project were:

Martin Weaver of Martin Weaver Conservation Consultants Inc.
Craig Sims, Heritage Consultant
Robert Triebe, of Jaques Whitford Environmental Limited
Port Hope Patterns Limited

Plaster Conservation as executed at Notre Dame was preceded by a thorough investigation of all relevant conditions. Two condition reports were prepared by HPCS in early 1999 for review by the architect. In the absence of expertise on the subject of plaster conservation, Professor Ian S. Hodkinson of Queen's University, Kingston, Ont., was consulted for an opinion of the HPCS recommendations. The Hodkinson report entitled <u>Review of the Recommendations for the Conservation of the Lath and Plaster Ceilings over the Nave and Side Aisles of Notre Dame Cathedral, Ottawa</u> is appended.

The scope of work that was finally executed was based on these reports and was carried out in three stages.

- Stage One: An initial contract covered the ceiling of the nave and sanctuary, the crockets and the ceilings of the gallery of the sanctuary.

- Stage Two: A second contract carried out under a change order to the initial contract conserved the plaster columns in the sanctuary, the ribs that cross the nave and sanctuary, replication of missing ornament, and a host of other specific items.

- Stage Three: A third phase of work was in the way of a donation of services by HPCS to the Archdiocese in which column capitals and drops at the sanctuary walls were conserved or replicated.

These three stages of work provide the outline for this report. Each element of work is given an individual chapter in the report in which all relevant information is described. The Appendices consist of sub-reports, technical data sheets and other documents that support the text.

Plaster conservation activity got underway on March 15, 1999, and continued through July of that year.

Stage One: Initial Contract Phase

NAVE AND SANCTUARY CEILING

The nave and sanctuary ceilings are of plaster over wood lath. Up to 40% of the plaster was in precarious condition due to damage to the keys and lugs that suspend it from the wood lath. There was no evidence of structural damage from water infiltration, and none of the plaster had actually given way.

Typical conditions illustrated in the HPCS pre-conservation plaster condition report.

1 Typical test section of plaster after insulation removal before testing of the lugs.
2 The same section after lug testing and cleaning. White sections are removed lugs.
3 Removed material.

In Test Area 9, shown above, there was a total of 105 linear feet of effective lugs. 36 linear feet were found broken. The percentage of unsound plaster was therefore 34%. 20 test areas were examined.

Of great concern was that a major restoration was planned for the interior of the cathedral, which had been redecorated in the 1930s. The programme included extensive cleaning and restoration work on all decorated interior finishes. The ceiling would be repainted in a colour scheme based on research of earlier finishes.

If conventional plaster repairs were undertaken, all estimates suggested that up to 50% of the plaster might be lost. In a conventional process, it would be replaced with new plaster or drywall. Apart from the obvious fact that replacing original plaster with new material is undesirable from a conservation standpoint, there is also the serious issue of the impact such a wholesale plaster replacement process would have on the rest of the interior of the building.

The activity of removing loose plaster is extremely dirty and would result in all the dust and debris from above the plaster being added to the dust and grit of the plaster itself being deposited in the interior. The replacement process of resurfacing the wood lath with wire or gyprock lath is also a gross activity, inevitably creating a large amount of construction debris.

Concern for delicate surfaces and ornament throughout the site underscores the need for a conservation approach that deals with the plaster problems without creating collateral damage to other important features of the cathedral. The consolidation of nave and sanctuary plaster was carried out from within the attic space above the ceiling. Large exhaust fans were installed in the attic to improve ventilation for the technicians, remove airborne dust, and eliminate the harmful effects of the methanol used in plaster consolidation.

The construction manager's forces removed old insulation and debris from the attic.

The entire upper surface of the ceiling was carefully cleaned with vacuums.

Special rigging was required to permit the safe access of workers over the entire attic surface. Deep ravines in the attic correspond to the soaring arches visible in the Cathedral below.

Each plaster key was hand tested, and where found loose, removed. Further vacuum cleaning left the upper surface of wood lath and plaster dust-free and ready to accept the consolidants.

Large quantities of loose broken plaster and debris of all sorts was removed from the attic. Only after this kind of thorough cleaning can the plaster be successfully consolidated. Once cleaned, the plaster is ready for consolidation.

Cleaned and ready for consolidation.

Much of the debris and garbage that had accumulated in the attic over the past century was a potential fire hazard.

A dilute mixture of acrylic resin and methanol (15% resin) was spray applied to the surface with agricultural backpack sprayers. The methanol, acting as a surfactant, wets the surface and allows the resin to penetrate deep into the plaster. Three applications of diluted resin (15%, 30%, and 50%) were done, finishing with an undiluted final coating of resin. In this process, the methanol evaporates into the attic atmosphere and is exhausted by the fans. This leaves the resin deposited in the plaster. The acrylic resin used is 46% water, and 54% resin solids. After the evaporation of the methanol, the resin coalesces, with its water content evaporating to be exhausted outside the building.

The condition of the plaster after this stage is much improved. It is a uniformly strong, coherent material - consolidated - where before it had been crumbling and of very uncertain and diverse quality.

SAFETY: Workers were protected primarily by the stringent control of concentrations of vapour in the atmosphere. This was accomplished with a complex temporary ventilation system and continuous monitoring. Concentrations of methanol never exceeded 200 PPM. Jacques Whitford Environment Limited designed the workplace safety protocols.

Following a period of curing and evaporation, the missing plaster keys are replaced. A thick gelatinous adhesive was made from the same acrylic resin and mixed with lime, fluid petroleum coke and micro-balloons. For application, the adhesive was loaded into 300 ml caulking tubes. 750 tubes of this material were used on the cathedral plaster conservation.

The adhesive is carefully gunned into the spaces between the laths where the loose keys had been removed. It bonds to the consolidating acrylic and provides the structural strength required to hold the plaster to its substrate.

The process changes the wood lath and plaster system from being essentially a suspended ceiling system - the weight of the plaster supported by the lugs and keys - to an adhered system - the weight being carried by the bond of the adhesive between the consolidated plaster and the substrate.

Work was carried out over a six-week period with no loss of original plaster, and no indication from within the cathedral space that anything had changed. Materials used in the process are:

Rhom & Haas acrylic resin Rhoplex MC76. This is a water-soluble pure acrylic emulsion available in drums. Most commonly, MC76 is employed as a cement and stucco modifier. HPCS has used it as a plaster consolidant in historic buildings since 1985.

It is combined in various ratios with three fillers:

Petroleum fluid coke is a filler in the adhesive. It is a granular carbon powder that expands in the presence of the water base in the Rhoplex. The expansion corresponds exactly to the shrinkage that occurs in the Rhoplex as it coalesces and loses moisture. This results in a stable non-shrinking adhesive.

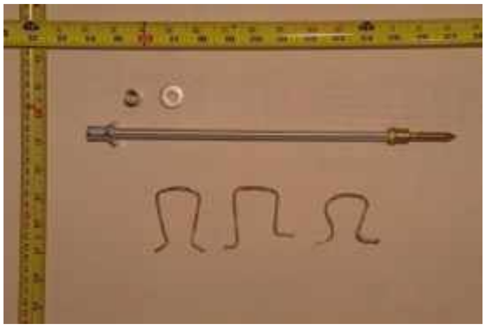
Hydrated lime is a filler in the adhesive.

Micro-balloons are a filler in the adhesive.

The three fillers, each with a different granular size, act as aggregates in the adhesive, providing strength and volume.

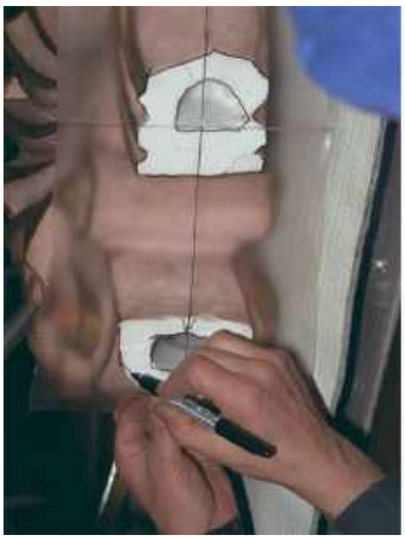
CROCKETS

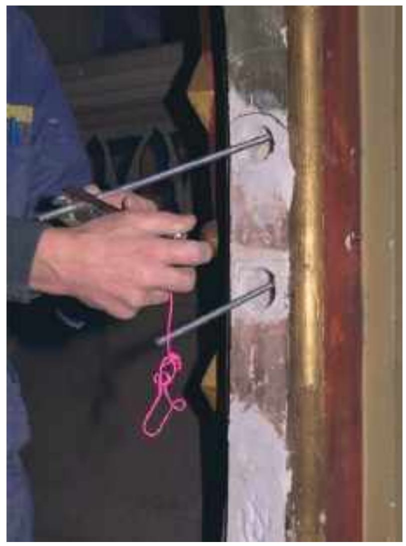
The crockets at Notre Dame are made of
hollow slip -cast plaster. Wall thickness varied



from over one inch to less than 1/8th of an inch. They were attached to the ceiling rib with a dab of simple plaster of Paris bonding combined with a light wire clip buried in both the rib and crocket. The crockets weigh up to 40 lb. and are evenly spaced along the sanctuary rib between 35 and 65 feet above the altar.

Initial inspection indicated up to seven of the crockets had broken their plaster connection and their attachment was dependent on the fine metal clips and the web of light piano wire loosely slung under them and fastened to the outsides of the rib. It was evident that this wire was a later addition that tried to address the danger of these elements falling to the floor. Clearly, there was a safety concern that had to be addressed in any conservation scheme.





Matching holes were enlarged within the attachment "footprint" surface of the crockets, so that when the crocket was in place, there would be a pair of 1 ½" holes connecting the interior of the crocket with the interior of the rib.

The crocket was fitted over the rods and held in place with temporary fastenings. This left the rods extended 12" to 16" inside the hollow crocket. The crocket ends of the rods are fitted with large washers and nuts.

A pair of 1" holes were drilled through the top of the crockets.

HPCS removed all 18 crockets and carried out the following conservation procedure on each one.

Repairs were made with light plaster of Paris. Every effort was made to preserve the original painted and gilded finish. The wall thickness of the crockets varied from 1/4” to two inches.

The original fastenings were simple wires bent in a “U” shape and embedded in both the crocket and the cathedral rib during installation.

The replacement fastening shown here is a stainless steel rod with a wood-cutting thread on one end and a series of nuts and washers on the other.

SANCTUARY GALLERY CEILING

The sanctuary gallery ceiling is of typical wood lath and plaster. Investigation had indicated that up to 1/3 of the plaster keys and lugs had broken over time and that large segments of the ceiling were in danger of collapse. In many areas, large plates of plaster had indeed settled away from the substrate and were being held in place by the jamming of the cracked edges of the plaster against adjacent pieces. The surface of this ceiling system is only partly visible from the nave. Plaster stars once decorated the surface of the ceiling. Today, only a few remain intact. For reasons of economy, the decision was taken to stabilise the plaster in its present dislocated condition rather than go to the considerable expense of realigning the dislocated planes back to their proper position.

Access to the sanctuary gallery ceiling was gained by lifting portions of the sanctuary arcade floor. The construction manager did this work for HPCS. Ventilation was provided throughout this work, and confined space safety requirements were met for the safety of the technicians.

The conservation process for this area was as follows:

All plaster keys were hand-tested, with the removal of any that were considered loose or broken.

The plaster surface was thoroughly vacuumed.

Acrylic resin in a dilution, with methanol, of 15% resin was liberally applied in several applications to ensure complete penetration.

Further applications of resin in dilutions of 30% resin and 50% resin were made.

A final application of 100% acrylic resin was applied.

A filled adhesive consisting of acrylic resin, micro-balloons, lime and fluid petroleum coke was applied from caulking guns to replace the plaster keys that had been removed.

Following conservation, the plaster is stable and well-attached.

Using a traced template as a guide, a pair of 1 1/2" holes were bored through the plaster rib face within the "footprint" of the crocket-mounting surface. Two parallel attachment rods were wound into the wood structure of the rib.

Typically, any conventional repair would have been at the expense of marble faux finish. Conservation here included removal of a previous repair.

A carefully calculated quantity of low-density expanding urethane foam was mixed in several small batches. This material was poured into the crockets and allowed to expand. The low density of it means that expansion is gentle and gradual.

Within twenty minutes the foam expands to fill the crocket and extrudes through the connection holes into the rib core where it forms a small mushroom shape. Thus the crocket is reattached. The foam locks around the rods and bonds to the inside surface of the crocket.

The connection of the crocket to the rib was to be flexible but discreet. To this end, an acrylic caulk was used to fill the hairline joint.
The crocket tail element was then razor-cut off the crockets and securely fixed to the rib face. The joint between crocket and crocket tail was made flexible with the same acrylic caulk.

Fastening the crocket tail to the rib was done with a countersunk 1/4" lag screw installed in a predrilled hole through the tail into the structure of the rib. The temporary wire straps were removed and cosmetic repairs were carried out to cover all drilled holes.

The foam used is a low-density (2 lb. per cu. ft.) urethane commonly used as a flotation material in boat manufacturing. It is a closed cell material that is very stable and resistant to water or water vapour, mildew, insect attack, and has no properties that would cause a conflict with any of the material around it. The stabilising effect of this foam filling the cavity of the crockets is quite remarkable.

With their new shock-absorbing flexible mounting, the crockets are free to vibrate with the building structure, as it no doubt will continue to do.

Cosmetic repairs and finish conservation were executed by others after the reattachment.

PLASTER COLUMNS

The columns in the cathedral are decorative and have no structural role. Typically, with a few exceptions, they are made of wood lath covered in plaster much the same as a wall or ceiling system would be constructed. One-inch thick by 12-inch

diameter circles of rough pine was covered in lath to produce a cylindrical object of the desired length. This was rough plastered and finished with a gypsum putty coat. Painted decoration to simulate marble was applied over the putty coat and finished with a glossy varnish.

Deterioration of the columns was caused over the years by slight movements in the building. The thin and brittle plaster coating with its fine structural keys in the cylinder could not withstand this flexing. Additionally, many nails and fasteners were found installed haphazardly in the columns. Most of these caused fracturing that required attention. In some places whole sections of plaster had broken away from the cylindrical forms and only stayed in place by the friction of adjacent secure plaster.

TREATMENT OF COLUMNS

As elsewhere, the consolidant used consisted of various dilutions of Rhoplex MC76.

Technicians used hypodermic injection through surface cracks to inject the material. The consolidant was made to penetrate to the wood lath core of the columns and bond the plaster to the wood. In some areas, there were large curved sections of column surface that were completely delaminated. These were removed, cleaned and reattached using an adhesive based on Rhoplex and fillers, as with common plaster surfaces.

In repair areas where the finish plaster was completely missing, new material was cast in place using a smooth Mylar form around the adjacent cylindrical shape. This provided a seamless repair that did not affect any surrounding painted finish.

In all cases, our intention was to stabilise the plaster with minimal intervention. Retention of the faux finish was paramount.

The two exceptions to this construction method are:

Two solid plaster columns at the outer corners of the altar consist of two-foot long hollow cast plaster of Paris sections stacked together like chimney pots to produce the desired floor-to-ceiling height. These have a cast double-helix spiral-like decoration that produces a diamond pattern on the surface. Each diamond is decorated with one of four cast plaster elements. The elements are: Scotch thistle, shamrock, fleur-de-lys and Cornish rose.

Repairs of the two cast plaster of Paris columns were by surface injection at the joints with consolidant.

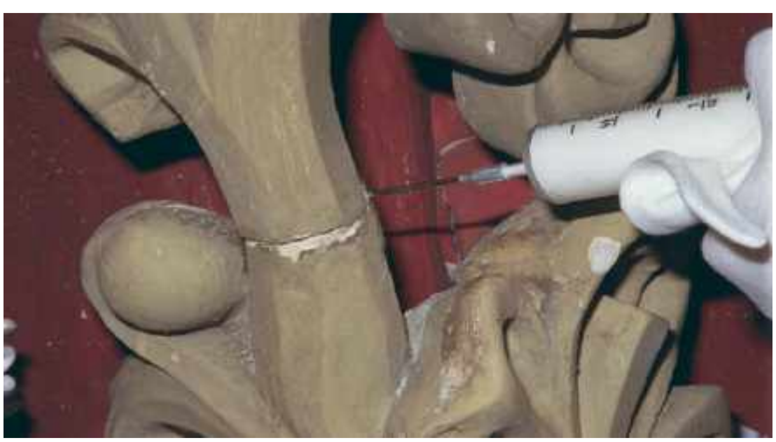
Missing elements were replicated by producing silicone rubber molds of each of the four decorative elements and casting the required replacement units. The replacement elements were cast in plaster of Paris and attached with Rhoplex-based adhesive. Over 150 such replacement elements were required.

The lowest level of columns in the nave consists of structural posts covered for appearance with carefully joined wood. There is no plaster associated with these.

ORNAMENTAL ELEMENTS

This conservation consisted of two phases: Conservation to existing decorative elements, and replication and replacement of missing decorative elements.

A major part of the cathedral decorative scheme consists of hundreds of cast plaster of Paris elements representing various forms of vegetation. In some cases, like along the ceiling ridge, they are applied directly on ceiling surfaces in clusters to make bosses. In other cases, a large cast plaster element makes the base onto which many smaller elements are attached to produce the capital of a plaster column. Some of these elements are hollow slip cast like the crockets, while others are solid. Over the years, many of these elements have fallen off due to vibration or other



accidental trauma. Many are located high up on the cathedral ceiling and at the tops of columns where if they should fall, serious danger to safety would be the result.

Testing and Conservation

All elements were tested by hand for security. This testing consisted of sounding for vibration with a rubber mallet to determine the presence of cracks. Each element is tapped with the mallet while being held by the technician. Even the slightest cracks echo the tapping sound as a rattle that can be felt and often heard by this method.

Slowly, as a vibration is felt, the technician moves the mallet along the surface to isolate the vicinity of the movement. When found, it is tagged and treated with consolidant. After the coalescence, when the consolidant should have tightened the crack, the testing is repeated to determine the presence of any additional vibration. If found, the process is repeated until the tapping with the mallet produces a uniform thud indicating good attachment and no vibration. On the complex ceiling bosses, this process was repeated as many as ten times to ensure that the heavy elements attached there were indeed secure.

In some cases the vibrating element was removed during this process. These was usually where the vibration seemed to emanate from the actual original connection of element to surface. Often the intended connection surface was covered in grime and dust, indicating that the joint had not been made properly in the first place, or the damage had occurred long ago.

In these cases, rinsing with a fine spray of methanol was done to pre-wet the plaster for the consolidant.

In other cases, the element was part of a cluster of attached parts making up a column capital.

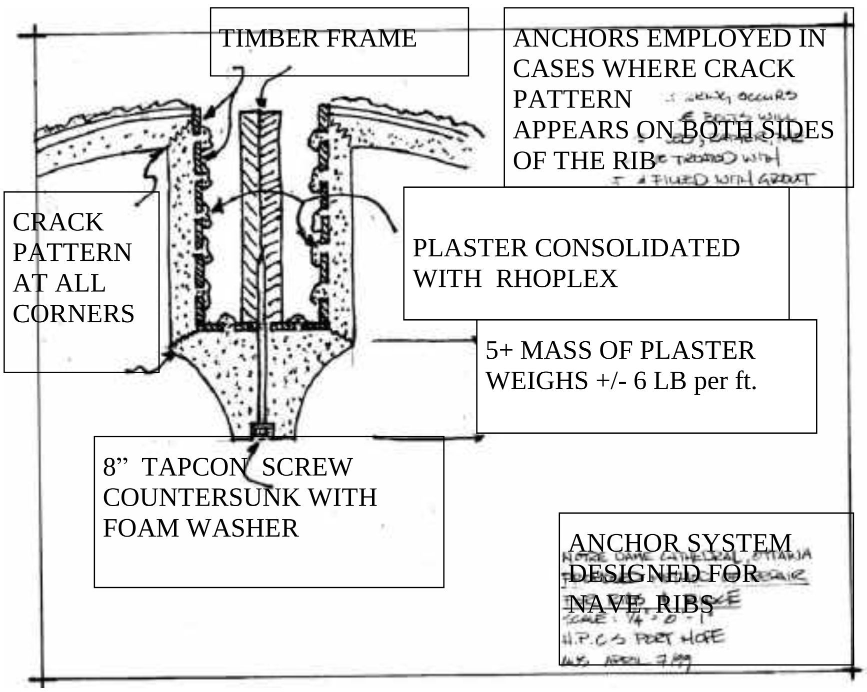
It was determined that some of the plaster elements had failed repeatedly in similar ways. Typical of this class was the element found as part of several column capitals to the spring line of the ceiling arch.

One particularly ornate element that caused concern was a double-headed branch form with a cross-sectional area of less than 1 square inch joining otherwise unsupported parts weighing over three pounds. Of the 26 examples, 14 had failed and broken at the narrowest point, dropping a dangerously heavy part to the floor 50 feet below.

Replication in this case was in low-density urethane foam cast in a mould made from a removed original example. The foam is stable, takes guilding, paint and varnish like plaster, and is easily attached.

Important from a safety perspective, the replica weighs less than three ounces. In the unlikely event that one of these elements should fail, no damage would occur.

Repairs to this element consisted of adding urethane sections where the original had dropped off. Full replicas were cast in urethane and then cannibalised to provide just the section required for the repair. Fracture lines in the original were cut smooth and the urethane repair part was cut to fit. Sections were attached to the original with Rhoplex-based adhesive and reinforced with fine bamboo dowels.



In this way, the original guilding of the subject element was preserved, with infill finishing required only on the urethane replacement portion. In some cases, entire plaster elements have fallen to the floor. In these cases, moulds were created from original existing samples, and replacement parts were cast in either plaster of Paris or urethane. Urethane was used in any case where the part would constitute a safety hazard if it failed.

GALLERY RIBS

Ribs in the gallery ceiling were treated by injection of Rhoplex-based consolidants from the face side. The shape and configuration of the gallery ribs was similar to those in the nave, but being smaller in size, the structural system appears to have been adequate to support the lower mass of plaster. These ribs suffered from a different design flaw.

Consequently, cracking patterns differed from those found on the much larger nave ribs. Here we observed a repeated pattern of cracks running longitudinally down the centre of the face of the ribs. This was not found in the larger nave ribs. This pattern resulted from the framing of the rib interior with two parallel laths making up the sub-face. The cracks simply developed in the unstopped space between these laths. A preferred method of lathing would have interrupted this uniform long gap with the insertion of solid blocks at two-foot intervals. Properly, these blocks would have contained protruding nails or screws for the plaster to tie onto.

Cracks were cut out with a Dremel tool accompanied by a vacuum nozzle to contain dust.

RIBS IN NAVE AND SANCTUARY

The main ceiling over the nave and sanctuary is crisscrossed with plaster ribs. These ribs are not structural in any way but are constructed to follow and highlight the groins and hips that are created by the intersection of window gables. Each rib is +/- 30 feet long. There are 60 ribs in all and, including the central ridge, the total length is over 2,000 feet.

The ribs were constructed during at least two different periods in the evolution of the building. Different techniques were used to make the two types, but the essential system is very similar. The ribs were made of conventional plaster over a wood lath frame. The general shape was created by applying wood lath in strips to a series or profiled boards that were fastened at two-foot intervals along the line of the groin or hip to be embellished.

The ribs are twelve inches wide and protrude below the ceiling as much as sixteen inches. A flat surface of plaster that makes the face is four inches wide with two generous coves returning toward the ceiling and finishing in two parallel sides of eight inches in depth. The body of the ribs above the cove is hollow, with a lath covering its sides and top. The extension to bring out the face and coves is solid plaster. The failure is due to the excessive volume of unsupported plaster that makes up the coves and flat face of the ribs. Essentially, there is a volume of plaster up to eight inches wide and six inches deep running the whole length of each rib that is unsupported with any effective reinforcement. The reinforcement that was originally in place consisted of heavy jute tied to nails left protruding from the inner structural face of the rib. This string line would have been intended to provide something for the wet plaster to grab onto as the form was being built up in layers.

Conservation of the ribs consisted of providing a consolidation process for the conventional plaster and lath portion of the ribs and a mechanical connection between the large unsupported mass of plaster and the structure above.

Consolidation was achieved by application of Rhoplex-based consolidants into the core of the ribs from within the attic. In areas where access was not possible from the attic, discreet holes were drilled through the sides of ribs so that consolidation materials could be injected. Cracks along the ribs provided openings for further consolidation.

The mechanical fastening was necessary because of the large volume of unsupported plaster that made up the lower side of the ribs. It was evident that where cracks were found parallel to the ceiling surface and below the inner frame, this bulk of unsupported plaster was working its way off the ceiling. This was particularly obvious where cracks had occurred on both sides of a given rib.

The mechanical connection system employed was as follows. A 5/8" diameter hole was bored two inches deep through the centre of the face of the rib toward ceiling surface. This hole was extended to full depth with a 3/8" diameter bit. When the bit caught wood the hole was stopped. A long threaded 1/4" lag screw equipped with a 5/8" X 1/2" sponge rubber washer was wound into the pilot hole and tightened

sufficiently to slightly compress the cracks along the rib sides. In a few cases the 3/8" hole missed any contact with wood. In these cases, new holes were bored on either side of the failed hole. This ensured that good mechanical contact was made. The 5/8" holes were filled to the surface with plaster of Paris and repainting followed. Six hundred of these mechanical connections where made through the rib system. The method gave a flexible suspension to the ribs.

ARCADE WALL AND CEILING PLASTER

The walls and ceilings of the arcades are a simply plastered and otherwise unembellished service corridor to the nave attic, to the gallery attics and most important, to the works of the sanctuary organ. They are relatively less in the public view than other spaces in the cathedral. Because of this obscure location, the arcades have never been redecorated since construction. They contain original finishes.

The protection of original plaster in the arcades was not considered as important as in other places even though it was in the worst condition of any plaster found in the project. More important was the consideration of minimising dust and debris that would have resulted from any conventional approach to repairing this plaster. Under normal construction site circumstances, most or all of this plaster would have been deemed worthless and shovelled off the walls and ceilings to be replaced with new plaster or drywall.

A conservation approach was taken not so much to protect the plaster as to prevent or minimise the collateral damage that would certainly be part of a conventional approach. Under normal circumstances, 75% replacement would have been called for. After consolidation, only 5% replacement was needed.

Access to the inner surface of plaster and lath was allowed by drilling through the surface.

The approach consisted of drilling 1 1/2" access holes through the plaster at intervals between the rafters along the highest point of the ceiling. This allowed for the insertion of a wand into the void above the plaster from which a consolidant could be sprayed under moderate pressure.

Large volume spaying through these centrally located access openings caused consolidant to run freely down the interior slope of the ceiling structure and permeate the plaster and lath as it went. In areas where this plaster was badly cracked or in fact missing, leaks of consolidant were unavoidable. This basic process stabilised the arcade ceiling plaster. No attempt was made to recreate missing keys or to otherwise strengthen or reattach the plaster.

Access to the inner side of the arcade wall was through the gallery attic. Here vertical plaster that was unstable was treated with a similar spraying technique.

PLASTER AROUND CLERESTORY WINDOWS

During the project, all the clerestory windows were removed for restoration. The original plaster wall surface returned onto the wood edge of the window frames. This joint had to be broken for window removal. Prior to this work, technicians consolidated the plaster in this area in order to avoid losses that would occur as the windows were removed.

There was a typical expansion/contraction crack pattern where the plaster connection changed from plaster on lath to plaster on stone at the window edge. Technicians used high speed Dremel tools with diamond bits to mill out the cracks 1/8" wide and to the full depth of plaster, either bottoming at the lath or the stone substrate. Consolidant was gently injected to penetrate a wide area around the crack. The cracks were filled with a flexible adhesive based on Rhoplex MC 76.

After window removal and replacement, damage caused during that activity was repaired in a similar manner. New wooden stops were applied at the window edge to finish the joints.

DELAMINATION OF PLASTER AT VARIOUS LOCATIONS

At several locations in the cathedral, specific different delamination conditions presented themselves. These were dealt with individually and being generally on the subject of delamination, are dealt with in this section.

- Delamination of flat plaster on the sides of the arcade openings

The arches of the arcade opening are framed up around 12" square structural timber columns. From the spring line of

the arches - 36' above the railing - to the point, conventional lathing over the arch-shaped framing boards was done. Below the spring line, however, lath was applied directly to the square timber. This method makes no allowance for necessary keying of the base coat of plaster. Consequently, the lower 36" of plaster has cracked along the corners of the timber and separated from the face of the timber and lath in a sheet - solid in its own right - but minimally attached. These sheets of plaster weigh over 10 lbs. and are 40 feet over the nave seating.

Removal and replacement would have resulted in considerable dust and debris. The plaster sheets were injected with consolidant around their perimeter and a 3/8" X 1" pine batten was fastened vertically through the plaster into the timber. Movement around the wood screws that attach the batten was anticipated, in addition to the movement that caused the original breakage and that will presumably continue – that can indeed continue with no further ill effects.

- Delamination of putty coat plaster in the arcade railing panes.

Panels below the arcade openings were decorated with a pattern intended to represent a balustrade. In three of these locations, the surface putty coat of plaster was delaminated in large thin sheets. In one of the locations the material had apparently fallen off and was lost, exposing the rough ground plaster. On the others it was still attached but very loose.