City Registry Office

70 Nicholas Street, Ottawa

Building Relocation Feasibility

April 2022

Prepared By:

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JCAL Project No. 21143

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1 INTRODUCTION

This report is based on a request from Cadillac Fairview to review the structural feasibility of relocating, in its entirety, the City Registry Office located at 70 Nicholas Street.

The investigation was completed by a team of specialists from John G. Cooke & Associates Ltd. (JCAL) (structural) with collaboration from Cadillac Fairview, Zeidler Architecture, Entuitive, Barry Padolsky Associates Inc., Commonwealth Historic Resource Management Reliance Construction of Canada Ltd., CDS Building Movers, Heritage Grade, David Edgar Conservation Ltd., Marathon Underground Constructors Corp, Morrison Hershfield.

This report outlines the feasibility of relocating the building in its entirety, including concepts for temporary support and bracing based on observations of the project team.

1.1 Project Team

The study and report was completed by the following team of professionals:

Chris Vopni, P.Eng, CAHP	(JCAL)	Heritage Structural Consultant
Nneka Murray, P.Eng.	(JCAL)	Heritage Structural Consultant
Natalie Smith, M.A.Sc., EIT	(JCAL)	Heritage Structural Consultant

1.2 Terms of Reference

The terms of reference are as follows:

- Review existing drawings, specifications, and reports.
- Visit the site to conduct a visual non-destructive review of existing interior and exterior conditions where exposed. Structural systems will be reviewed.
- The structural elements (roofs, masonry walls) were visually inspected from grade level. Interior foundation walls and exposed basement structure, as well as interior rooms were also visually inspected.
- Identify areas of minimally destructive exploratory openings to confirm as-built conditions. Review the conditions as they are exposed and instruct further work as applicable.
- Discuss feasibility options and concepts with the Consultant, Contractor, and Ownership groups at regular meetings.
- Prepare concept-level sketches for discussion and consideration by the Consultant, Contractor, and Ownership teams.
- Prepare a draft report outlining the structural feasibility of moving the building in its entirety, noting any temporary or conservation works that would be required. Submit Draft to client for review and comments.
- Prepare a final report for inclusion as an appendix in the Heritage Permit Application. This will include any comments received, including client comments.

1.3 Existing Documents

The following documents were available to JCAL for review:

- Particulars Respecting Registry Offices for the Province of Ontario (ca. 1874)
- Registry Office Relocation Options Analysis prepared by Reliance (September 2021)
- Heritage and Planning Comments – Pre-Application Comments from City of Ottawa (November 4, 2021)
- Heritage Pre-Consultation Presentation, by Zeidler (October 20, 2021)
- Memorandum 1-45 – Barry Padolsky Associates (2021-2022)
- Ottawa Registry Office – Dismantling Plan by David Edgar Conservation Ltd. (March 2022)

The following previous work was completed by JCAL:

- Structural Condition Assessment (July 20, 2021)
- Relocation Options – Structural Assessment DRAFT (January 17, 2022)
- Review of exploratory openings (Feb/March 2022)

The following work was completed concurrently with this report and referenced herein:

- Relocation of Heritage City Registry Office – Overview – CDS Building Movers (April 2022)
- Heritage Moving and Conservation at 70 Nicholas St – Heritage Grade (April 2022)
- Registry Building Relocation Pile Shoring Plan – WSP (April 2022)

2 DESCRIPTION OF THE BUILDING AND ITS CONDITION

The City of Ottawa Registry Office (CRO) is located at 70 Nicholas Street. It was constructed circa 1873 and is designated by the City of Ottawa under Part IV of the Ontario Heritage Act. The building is primarily load bearing masonry with load bearing brick walls set on a limestone masonry foundation.

The wood roof trusses span north-south and bear on the north and south exterior walls. The ceiling is a 3-wythe, 3-span brick vault that spans east-west and bears on the east and west exterior walls and two interior brick walls. Two 1" diameter tie-rods connect the east and west exterior walls and are terminated by a 12"x5"x1/2" steel plate within the wall composition. The interior and exterior brick masonry structural walls are approximately 6 wythes thick. An additional exterior facing wythe of brick is included at the exterior walls. This facing wythe is separated from the loadbearing structure by a 1" cavity and is laterally connected to the structural wall with diagonal bonding bricks that span the cavity, spaced every ±16" horizontally and approximately every 4 courses vertically. The facing brick is complemented by ashlar stone at the window and door surrounds, cornice, and gable/pediment ornamentation. Exploratory work has revealed that the ashlar stones bridge the cavity and provide bonding into the depth of the structural wall.

The stone masonry foundation walls at the exterior perimeter are ±40" thick with rough-cut rubble coursed face stone and limestone rubble back-up. Within the building footprint are rubble stone foundation walls supporting the intermediate loadbearing north-south brick walls with additional east-west walls at ±34" c/c to support the 6"x40" limestone floor slabs. The interior foundation walls are approximately 19" thick and ±13' high, presumed to be founded on bedrock. Exploratory work has confirmed that the stone slabs abut the interior face of the structural walls and do not pass under the brick.

Historically, a brick masonry chimney rose above the roof of the building, however it was dismantled in the past. The chimney will be reintroduced with the forthcoming project following the relocation. The reconstructed chimney will be connected to the building with appropriate reinforcing to meet the requirements of the seismic requirements of the current Building Code.

In general, the structure is in fair to good condition. Restoration work was performed circa 2017 and appears to be performing well. No signs of distress at or surrounding the repairs were observed. Exploratory work was carried out to assess the ease of removal of the existing bricks at the areas of original construction and at areas of known restoration. In both cases, bricks were removed intact, and the mortar could be removed without too much effort. This is indicative of soft, lime-based mortars which are most compatible with the brick from this era. The mortar in the restoration work is performing comparatively well with the original mortar which was originally specified to be mixed at a ratio of 1:3 lime to sand. Higher-strength Portland cement-rich mortars are typically well adhered to bricks making the mortar challenging to remove without damaging the brick. Any localized removals of bricks can be completed effectively with minimal damage and a high rate of salvageability.

The limestone has been found to be weathered in most instances, and a program of repair and replacement is required. This work should be considered general maintenance and not a by-product of the proposed relocation. We recommend that this work precedes the relocation to provide a structure in its most stable form.

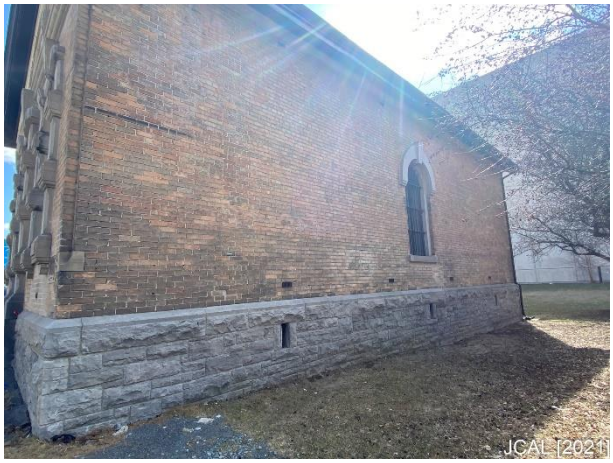


Photo 1a: North Elevation [JCAL (2021)]

Photo 1b: Partial East Elevation [JCAL (2021)]

Photo 1c: South Elevation [JCAL (2021)]

Photo 1d: Facing Brick and Cavity [JCAL (2021)]

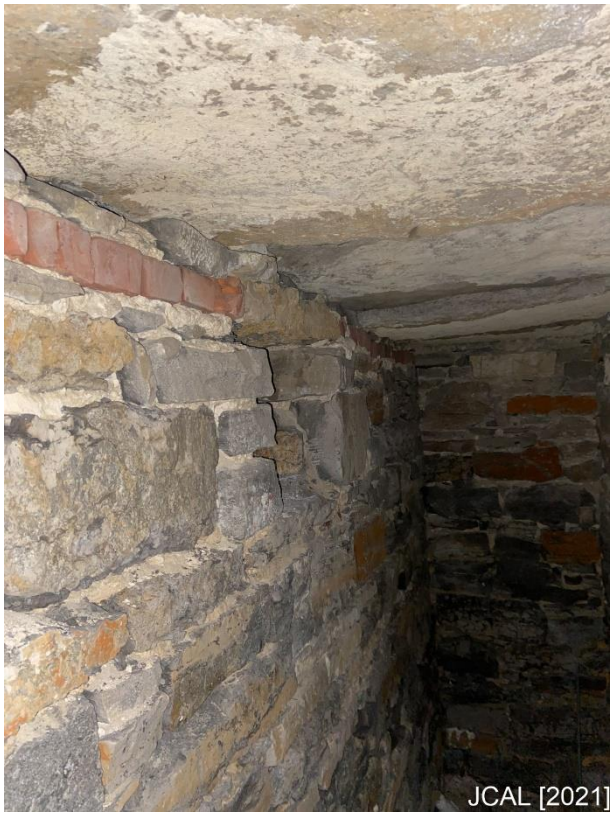


Photo 1e: Foundation and Stone Slabs [JCAL (2021)]

Photo 1f: Cavity and Diagonal Tying Brick [JCAL (2021)]

Photo 1g: Cavity and Diagonal Tying Brick [JCAL (2021)]

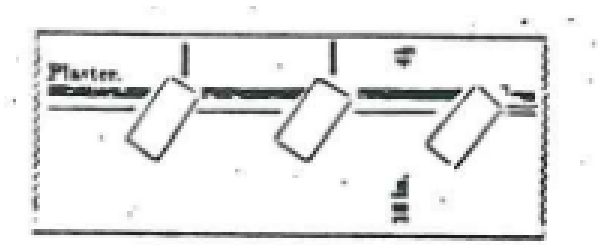


Photo 1h: Diagonal Tying Brick [Specifications 1874]

Photo 1i: Tie Rod End Plate [JCAL (2022)]

Photo 1j: Tie Rod [JCAL (2022)]

Photo 1k: Tie Rod End Plate [JCAL (2021)]

3 SEQUENCE OF RELOCATION

3.1 Enabling Work

Prior the setting out on the lifting and moving of the building, general maintenance of the masonry would be advantageous in ensuring the best overall condition of the City Registry Office. Generally speaking, masonry construction performs best as a homogeneous sum of all its parts. We recommend that any masonry maintenance work be completed ahead of the move. The building move is expected to be carefully monitored and executed in a way that dynamic loads are not applied to the building, but restored masonry can better accommodate any unexpected eccentric loading. Based on our review to date, we expect this work to include:

- Localized repointing of the exterior brick facing wythe where existing step cracking has been observed, including removal and resetting of loose bricks;
- Pinning of fractured stones throughout the elevations, primarily around window and door surrounds;
- Supplementary tying of the exterior facing brick to the backup structural wall. Observations and past experience suggest that the diagonal bonding bricks are fractured in many locations. This bonding technique between wythes of brick is very susceptible to failure as it offers a very small area of interaction between the tying and wall bricks.
- Removal of plaster at the interior face of the exterior walls, the soffit of the vaults, and the interior walls to expose the condition of the masonry and assess any supplementary maintenance work. A localized area of plaster flaking, suggesting moisture ingress, has been observed and may indicate weathered masonry.

Site works will be required to enable the move as well, in discussions with CDS Building Movers (CDS), a temporary roadway for the travel path of the building will be required. The construction work associated with the temporary roadway can be done concurrently with the masonry work mentioned above or with the preparation work listed below.

3.2 Preparation for Lifting

Temporary bracing will be required to protect the heritage building asset. The element that presents the most considerable risk is the ceiling vaults. Masonry arches are dependent on compression from self-weight. This compression presents an outward thrust to the gravity supporting elements that must be resisted. At the two interior walls, the thrust is resisted by the matching thrust of the neighbouring arch. The thrust at the exterior walls is presently resisted by the mass of the 6-wythe brick wall and two 1” diameter rods that span from the western to eastern exterior walls. In its present state, the forces are resolved and there are no signs of any distress in the system. Despite being unlikely, we are concerned with the potential of accidental eccentric loading that could change the loading at the arch. We have explored options of providing tie-down of the vaults to an internal scaffolding system connected to the lifting beams. This has been discarded because of potential movement of the lifting beams being translated through the scaffold and into the vaults. The currently proposed concept is to provide restraint at the springing point elevation of the vaults using a tension ring (shown on SK-S2, SK-S5, and SK-S6). A steel beam will be supported periodically for its dead load on east and west elevations. We have determined the total thrust of the arch under its dead load and the resistance provided by the two tie rods. The beams will be designed for the net force presently resisted by the masonry wall. The beam will be designed with strict deflection limitations (<2mm) and connected to tie beams along the north and south walls.

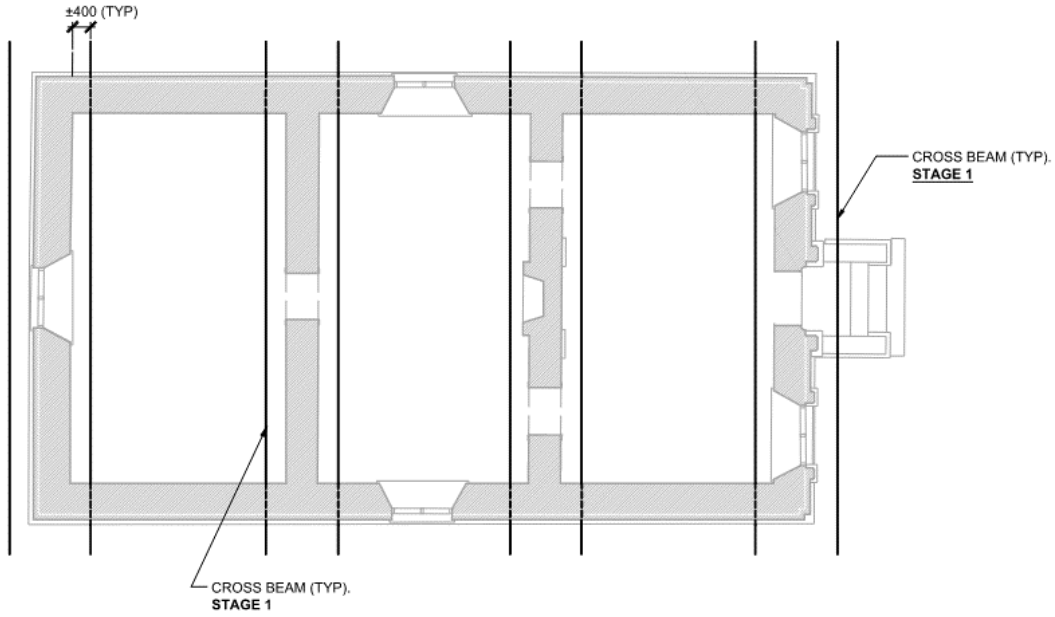
3.3 Lifting and Moving

Procedures for lifting and moving have been developed with support from CDS Building Movers. A copy of their sequencing has been provided separately and is summarized here.

The stone floor slabs will be cataloged, removed, and stored for future integration into the final space.

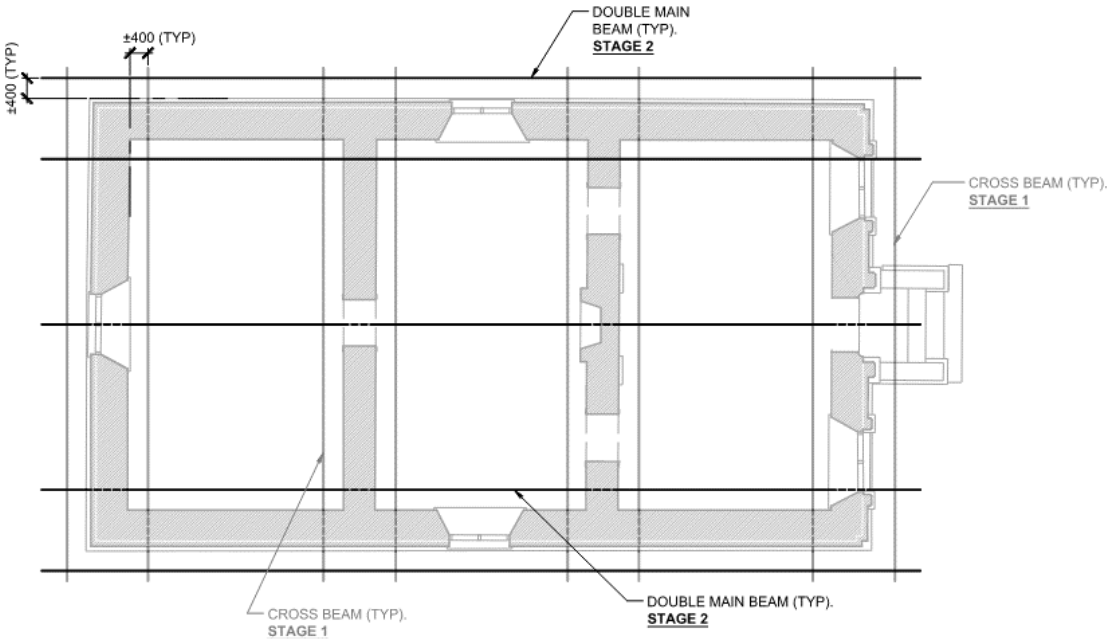
Stage 1: Install Cross Beams – The primary cross beams will be needled through the masonry walls. The cross beams will be the primary supporting elements for the north-south walls that support the vault. The

elevation of the cross beams has been selected to engage the top plinth course of stone. This takes advantage of the existing building attributes since this course of stone can act as lintels to support the facing brick above. At the locations of the beam penetrations, the masonry will be cataloged, dismantled, and stored for future re-integration. Once the opening is made, the beams will be slid into place, likely two sections will be spliced to span the entire length of the building.



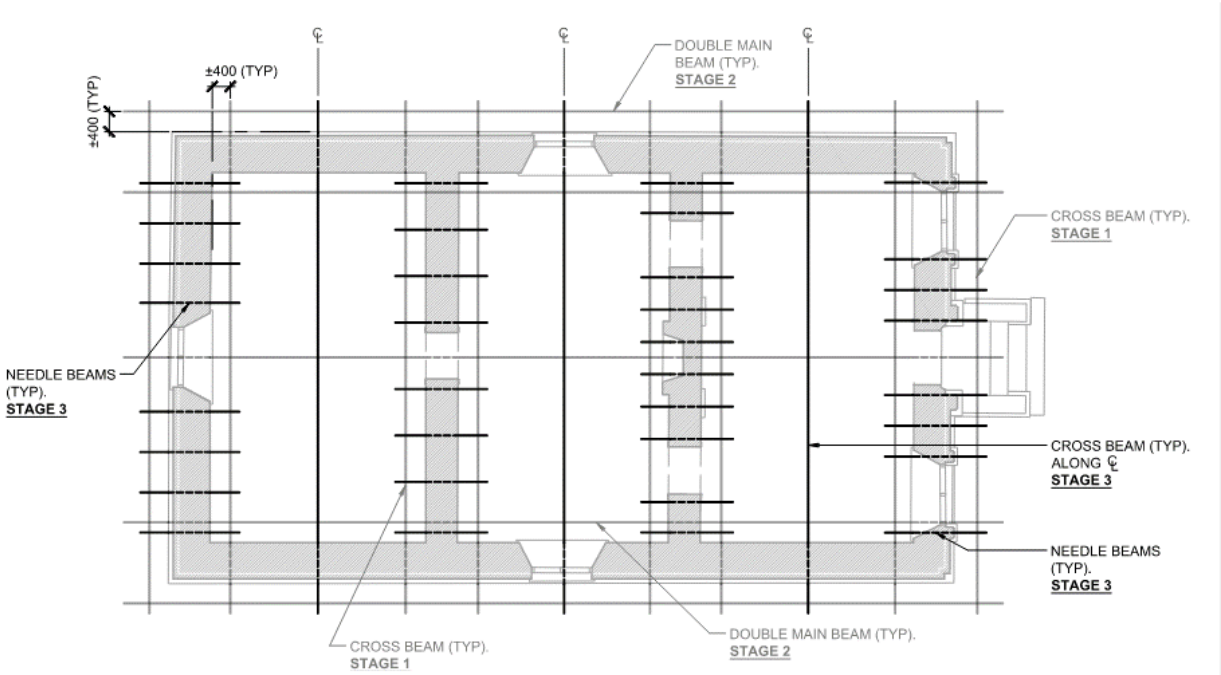
Stage 1: Cross Beam Installation

Stage 2: Install Main Beams – The main beams will serve as the primary lifting point and provide support to the cross beams. As with the cross beams, masonry will be cataloged, dismantled and stored for future re-integration. Select needle beams will be installed strategically to provide support over the main beam locations during dismantling.



Stage 2: Main Beam Installation

Stage 3: Install Needle Beams – At this stage the needle beams under the north-south walls will be installed in the same manner as the previous beams. These are the beams that interact directly with the north-south masonry wall and transfer load to the cross beams.



Stage 3: Needle Beam Installation

Stage 4: Lifting and Travel – A series of hydraulic jacks will be installed upside down in the cavity between the double main beams. This orientation will reduce the overall space required, which is a key constraint of the final location. The jacks will be simultaneously engaged to provide even lifting of the beams. The jacks will be set on cribbing on suitable backfill within and around the perimeter of the building. Once lifted, the main beams will be set on rails placed between the existing and new locations. The building will be transported along the rails to the final location.

3.4 Temporary Support During Excavation

Temporary steel pipe piles will be installed in advance of the move. At this preliminary stage, it has been discussed at a conceptual level with Marathon Underground and their engineer, WSP. The proposed strategy utilizes temporary concrete-filled HSS piles to support the main moving beams. Another methodology under consideration would utilize the existing structural layout and incorporate permanent piles and a series of transfer beams and slabs to support the building. In either proposed method, the piles and associated beams or slabs will be installed prior to relocation. This could occur concurrently with the enabling and preparation described above.

For this discussion and the included sketches, the temporary pile option is presented. The temporary piles would be strategically placed to align with the loadbearing walls of the existing building and will support the east-west main beams used for the move. The temporary piles are proposed to extend into the rock to an embedment below the proposed parking level P2. Excavation for the garage of the new building will occur around the temporary piles below the relocated existing building. Temporary bracing of the piles will be installed as excavation reaches the proposed parking level P1. Excavation of the rock for the remainder of the building not underneath the relocated existing building is proposed to be done by blasting. An attenuation trench will separate the blasting area from the area below the City Registry Office to reduce its exposure to vibrations. We recommend that vibration monitors be located on the existing structure to monitor the resulting vibrations to ensure they are kept within ranges suitable for existing buildings. We have experience in providing appropriate guidelines suitable for heritage buildings of this type and we will provide guidance for this stage of the work.

3.5 New Structural Support

The support provided by the new structure is presently considered as a structural transfer slab or series of transfer beams and slabs. The final design is being coordinated at this stage, considering the most efficient solutions that will maximize the use of the garage levels below. The type of structure selected will offer the same constraints, so the discussion here can be equally applied to both options. The most challenging constraint to accommodate is the future top of finished floor elevation, the available space below to accommodate adequate parking capacity, the proposed grading at the exterior to encourage drainage, and the most economical lifting point at the underside of the ashlar plinth course of the existing building. Based on preliminary sizing of lifting beams, we have developed schematic section SK-S4 to illustrate the most likely strategy for integration into the new structure. To achieve the desired elevation, the main beams will be set onto the transfer structure and shimmed as needed. Once in position, the space between the top of new structure and the current underside of existing building will be bridged by materials sympathetic to the existing building, or as an extension of the structure below. The exact detailing of this will be established through discussions with Reliance and whether bridging this gap with poured concrete or building it with masonry is most efficient. The opportunities we see as most likely are as follows:

- Pour the new structural concrete with slots to receive the moving beams. The space between the top of the new structure and the moved walls would be filled with brick masonry to suit the existing walls, leaving keying for future masonry. Once the building is supported on the new structure through the new masonry, the beams can be slid out one at a time and the slots filled with masonry keyed into the previously completed work.
- Pour the new structure to a consistent level to receive the moving beams. Between the moving beams, fill with brick masonry to suit the existing walls to meet the elevation of the moved building. Once the building is supported on the new structure through the new masonry, the beams can be slid out, one at a time, and the slots filled with masonry, keyed into the previously completed work.

The new structure will be detailed to accommodate areas where the existing foundation levels will be exposed. The existing stone from the foundations will be salvaged and used as a veneer at these areas.

4 DISCLAIMER AND LIMITATIONS

This report is based on and limited to information supplied to John G. Cooke & Associates Ltd. by representatives of Cadillac Fairview and by observations made during walk-through inspections. Only those items that are capable of being observed and are reasonably obvious to John G. Cooke & Associates Ltd. or have been otherwise identified by other parties and detailed during this investigation can be reported.

The work reflects the Consultant's best judgment in light of the information reviewed by them at the time of preparation. There is no warranty expressed or implied by John G. Cooke & Associates Ltd. that this investigation will uncover all potential deficiencies and risks of liabilities associated with the subject property. John G. Cooke & Associates Ltd. believe, however, that the level of detail carried out in this investigation is appropriate to meet the objectives as outlined in the request. We cannot guarantee the completeness or accuracy of information supplied by any third party.

John G. Cooke & Associates Ltd. are not investigating or providing advice about pollutants, contaminates or hazardous materials.

This report has been produced for the sole use of Cadillac Fairview and cannot be reproduced or otherwise used by any third party unless approval is obtained from John G. Cooke & Associates Ltd. No portion of this report may be used as a separate entity; it is written to be read in its entirety.

We trust this report covers the scope of work as outlined in our Terms of Reference.

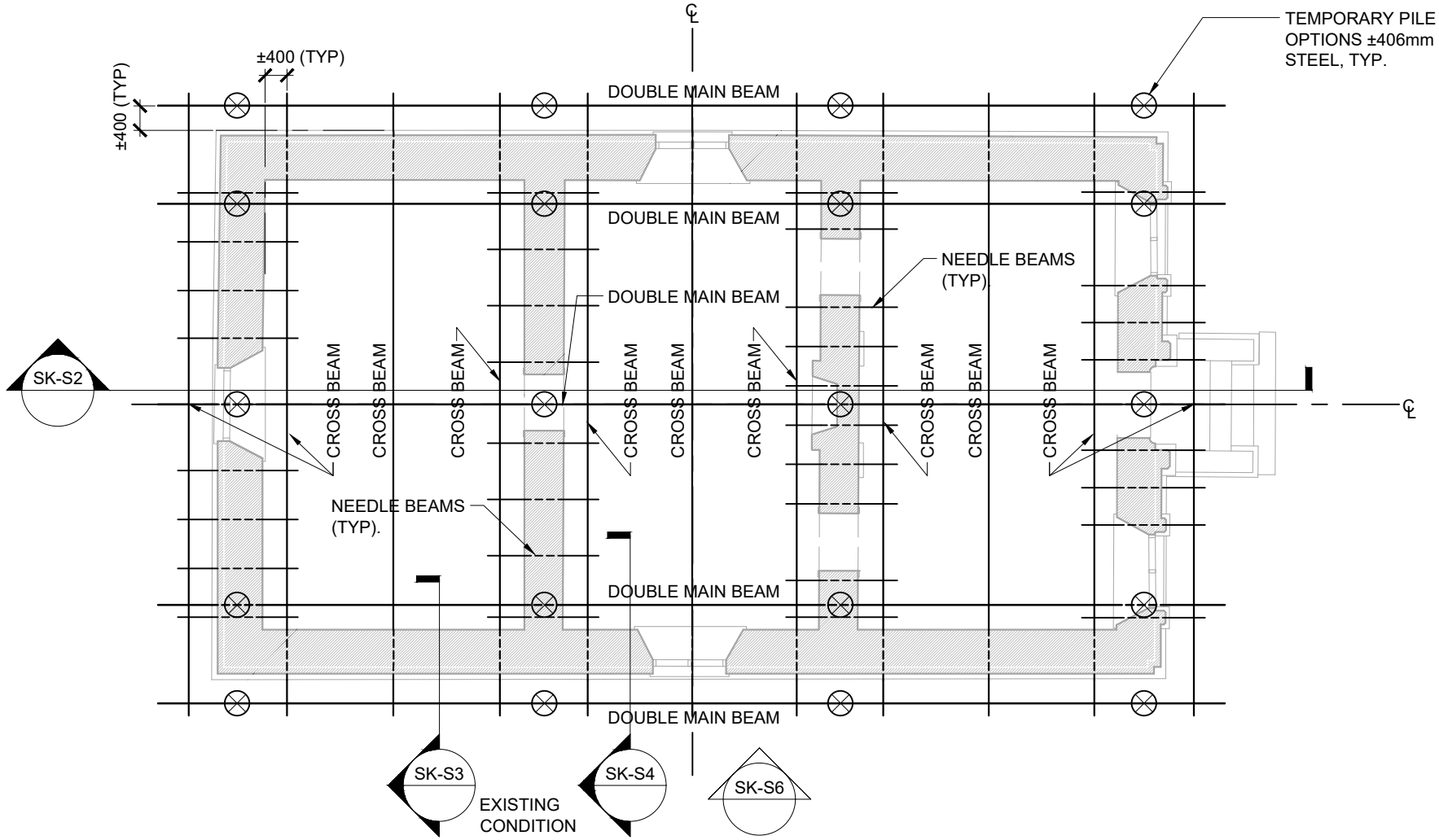
If you have any further questions, please do not hesitate to contact our office.

Yours sincerely,

JOHN G. COOKE & ASSOCIATES LTD.

Chris Vopni, P.Eng., CAHP
Associate

5 APPENDIX A - SKETCHES



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DRAWING: PLAN

PROJECT: REGISTRY BUILDING RELOCATION
70 NICHOLAS

CLIENT: CADILLAC FAIRVIEW

DESIGNED BY: CV

DRAWN BY: MB

SCALE: 1:100

DATE: 2022-04-22

PROJECT No. 21143

DRAWING No. **SK-S1**

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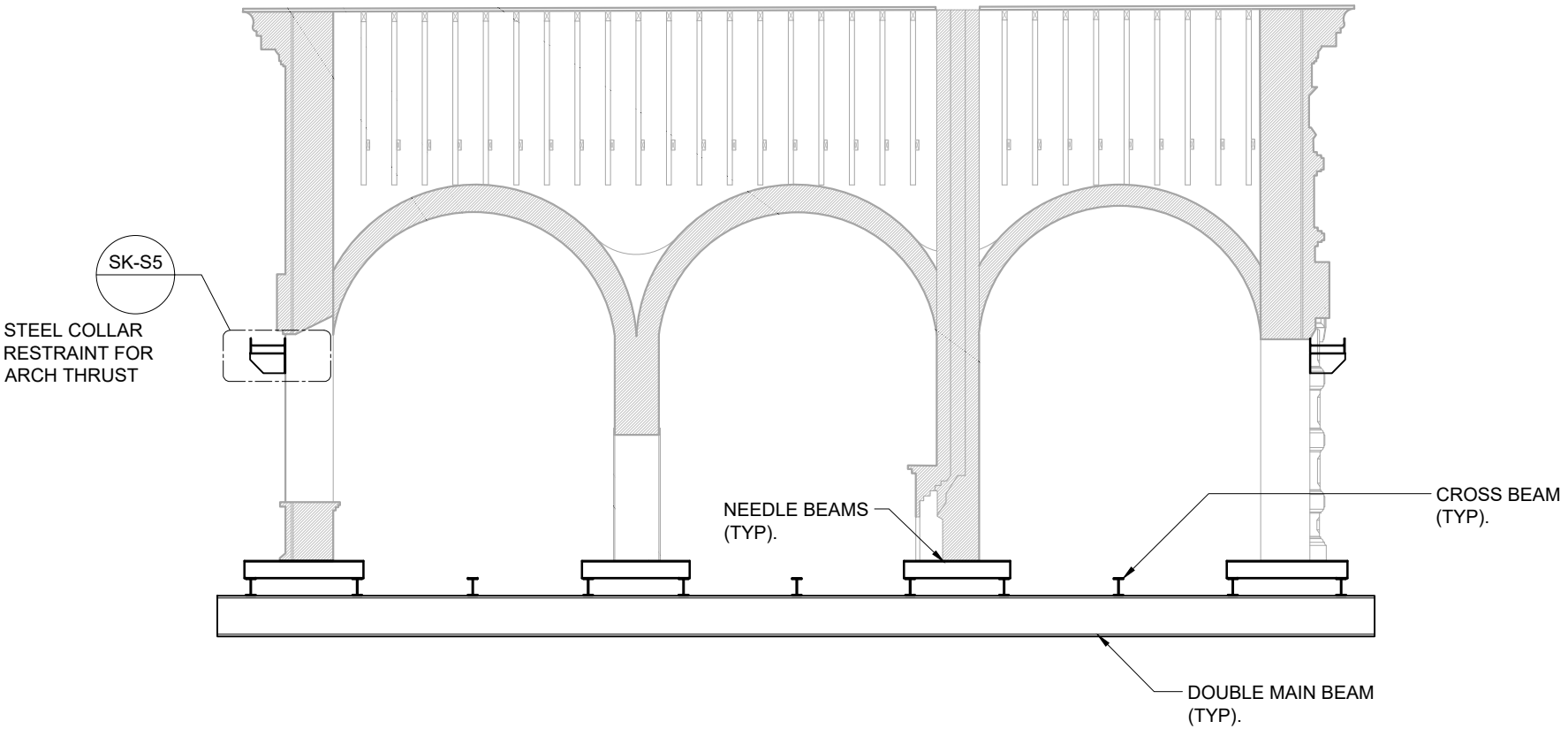

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DATE: 2022-04-22

PROJECT No. 21143

DRAWING No. **SK-S2**

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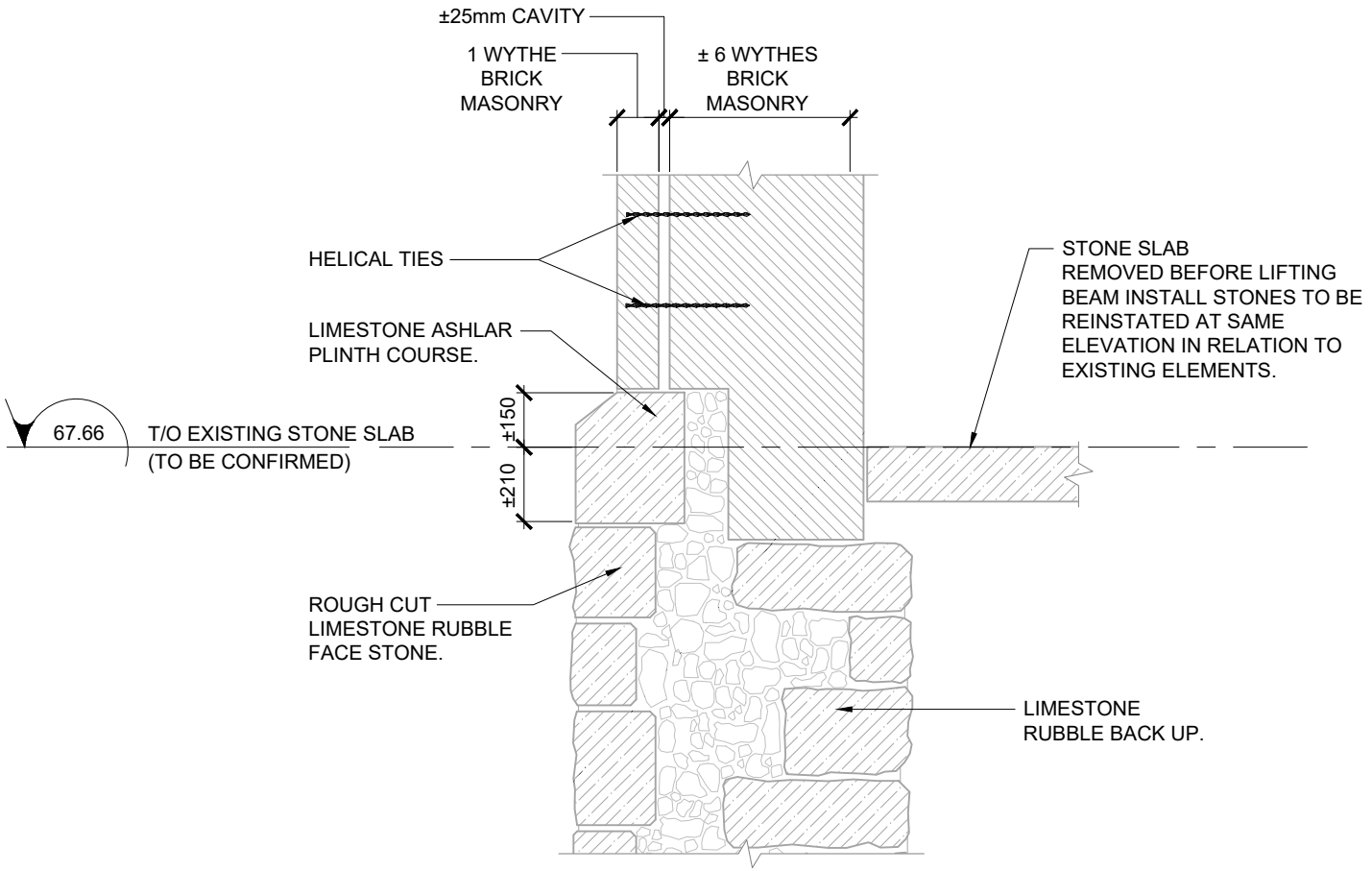

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DRAWING: DETAIL: EXISTING WALL SECTION

PROJECT: REGISTRY BUILDING RELOCATION
70 NICHOLAS

DESIGNED BY: CV

SCALE: 1:20

CLIENT: CADILLAC FAIRVIEW

DRAWN BY: MB

DATE: 2022-04-22

PROJECT No. 21143

DRAWING No. **SK-S3**

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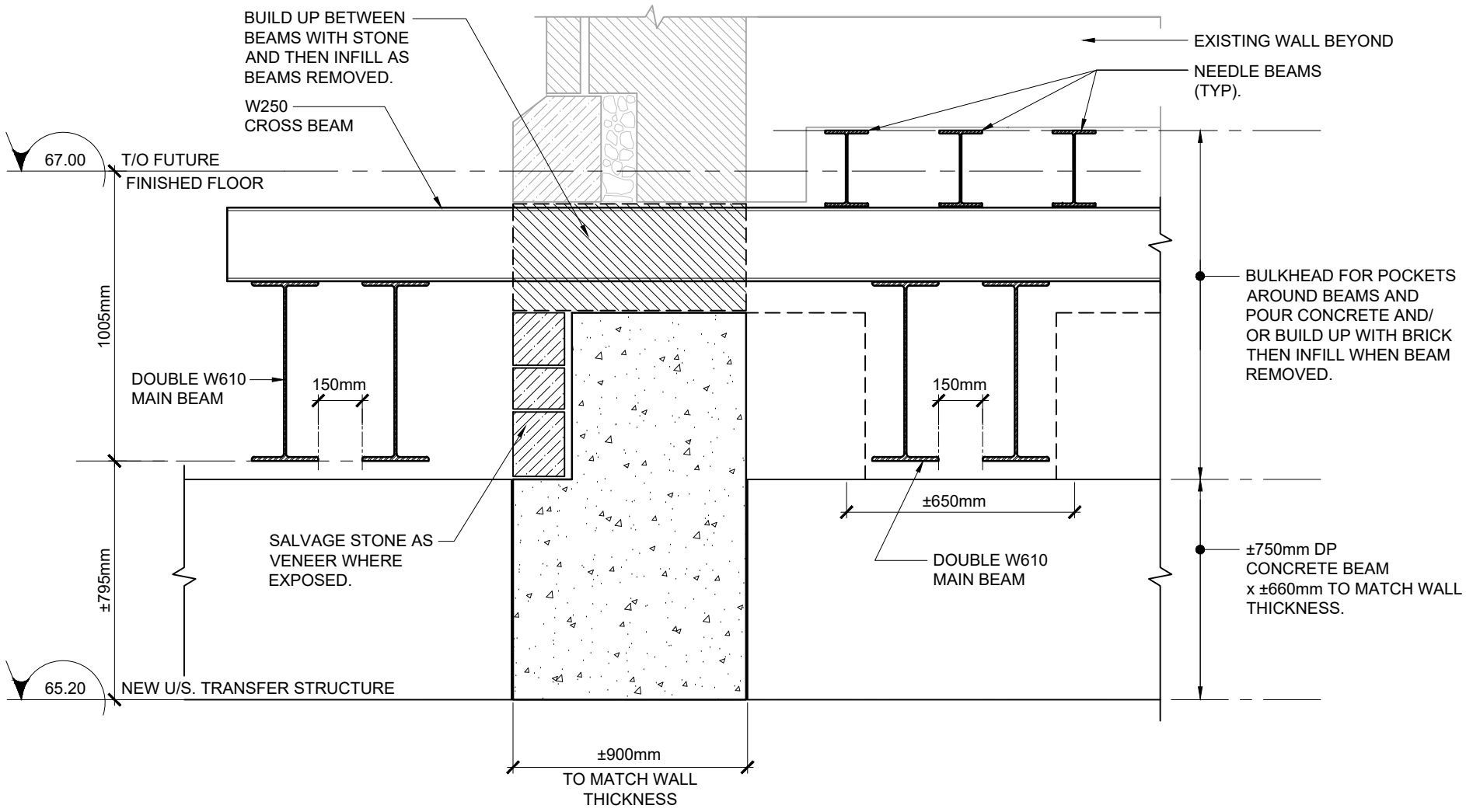

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DRAWING: DETAIL: NEW LOCATION - SECTION

PROJECT: REGISTRY BUILDING RELOCATION
70 NICHOLAS

DESIGNED BY: CV

SCALE: 1:20

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PROJECT No. 21143

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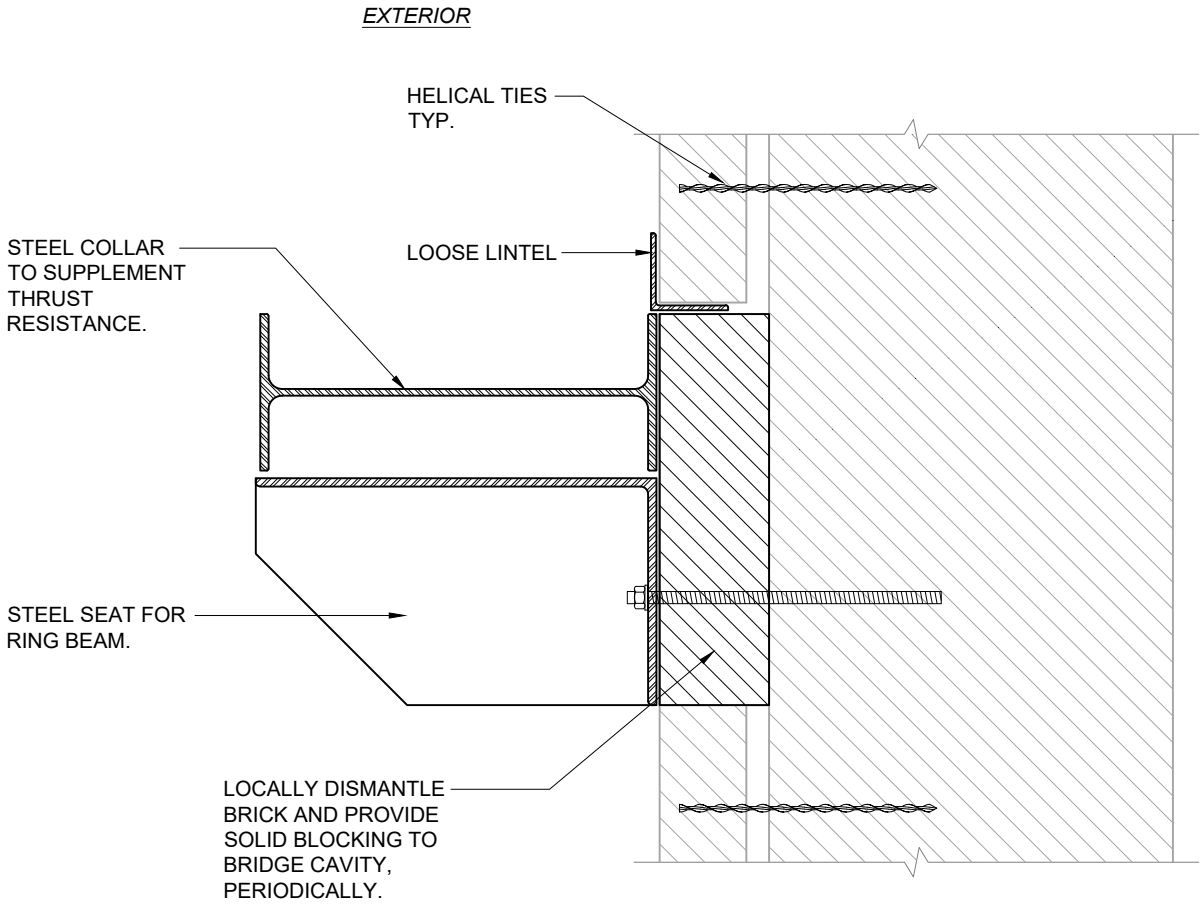

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DRAWING: DETAIL: VAULT TRUST RESTRAINT

PROJECT: REGISTRY BUILDING RELOCATION
70 NICHOLAS

DESIGNED BY: CV

SCALE: 1:10

CLIENT: CADILLAC FAIRVIEW

DRAWN BY: MB

DATE: 2022-04-22

PROJECT No. 21143

DRAWING No. **SK-S5**

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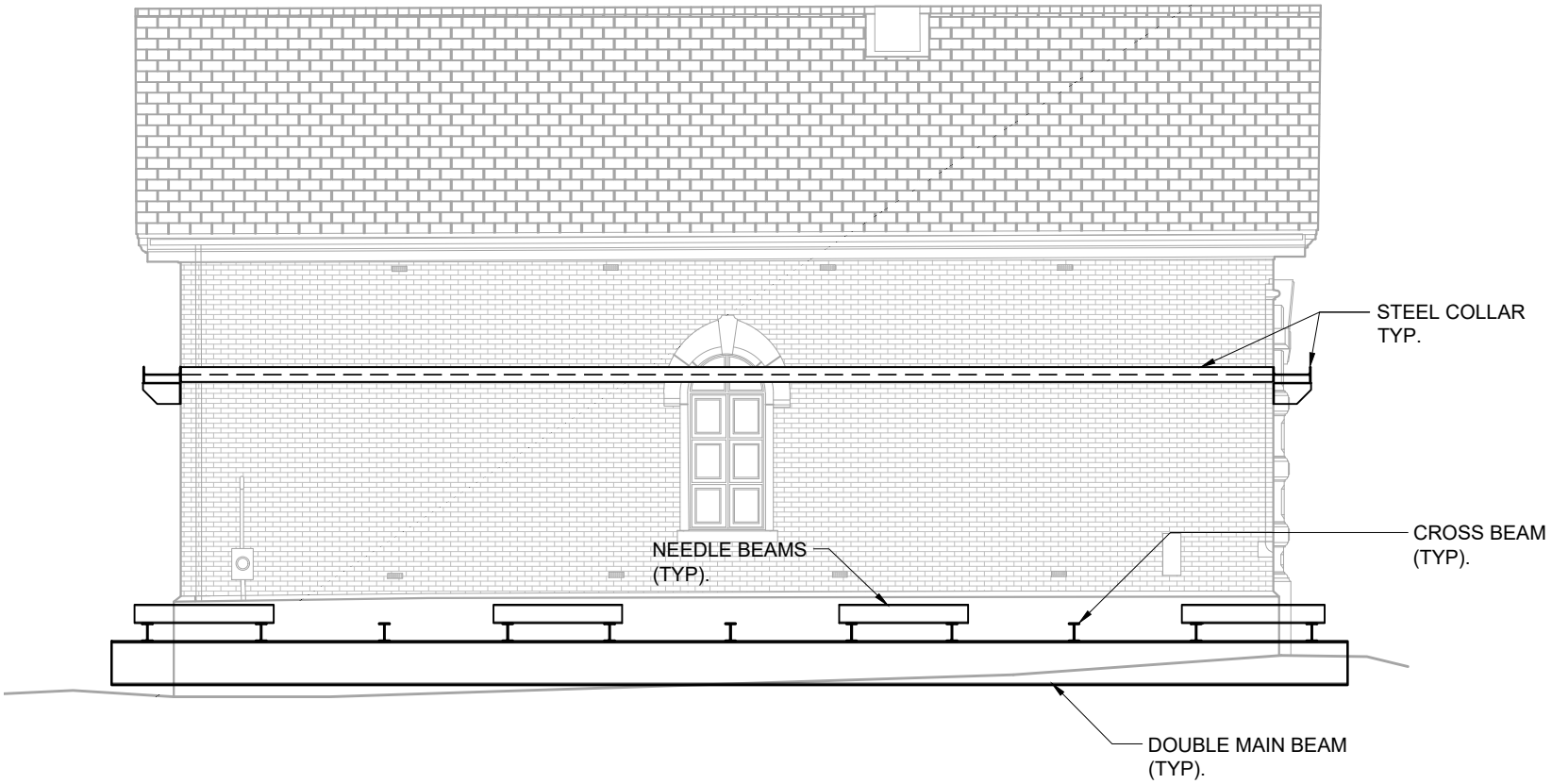

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DRAWING: ELEVATION: SOUTH ELEVATION

PROJECT: REGISTRY BUILDING RELOCATION
70 NICHOLAS

DESIGNED BY: CV

SCALE: 1:100

CLIENT: CADILLAC FAIRVIEW

DRAWN BY: MB

DATE: 2022-04-22

PROJECT No. 21143

DRAWING No. **SK-06**

SHEET SIZE 8x11 (216mm x 279mm)