North Bay Courthouse Seismic Structural Retrofit

The Buildings Show 2018

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Read Jones Christoffersen Ltd.
Creative Thinking Practical Results
Outline

- Introduction
- Condition Survey Assessment
- Conceptual Design Options
- Design + Construction
- Questions
Introduction

- Constructed 1989
- Four-storey provincial courthouse building (53 ft. height)
- Total floor area – approx. 100,000 sq.ft.
- Cast-in-place concrete foundations
- 6” thick concrete floor slabs on steel deck with structural steel framing
- Brick veneer cladding system with precast bands
Introduction
Building Structure Condition Assessment

- Cracking at interior concrete masonry unit (CMU) walls at stair shafts
- Building Structure Condition Assessment undertaken in 2014

Scope of Work:
- Visual site review of as-built conditions
- Review available construction drawings
- Review existing geotechnical reports
- Perform lateral analysis of the structure
- Development of potential remedial concepts
Building Structure Condition Assessment

- Assessment Conclusions:
  - No clearly defined lateral force resisting system
  - Existing steel beam-column connections did not have sufficient lateral capacity to meet requirements of Ontario Building Code (OBC)
  - Incidental lateral utilization of CMU walls at stairs
  - Lateral deflection resulting in cracking of CMU walls
  - Building structure at risk of severe damage or partial collapse if subjected to a design seismic event
Seismic Design Requirements

- Building Period – 0.4 seconds
- \( R_d = 1.5, R_o = 1.3 \) (Shear Walls Conventional Construction)
- Site Class ‘D’ – poor soils
- Equivalent Static Force Procedure
- Seismic Base Shear = Approx. 11% of Building Weight
- 4 seismic retrofit schematic concepts
- Maintain building operations during construction
Option 1 – Moment Frames
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Option 2 – Reconstruction of Stairwell Shafts
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Option 3 – External Shear Walls + Interior Bracing
Option 3 – External Shear Walls + Interior Bracing
Option 4 – External Precast Concrete Shear Walls
Option 4 – External Precast Concrete Shear Walls

- Shear walls at exterior of building – simplify construction
- Complement existing building aesthetics
- Interior work could be phased to maintain building operations
- Interior work completed during evenings and weekends only
Pilot Project – Interior Structural Modifications

- Pilot project in 2015

- Structural modifications undertaken at the southeast corner of the building on the 2nd and 3rd floor.
  - Used to estimate costs and determine feasibility for full scale project

- Mechanical and Electrical Interference study

- Consideration of temporary or permanent relocation of courthouse
Construction

- Start January 2016
- Substantially Complete by November 2017
- 23 Month Construction Schedule
- Approx. $14 million Construction Cost
Precast Concrete Shear Walls
Piles and Pilecaps
Exterior Steel Connections
Exterior Steel Connections
External Precast Concrete Shear Walls

- 13 exterior precast concrete shear walls
- Walls fabricated in sections to suit shipping approx. 39 wall panel sections
- Shear wall thickness varies 19” - 22”
- 3” recesses for architectural granite panels; hide construction joints, grout ports
- 35 MPa (5,000 psi), Exposure Class C-1
- Regular internal wall reinforcement + Dywidag post-tensioned threadbars with couplers to interconnect stacked panels
External Precast Concrete Shear Walls

- Formed side of wall is exposed
- Consistent medium sandblast finish surface with penetrating sealer
- Colour pigment and aggregate exposure to match existing building precast sills
- 3” recesses for bands of architectural granite
Precast Concrete Shear Walls - Fabrication
Precast Concrete Shear Walls - Fabrication
Precast Concrete Shear Walls - Installation
# Interior Structural Work

## Courthouse User Groups

<table>
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<tr>
<th>Group</th>
<th>Description</th>
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<tr>
<td>Victim/Witness Assistance Program</td>
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<td>North Bay Police</td>
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<td>Legal Aid</td>
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<td>Justice Of The Peace</td>
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<td>Superior Court Judiciary</td>
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<td>Provincial Court Judiciary</td>
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- Completed between January 2016 and May 2017 (17 months)
- Full occupancy of the courthouse maintained throughout
- Interior work completed during nights/weekends to not disturb courts
- 9 Phases
- Use of “Swing Space” for temporary relocation of occupants
Interior Swing Space
Phasing of Interior Work

Structural Upgrades to the North Bay Courthouse
Preliminary Phasing Plans
Phasing of Interior Work

Structural Upgrades to the North Bay Courthouse
Preliminary Phasing Plans

LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1

Continuous Construction Area
Nightly Construction/Daily Access Area

Creative Thinking Practical Results
Phasing of Interior Work

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Interior Structural Work
Floor Diaphragm Plate Connections
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Existing top and bottom slab reinforcing do not overcut corners when cutting reinforcing steel.

Prepare patch surface and place new concrete patch material.
Roof Diaphragm Plate Connections

75mm GAP FOR JOIST SHOE SUPPORT

EXISTING 38mm METAL ROOF DECK

S-MD 14-20x2" HWH #5 BM HILTI
BI-METAL Kwik-Flex Self-Drilling
Screws TYP. PROVIDE SIX (6) DECK
Screws PER SIDE INTO LOW DECK FLUTE

L152x152x9.5 - 830mm LONG
(EACH SIDE OF BEAM)

EXISTING STEEL BEAM
Interior Steel Drag Struts
Interior Steel Drag Struts
Interior Plan Cross Bracing
Interior Plan Cross Bracing
CMU Wall Repairs and Elastomeric Coating
Mechanical and Electrical Interferences
Embedded Conduits on Level 4
Before / After
Conclusions

- Step cracking within stairwell masonry walls led to building seismic retrofit
- Temporary and/or permanent relocation of Courthouse services considered
- In the end – desire to keep courthouse services in current location
- External Precast Shear Walls – proved to be most viable option
- Seismic retrofit complimented existing building exterior aesthetics
- Construction schedule requirements were met
Questions?