

# North Bay Courthouse Seismic Structural Retrofit with Precast Concrete Shear Walls



Creative Thinking  
Practical Results

Tim Van Zwol, M.Sc., P.Eng.  
Regional Manager / Associate  
RJC Engineers



INTERNATIONAL  
CONCRETE REPAIR  
INSTITUTE

2018 Spring Convention | **seismic**solutions | April 11-13 | San Francisco

# Outline

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



# Introduction



# Introduction

- Four-storey provincial courthouse building (53 ft. height)
- Constructed 1989
- 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



# Introduction



INTERNATIONAL  
CONCRETE REPAIR  
INSTITUTE

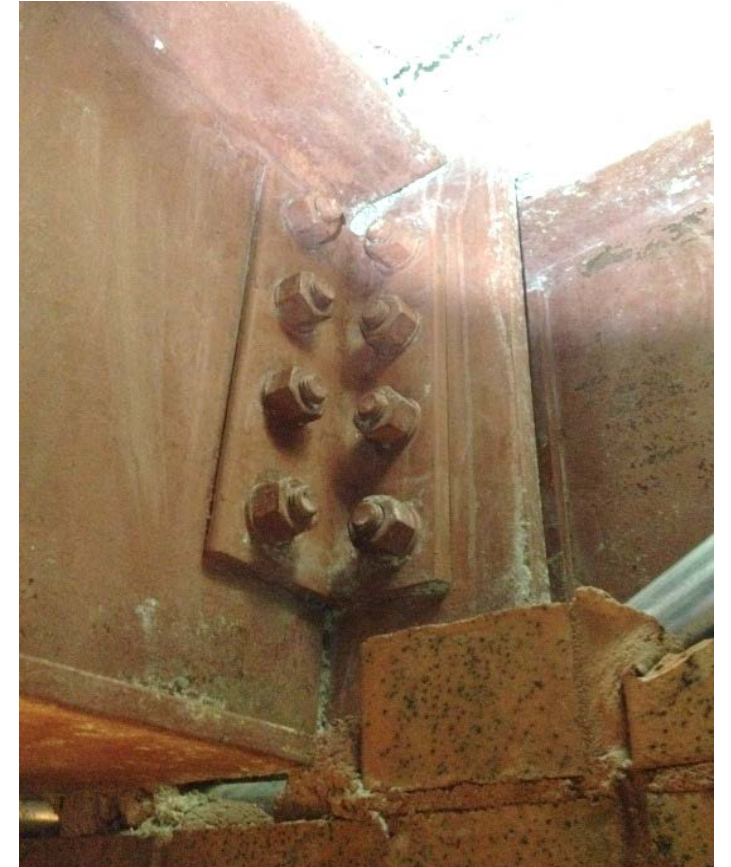
# Building Structure Condition Assessment

- 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
  - Cracking of CMU walls result of lateral deflection
  - Building structure at risk of severe damage or partial collapse if subjected to a design seismic event



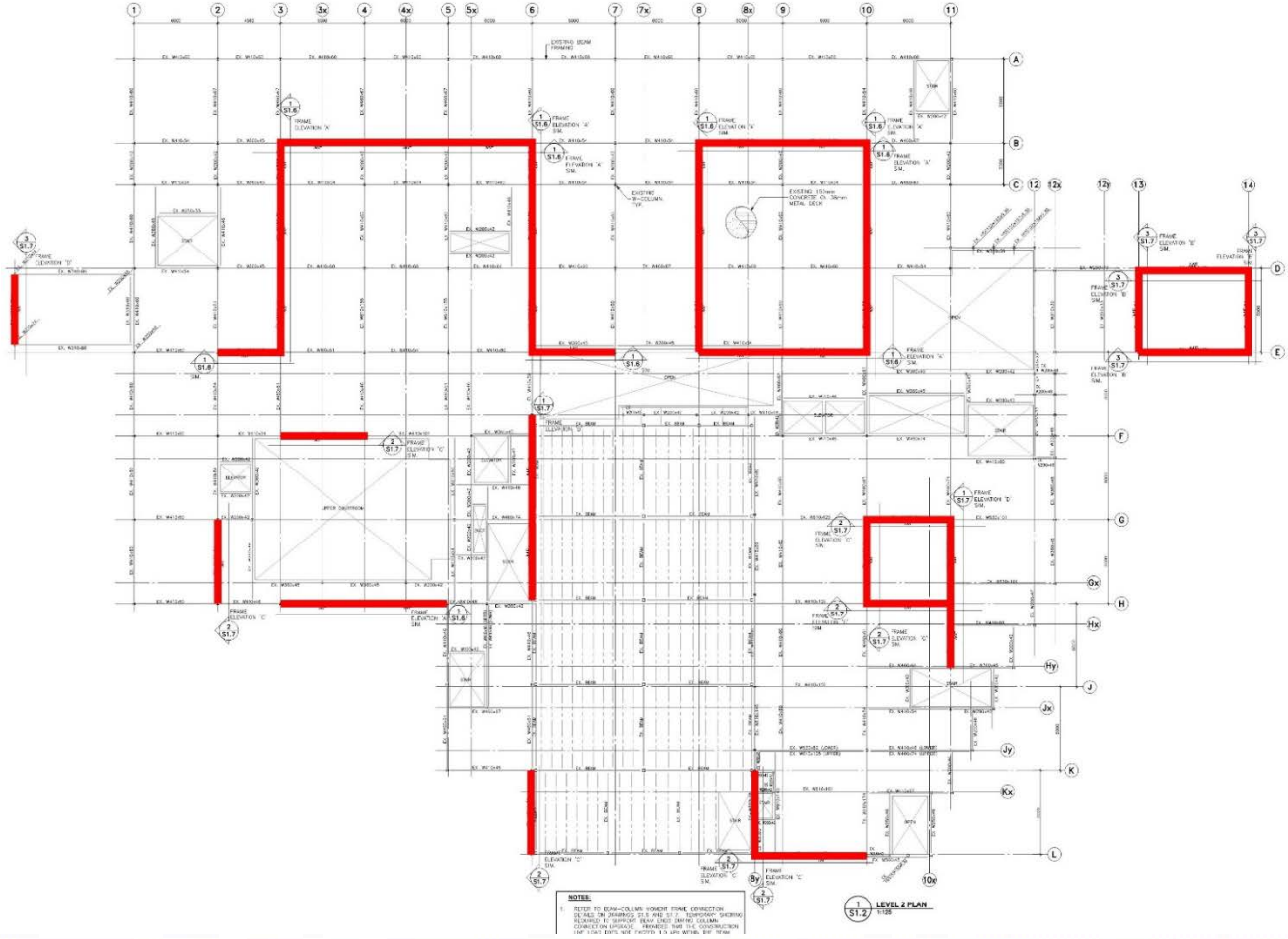
# Seismic Design Requirements

- 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

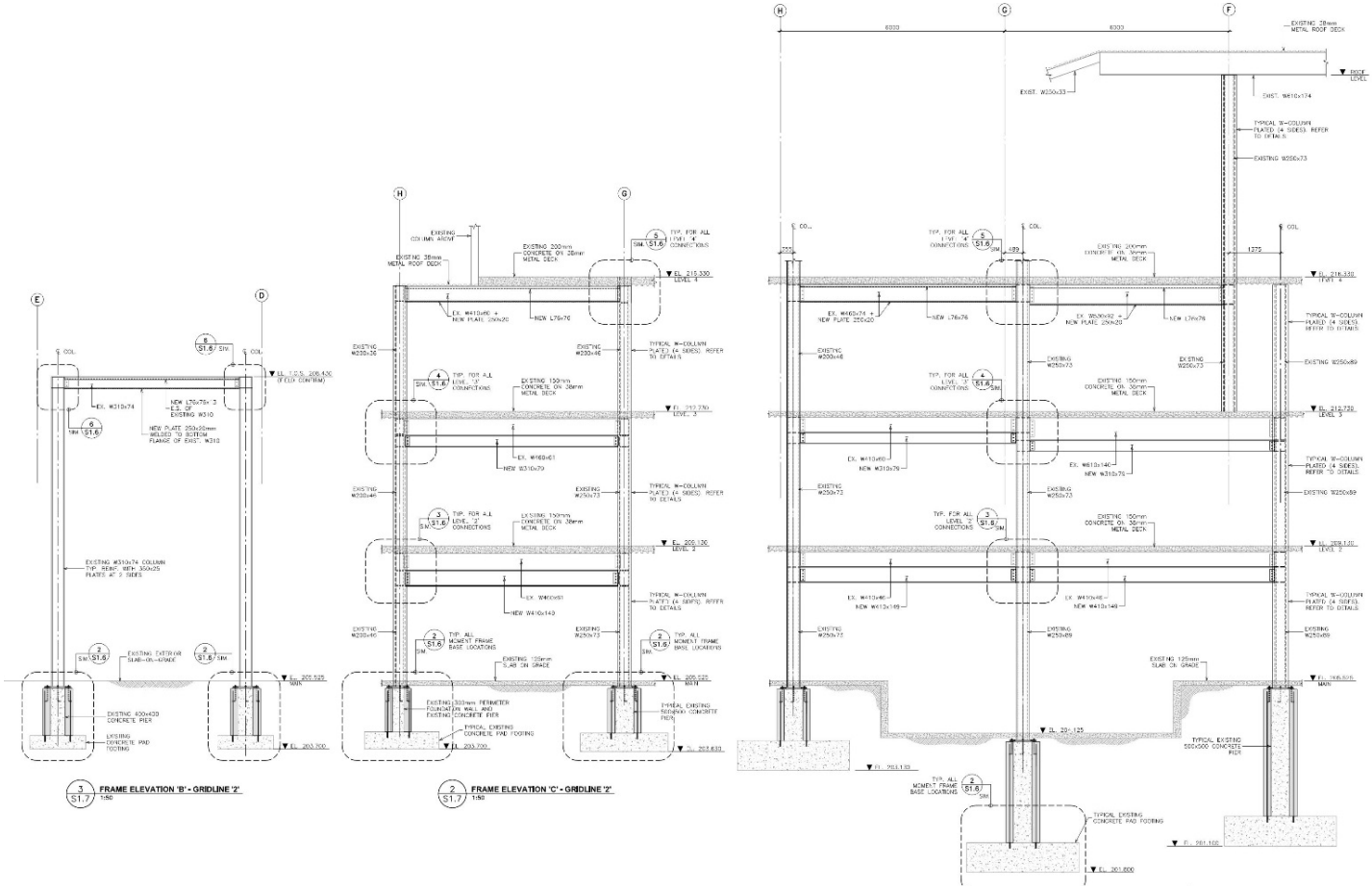




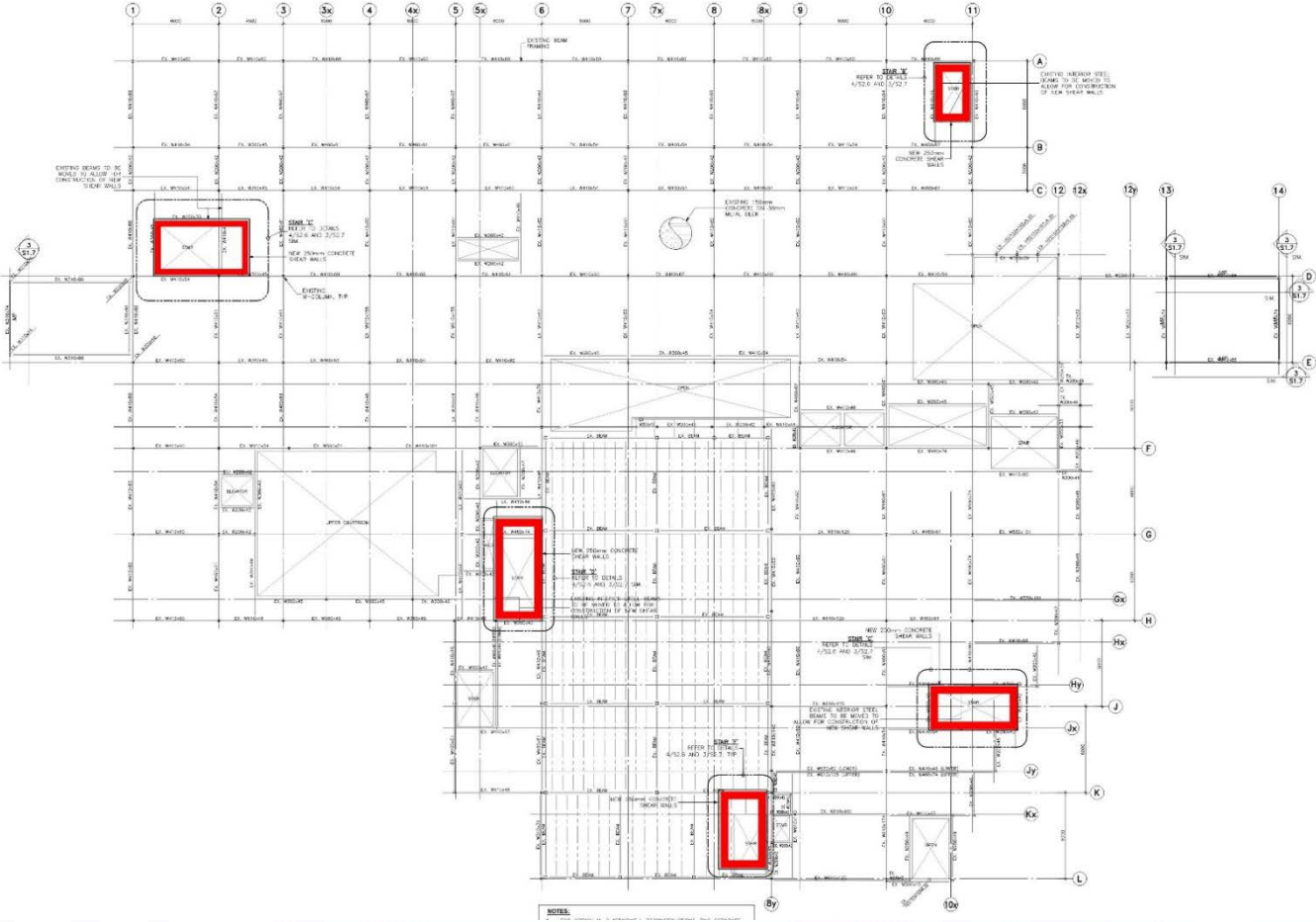
# Option 1 – Moment Frames



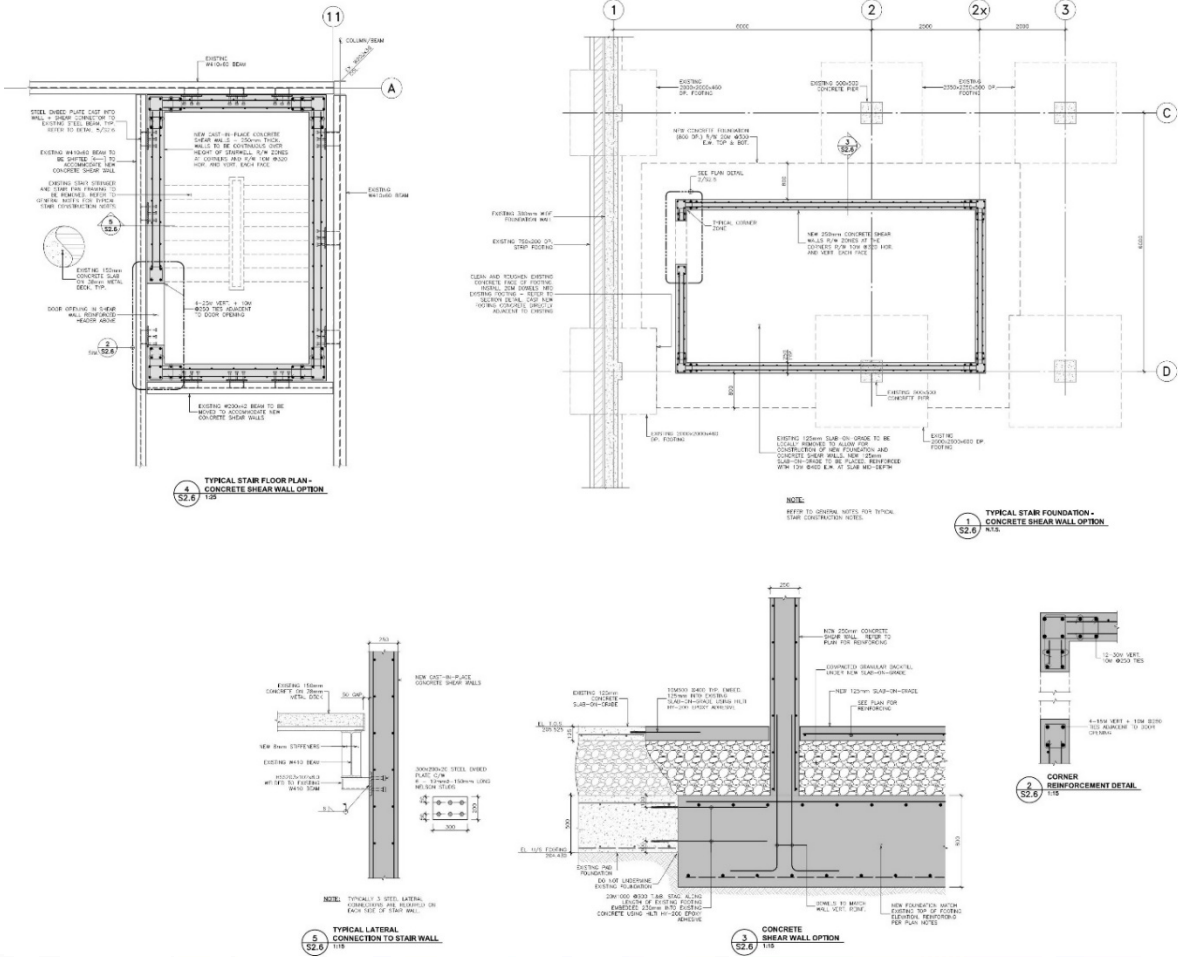
# Option 1 – Moment Frames



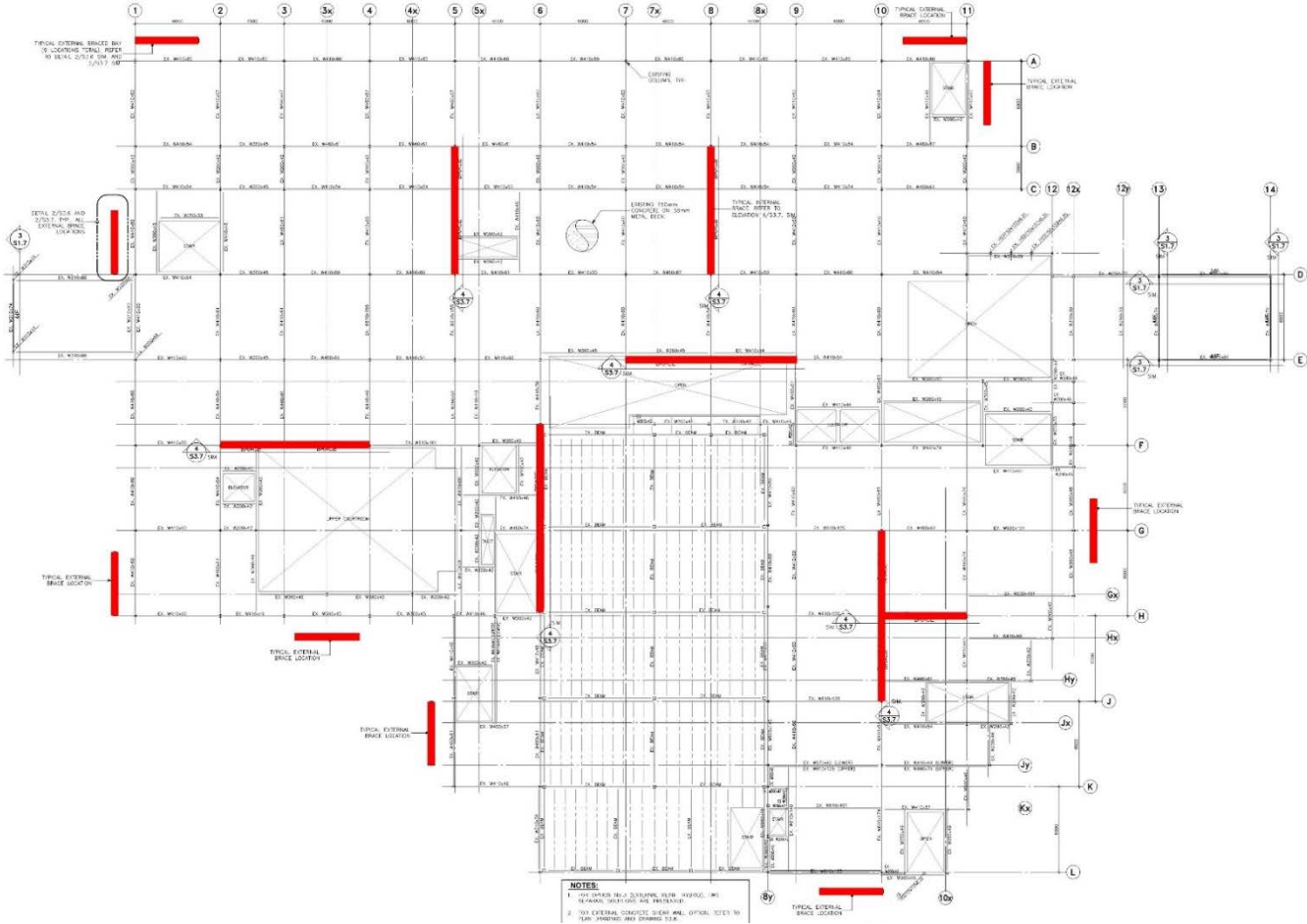
# Option 2 – Reconstruction of Stairwell Shafts



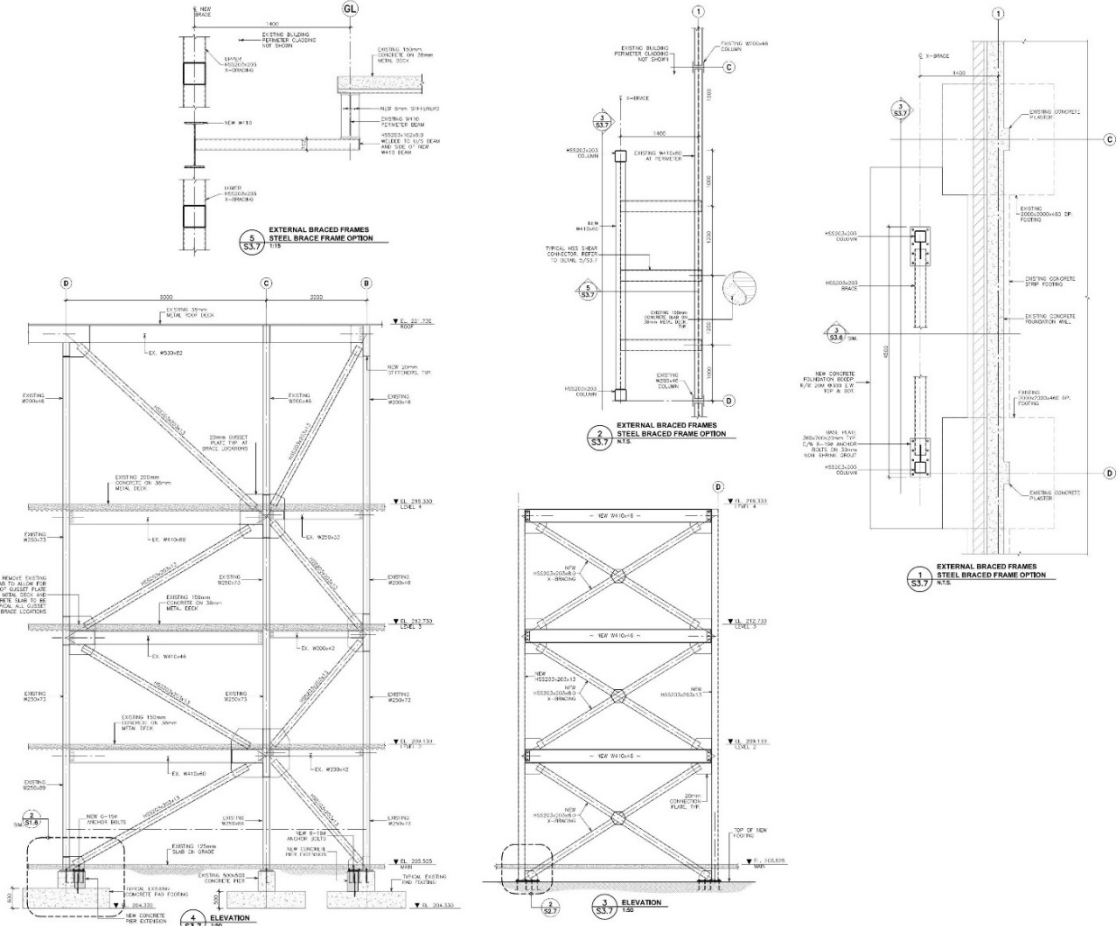
# Option 2 – Reconstruction of Stairwell Shafts



# Option 3 – External Shear Walls + Interior Bracing



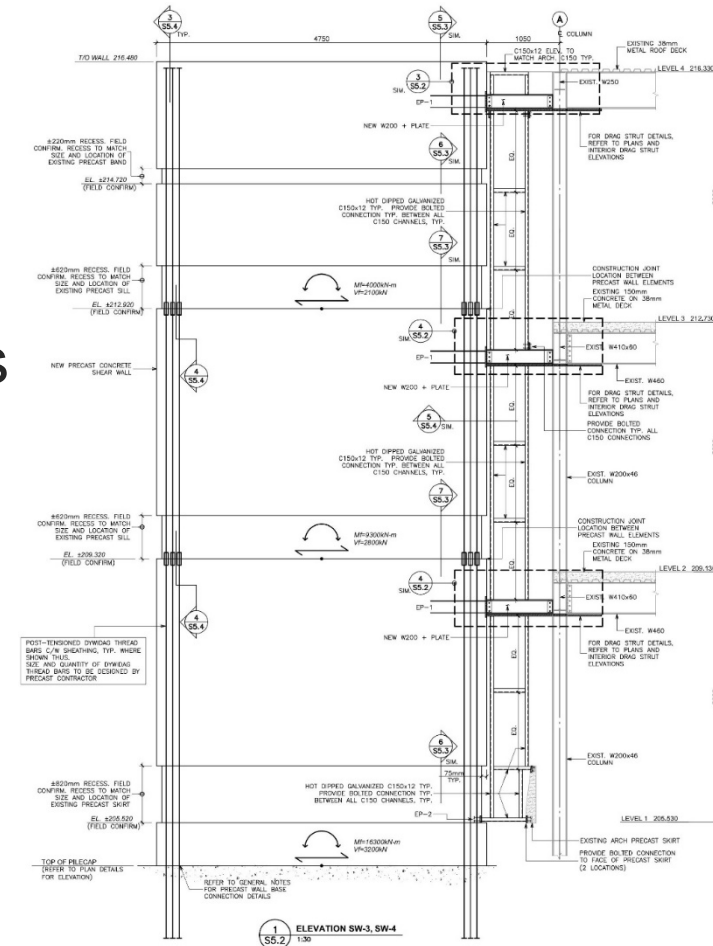
# Option 3 – External Shear Walls + Interior Bracing





# 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





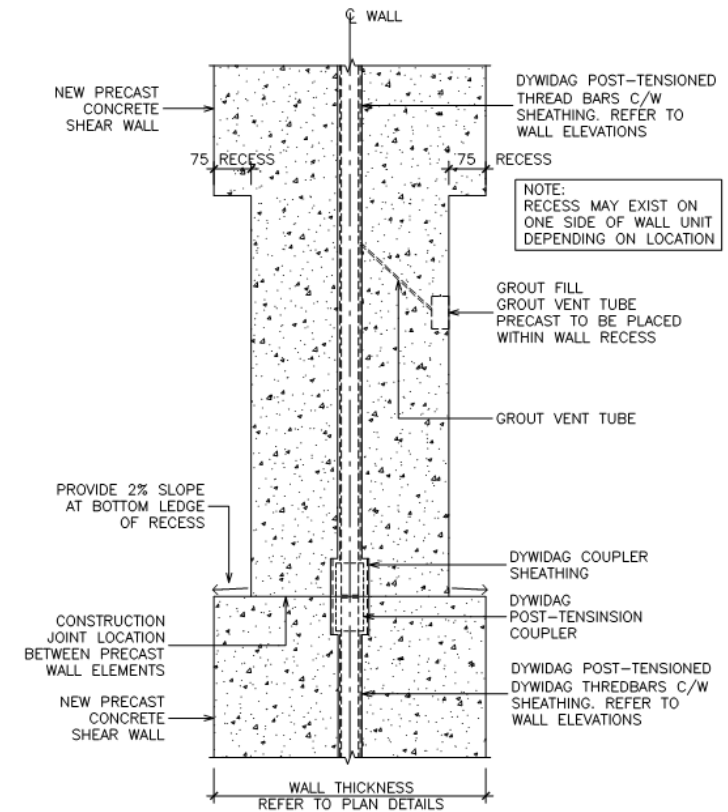
# Construction

- Start January 2016
- Substantially Complete by November 2017
- 23 Month Construction Schedule
- Approx. \$14 million Construction Cost



# External Precast Concrete Shear Walls

- 13 exterior precast concrete shear walls
- 35 Mpa (5,000 psi), Exposure Class C-1
- Shear wall thickness varies 19" - 22"
- 3" recesses for architectural granite panels; hide construction joints, grout ports
- Regular reinforcement + Dywidag post-tensioned threadbars
- Walls fabricated in sections to suit shipping



TYPICAL DYWIDAG COUPLER DETAIL AT WALL CONSTRUCTION JOINT

4  
S5.4 N.T.S.



# 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 architectural granite bands



# Precast Concrete Shear Walls - Fabrication



# Precast Concrete Shear Walls - Installation



INTERNATIONAL  
CONCRETE REPAIR  
INSTITUTE

2018 Spring Convention | seismic solutions | April 11-13 | San Francisco

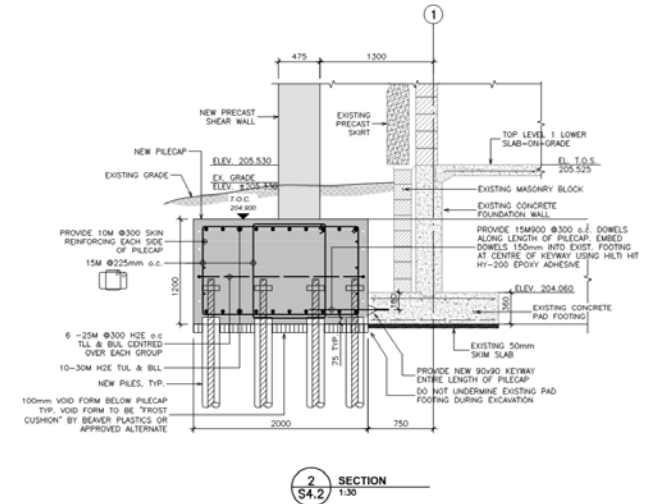
# Precast Concrete Shear Walls - Installation



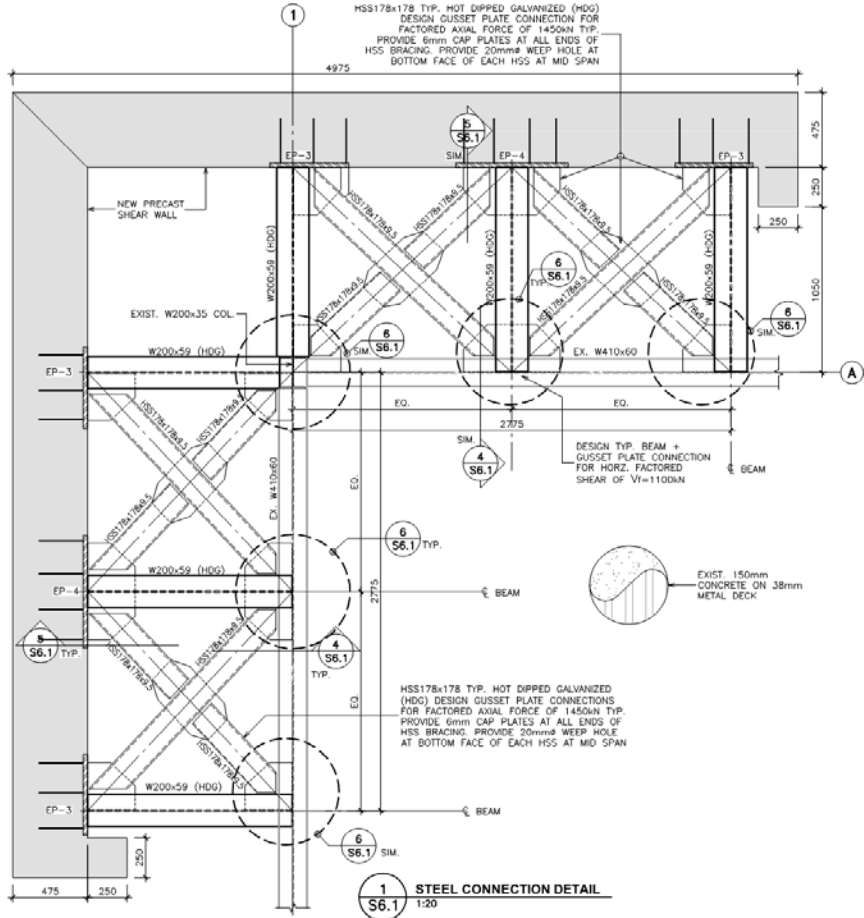
INTERNATIONAL  
CONCRETE REPAIR  
INSTITUTE

2018 Spring Convention | seismic solutions | April 11-13 | San Francisco

# Piles and Pilccaps

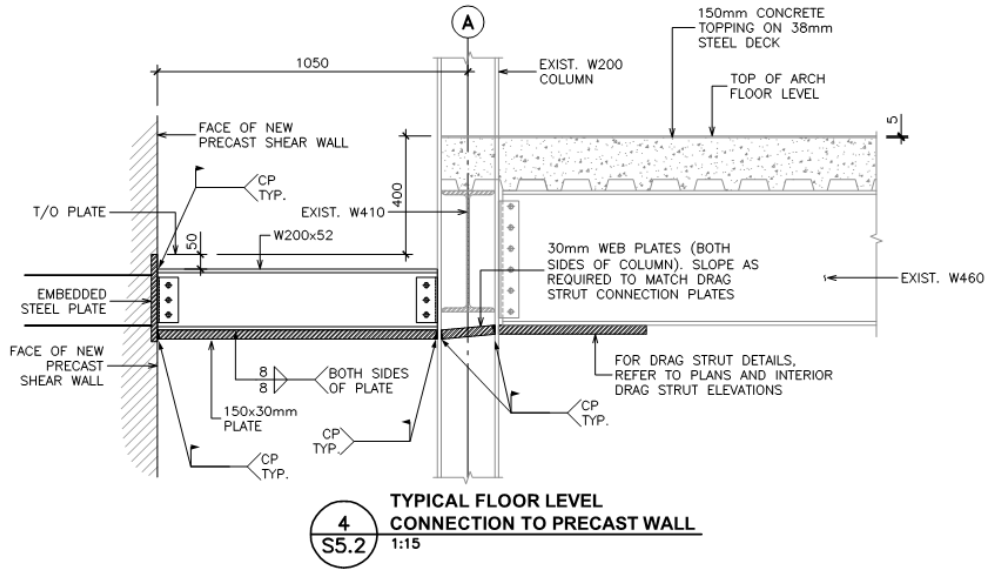


# Exterior Steel Connections





# Exterior Steel Connections



# Interior Work

## Courthouse User Groups

Victim/Witness  
Assistance  
Program

North Bay  
Police

Legal Aid

Justice Of The  
Peace

Court Services  
Division

Crown

Law  
Association

Family  
Mediation

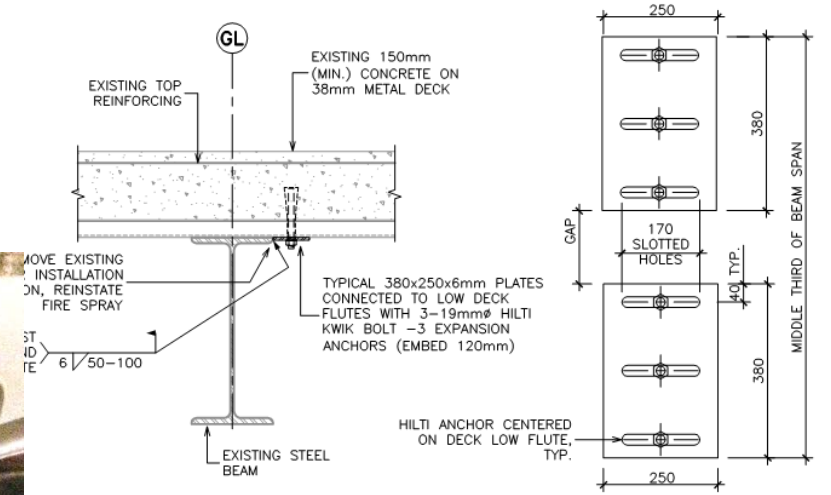
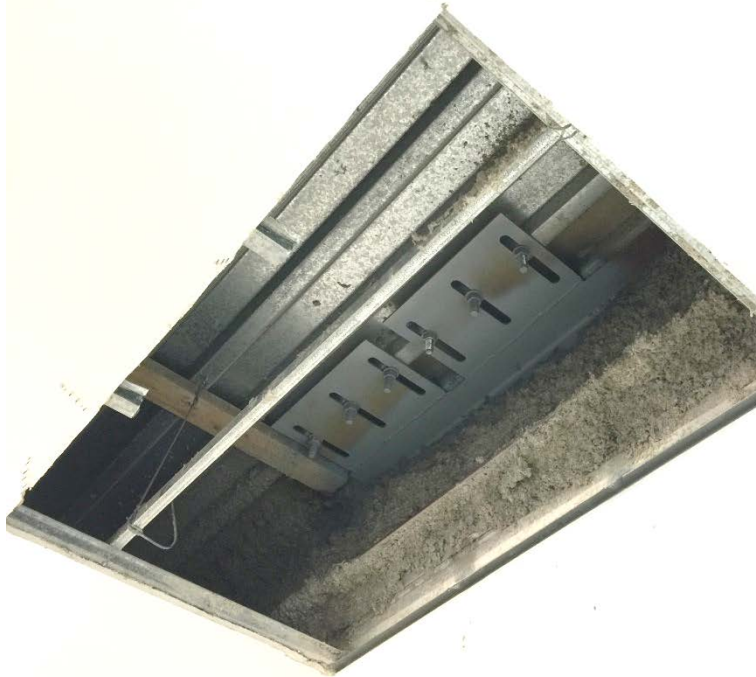
Superior Court  
Judiciary

Provincial  
Court Judiciary

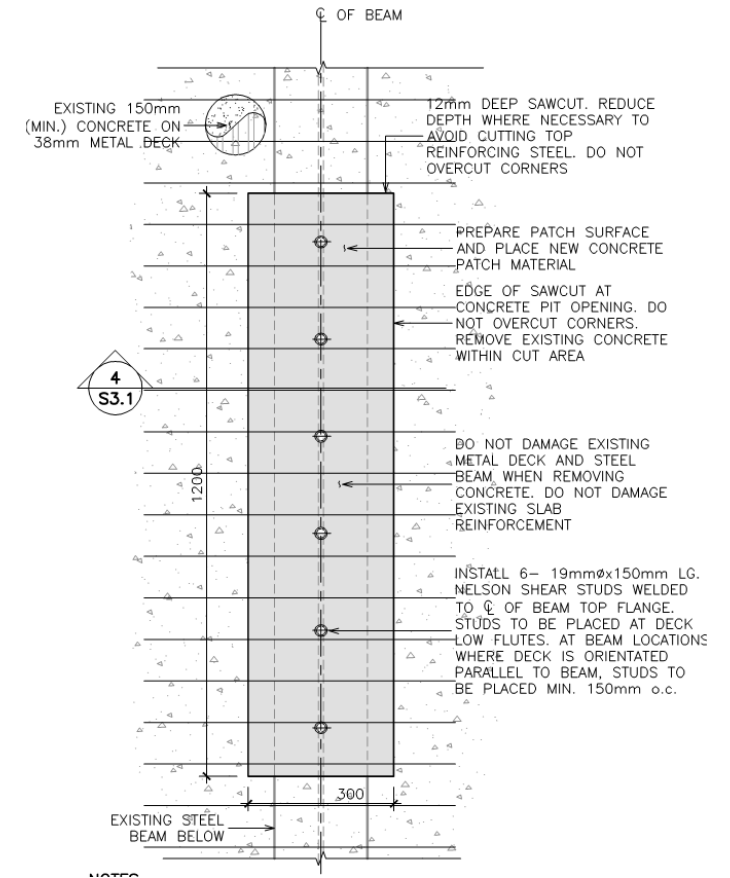
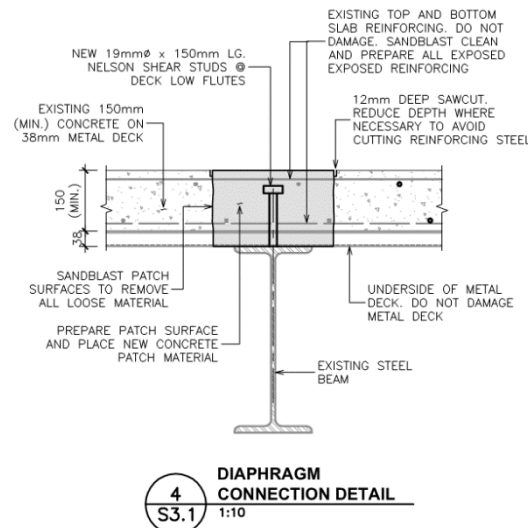
- **Completed between January 2016 and May 2017 (17 months)**
- **Full occupancy of the courthouse maintained throughout**
- **Interior work completed during nights/weekends to not disturb courts**
- **9 Phases**
- **Use of “Swing Space” for temporary relocation of occupants**



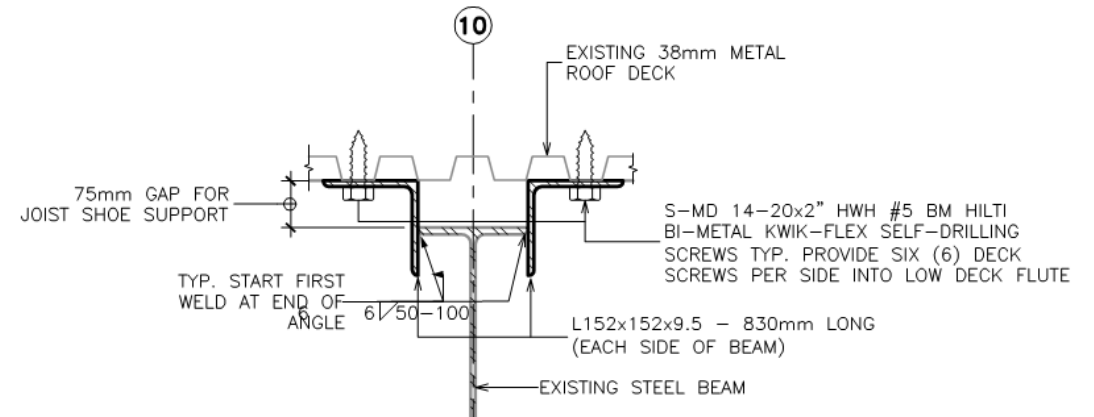
# Floor Diaphragm Connections



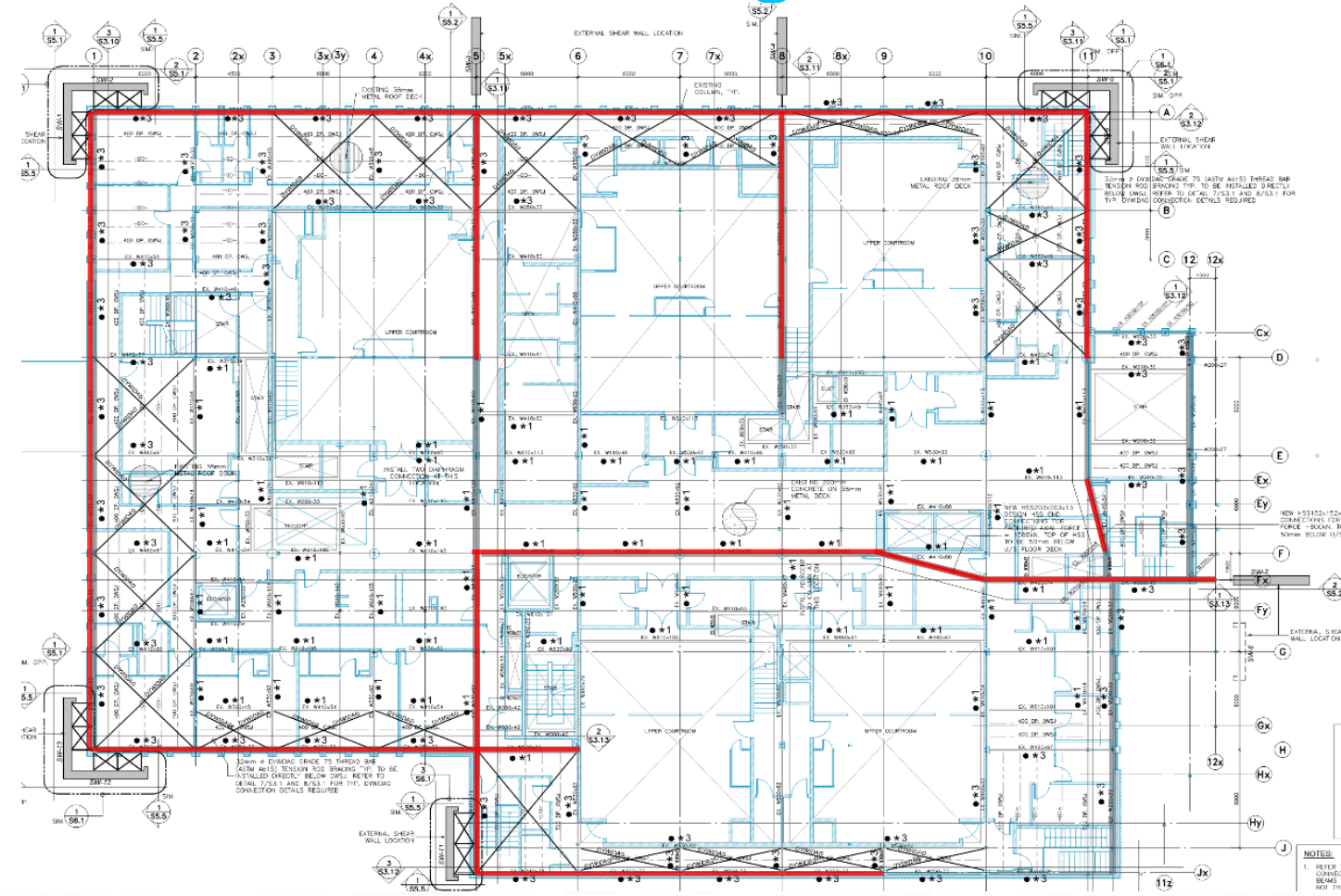
# Floor Diaphragm Connections



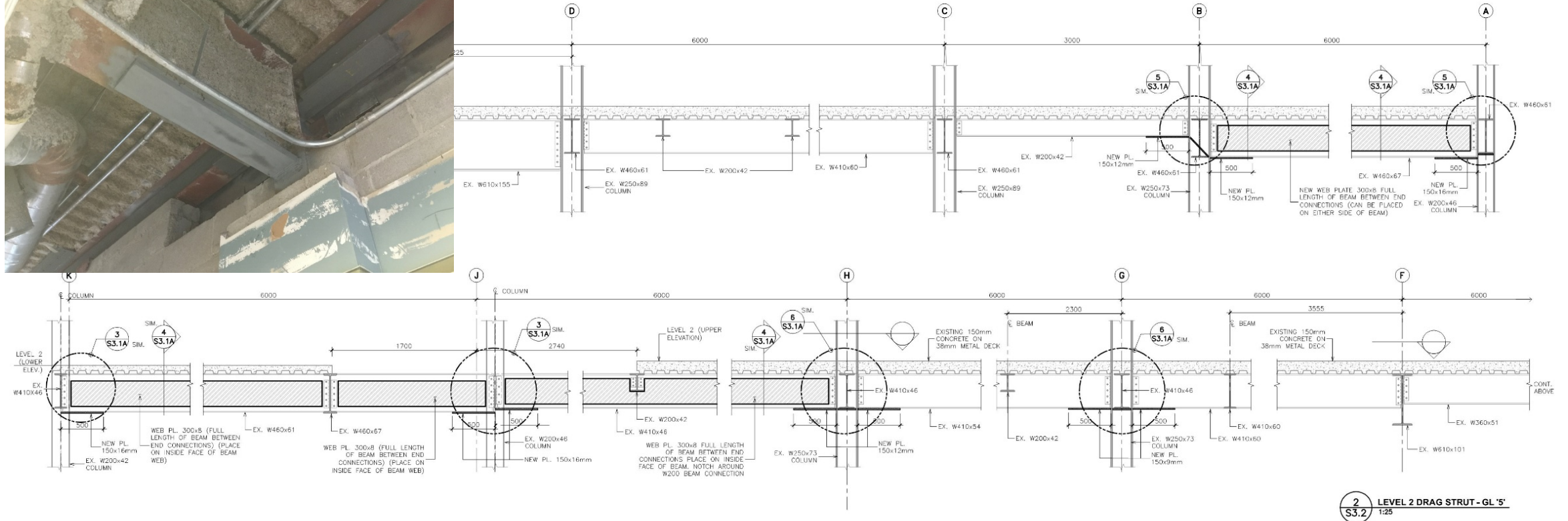
# Roof Diaphragm Connections



# Interior Steel Drag Struts



# Interior Steel Drag Struts



# CMU Wall Repairs and Elastomeric Coating





# Before / After



# Conclusions

- External Precast Shear Walls – proved to be most viable option
- Seismic retrofit complimented existing building exterior aesthetics
- Construction schedule requirements were met
- Project completed on budget



# Questions



Creative Thinking  
Practical Results



INTERNATIONAL  
CONCRETE REPAIR  
INSTITUTE

2018 Spring Convention | **seismic**solutions | April 11-13 | San Francisco