Peggy Ryan Williams Center

Ithaca, New York

AE Senior Thesis
April 14, 2014

Angela Mincemoyer

Structural Option

Advisor | Dr. Boothby

Peggy Ryan Williams Center

- Introduction
- Proposal
- Structural Depth
  - Gravity System
  - Lateral System
  - Bridge Truss
- Architectural Breadth
- Lighting Breadth
- Conclusion

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Photo provided courtesy of Holt Architects

Introduction

Owner | Ithaca College
Architect | Holt Architects
Structural Engineer | Ryan-Biggs Associates

58,200 GSF
4 Stories
Substantial Completion | March 2010

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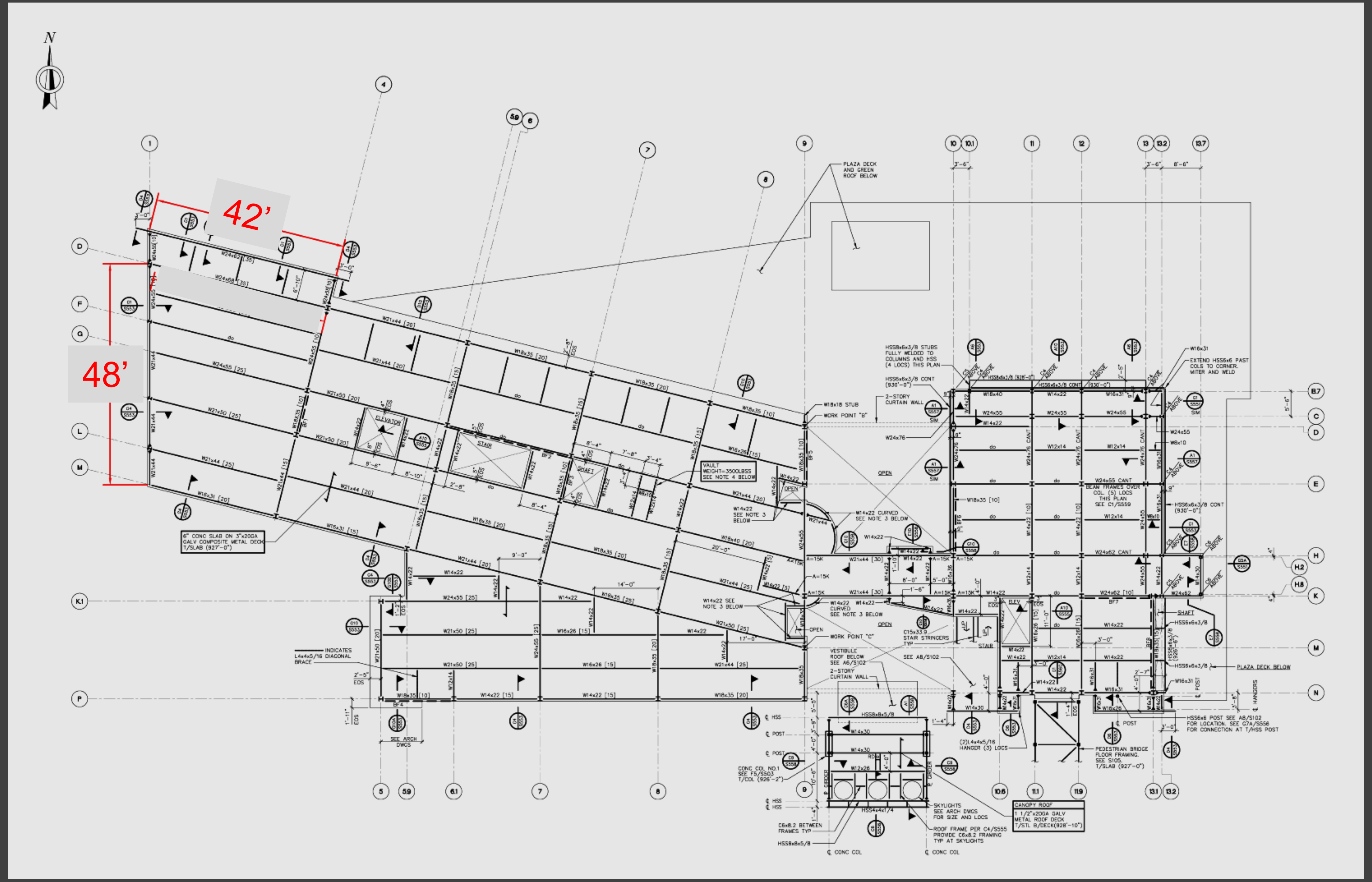

Existing Gravity System

Composite steel floor

3" x 20 gauge composite metal deck

6" concrete slab

Wide Flange

Beams, girder, columns

Irregular Layout

Geometry, cantilevers

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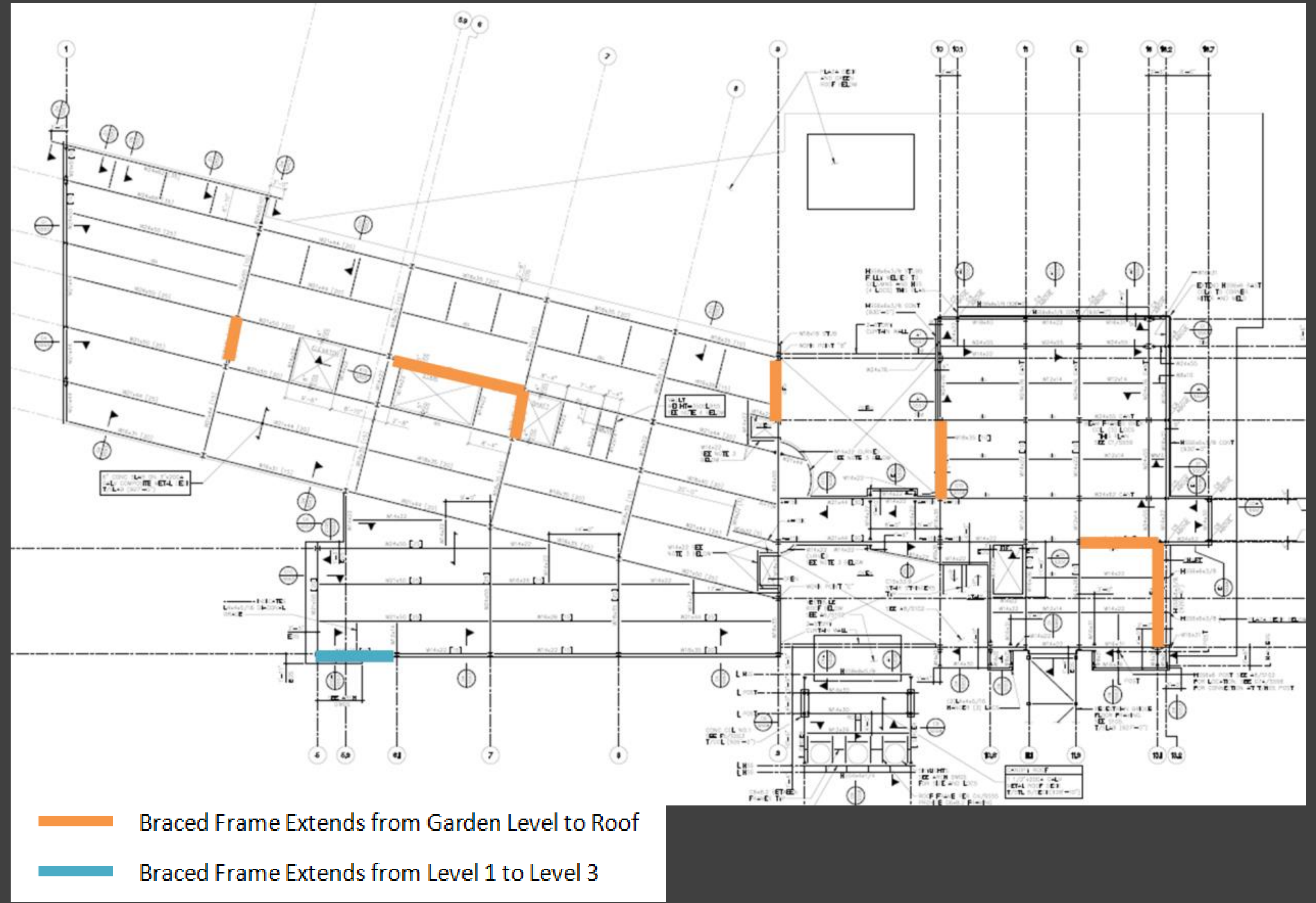

Existing Lateral System

Concentrically braced structural steel frames

North-South

East-West

Seismic Design Category A

Wind Controlled Design

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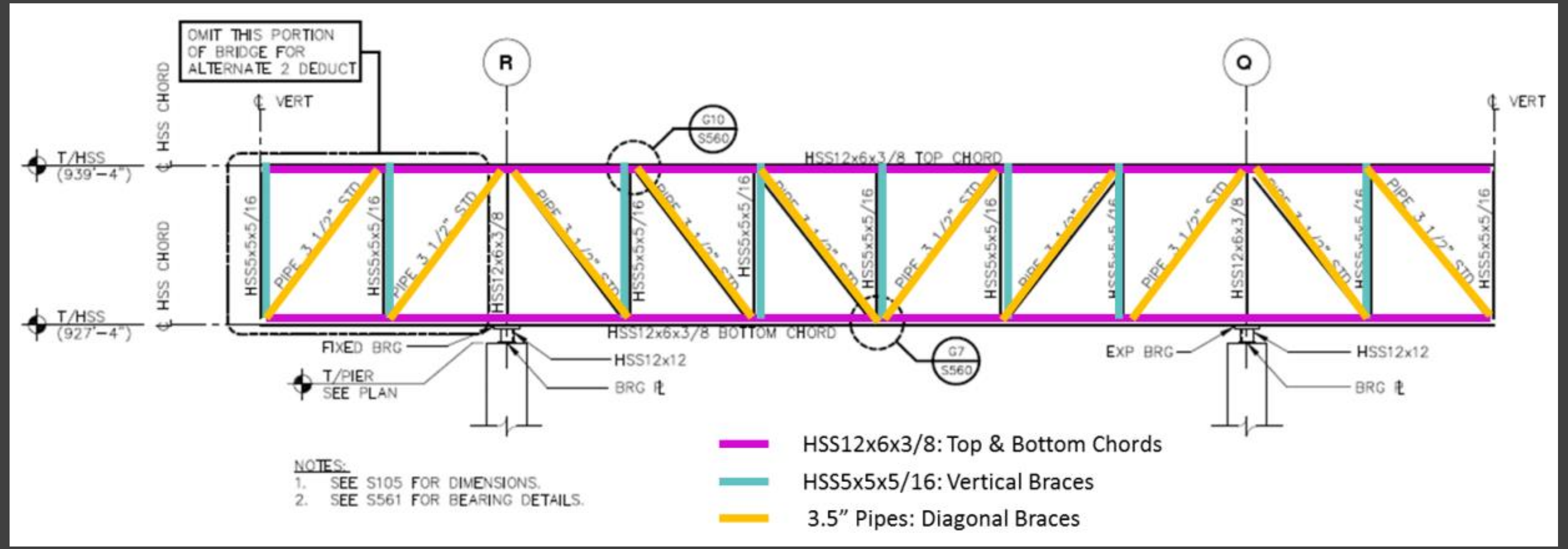

Pratt Trusses

HSS

3.5" pipe

Double Cantilever

Existing Bridge System

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Building

Scenario | Project Schedule is no longer critical

Proposal | One way concrete slab system with pan joists and girders

- Beneficial for cantilevers
- Accommodates varying spans & geometries
- Thinner slab
- Minimize architectural impact

Bridge

Scenario | Learning opportunity

Proposal | Two different redesign options will be considered

- Reflection of New York's historic covered bridges
- Reflect on original name of the building ("The Gateway Building")

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Proposal| One way concrete slab system with pan joists and girders

Goals| Design a one way concrete slab system while:

- Minimizing floor system depth
- Minimizing architectural impact

Bridge

Proposal| Two different redesign options will be considered

Goals| After considering two redesign options:

- Determine which option to move forward with
- Design one side truss of the bridge

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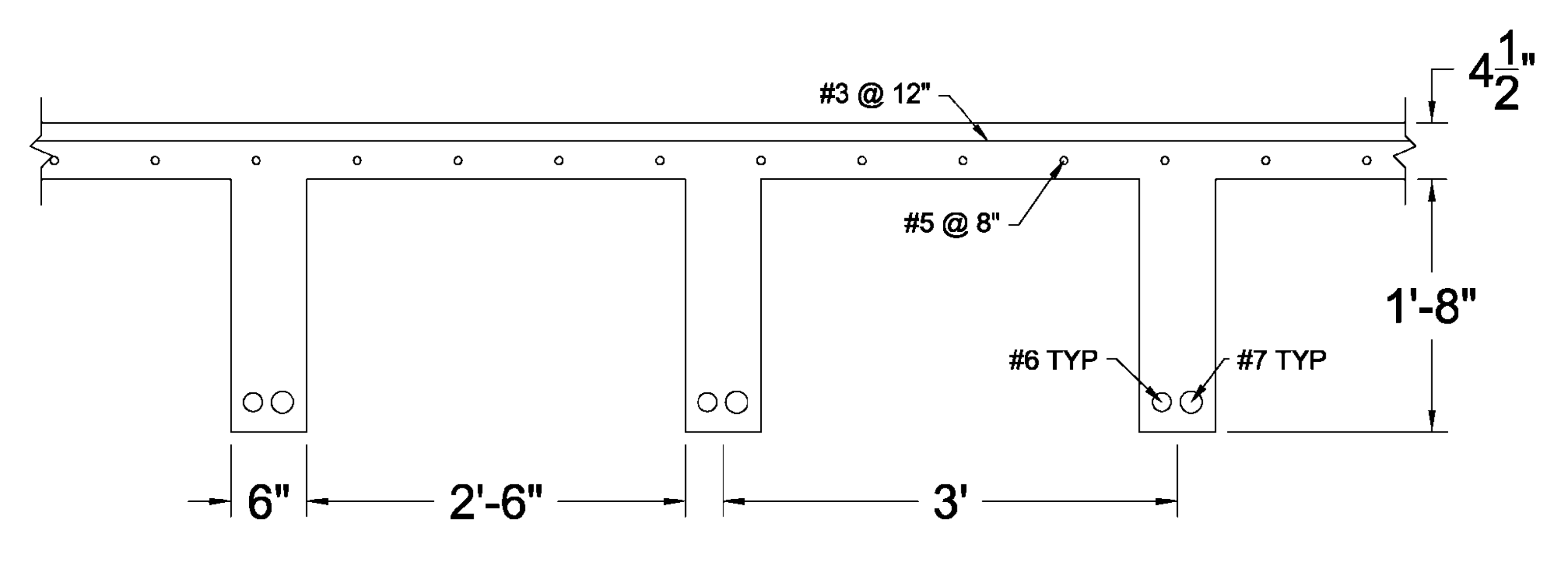

Pan Joist System

- CRSI Manual
- Same joist size and spacing used throughout
- 2 worst case spans considered
- 30” forms with 6” rib @ 36” o.c.
- 20” rib depth + 4.5” slab = 24.5” system depth
- f’c = 4,000 psi
- fy = 60 ksi

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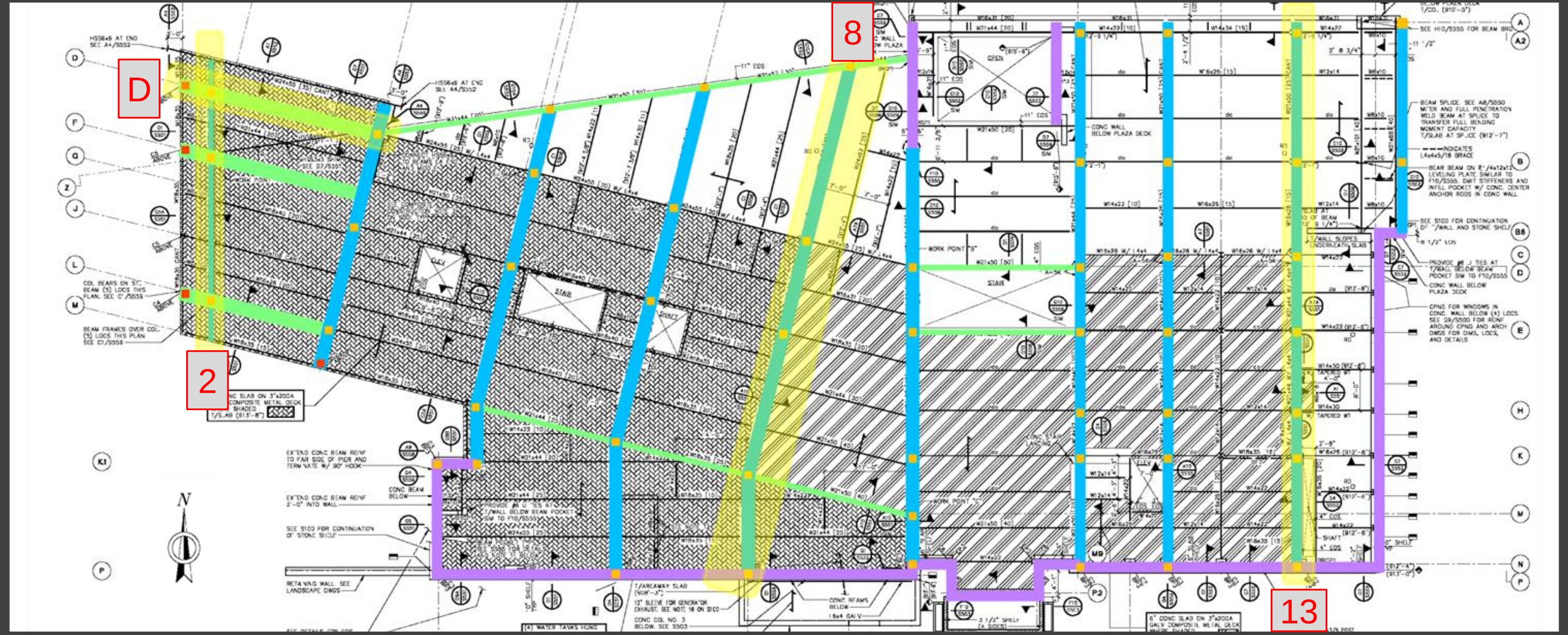
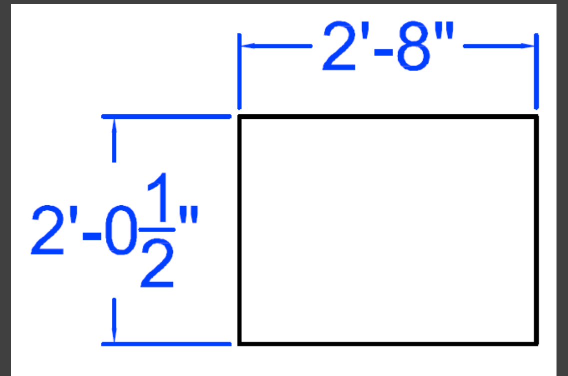
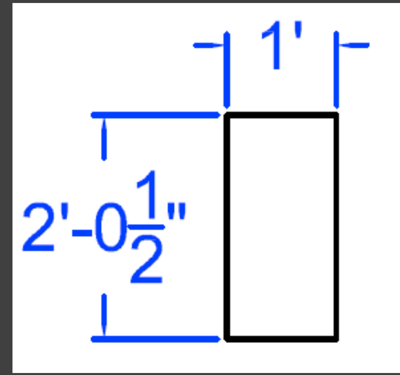
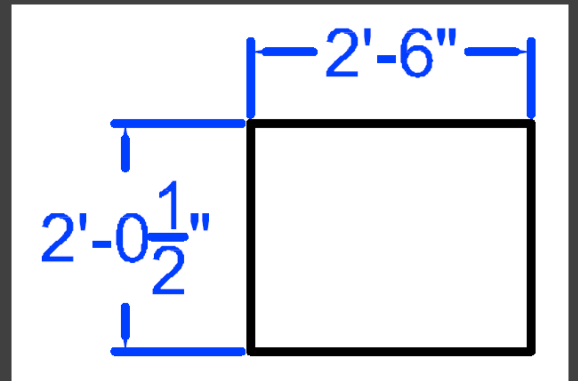




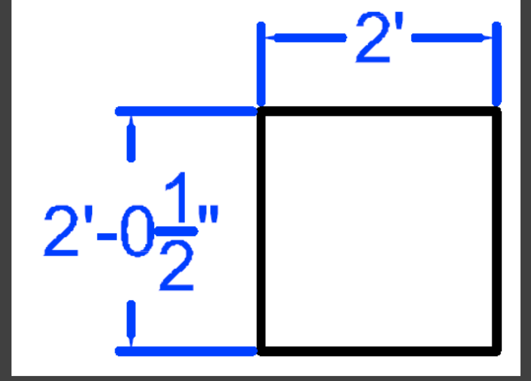
Column Line D



Column Line 2



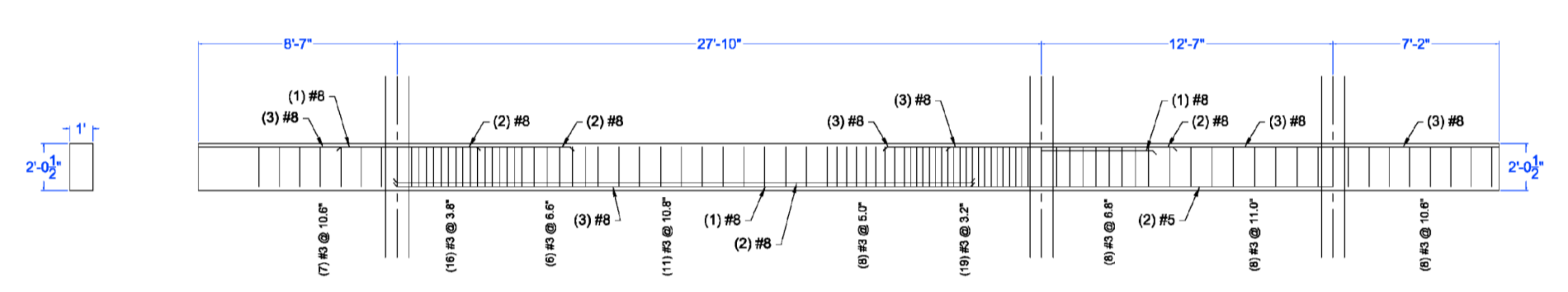
Column Line 8



Column Line 13

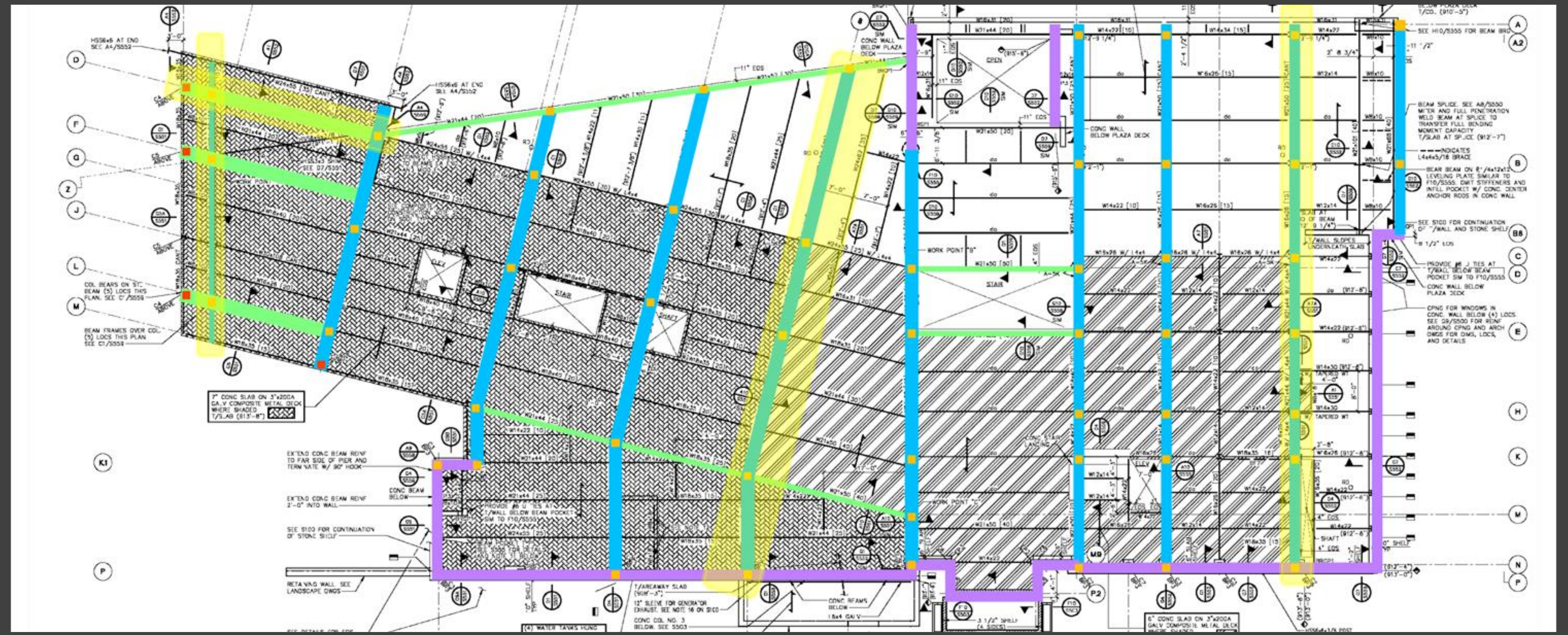
Framing Plan

- Designed members indicated
  - Chosen due to: Long spans, large tributary widths, high loadings
- Designed using spBeam
  - Strength requirements
  - Deflections checked per ACI 318-11 Table 9.5b



Girders/Beams

- Designed using spColumn
- Both axial loads from above & moments were applied
- Square section chosen
  - Ease of construction
  - Aid in future lateral system design
- All column sizes were increased to 18”x 18” for constructability



Columns

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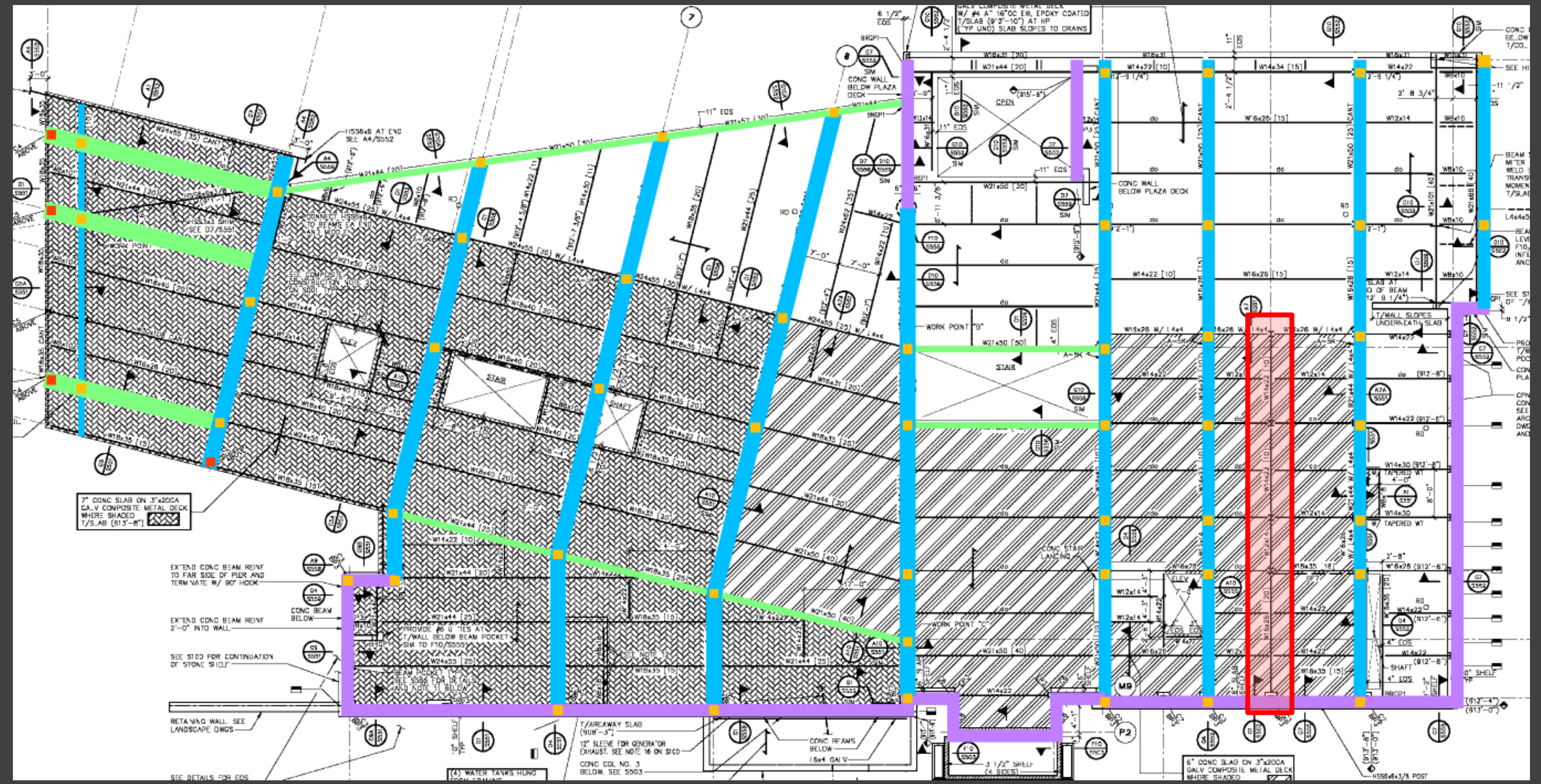
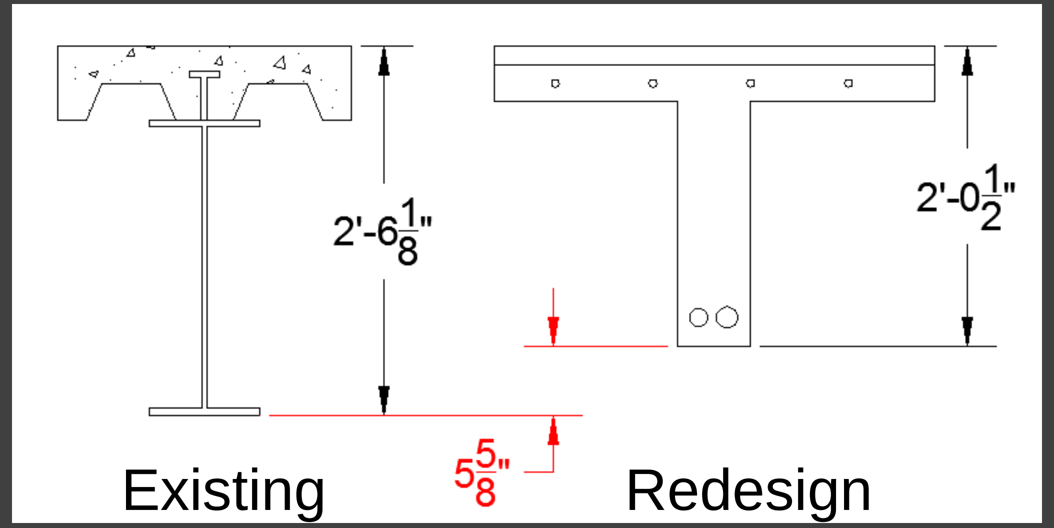
- Columns & girders were removed from original design
- Floor system depth decreased by 5-5/8”
  - Larger floor-to-ceiling height





Summary

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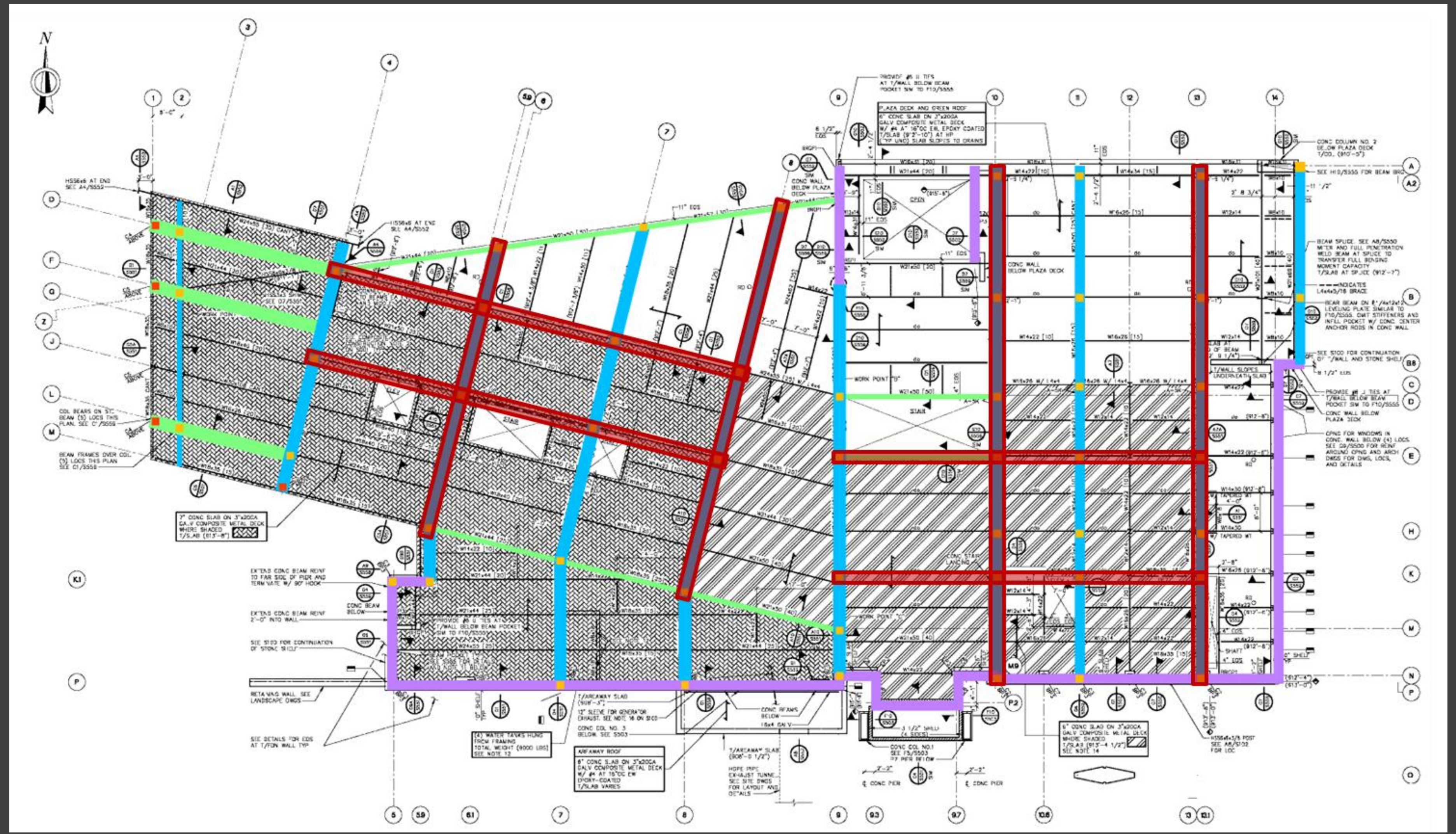
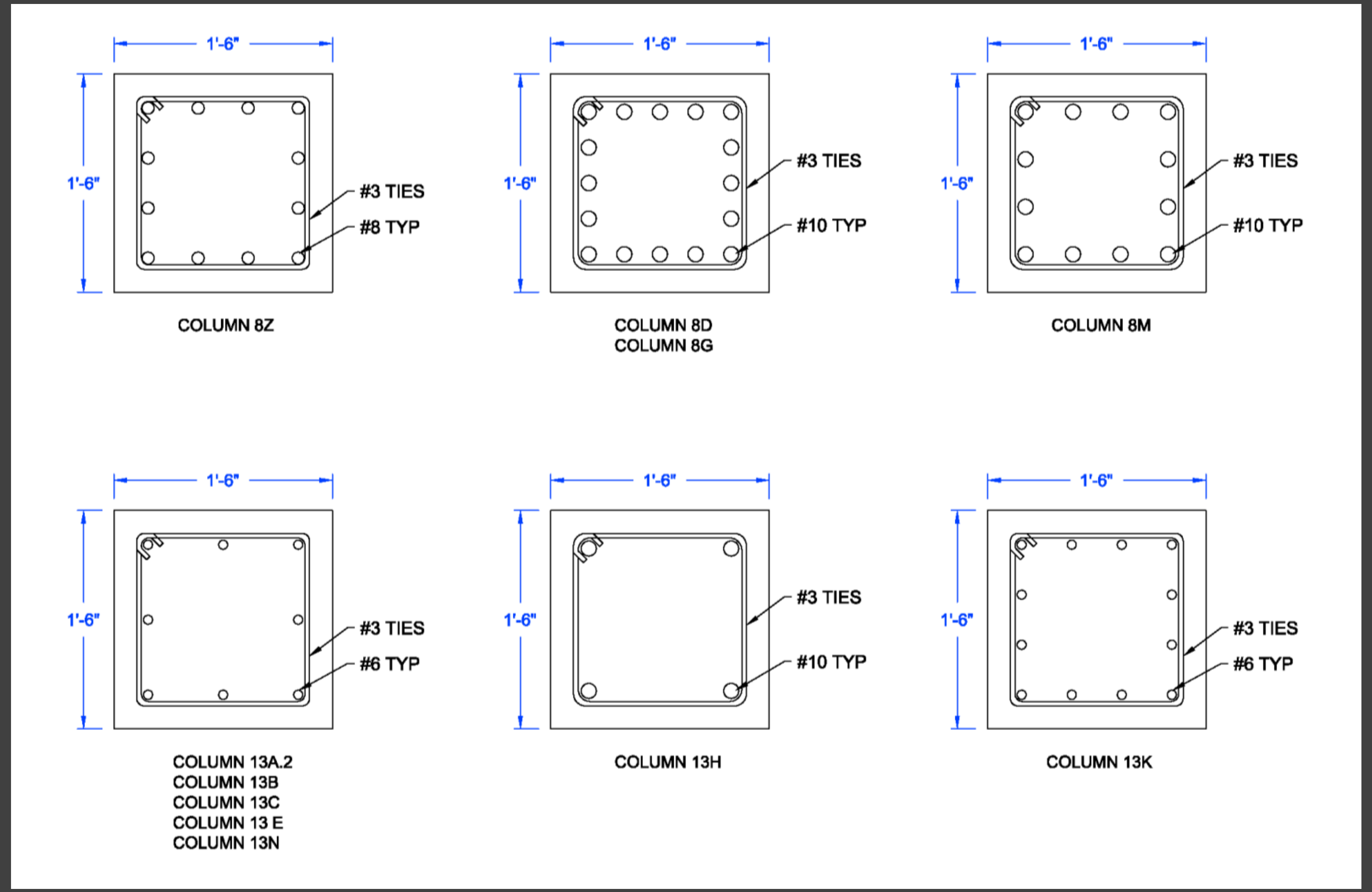
- Current lateral system
  - Concentrically braced structural steel frames
  - No longer the best option
- Gravity system may double as the lateral system
- Concrete moment frames in North-South and East-West directions
- 4 concrete moment frames were considered in each direction



Lateral System Introduction

- Both wind and seismic forces were calculated per ASCE7-10
  - Wind controlled
- Using spColumn, 18”x18” columns were designed
  - Biaxial bending was considered
- Worst case girder and joist were checked for beam-column interaction
  - Found to be adequate



Lateral System Analysis

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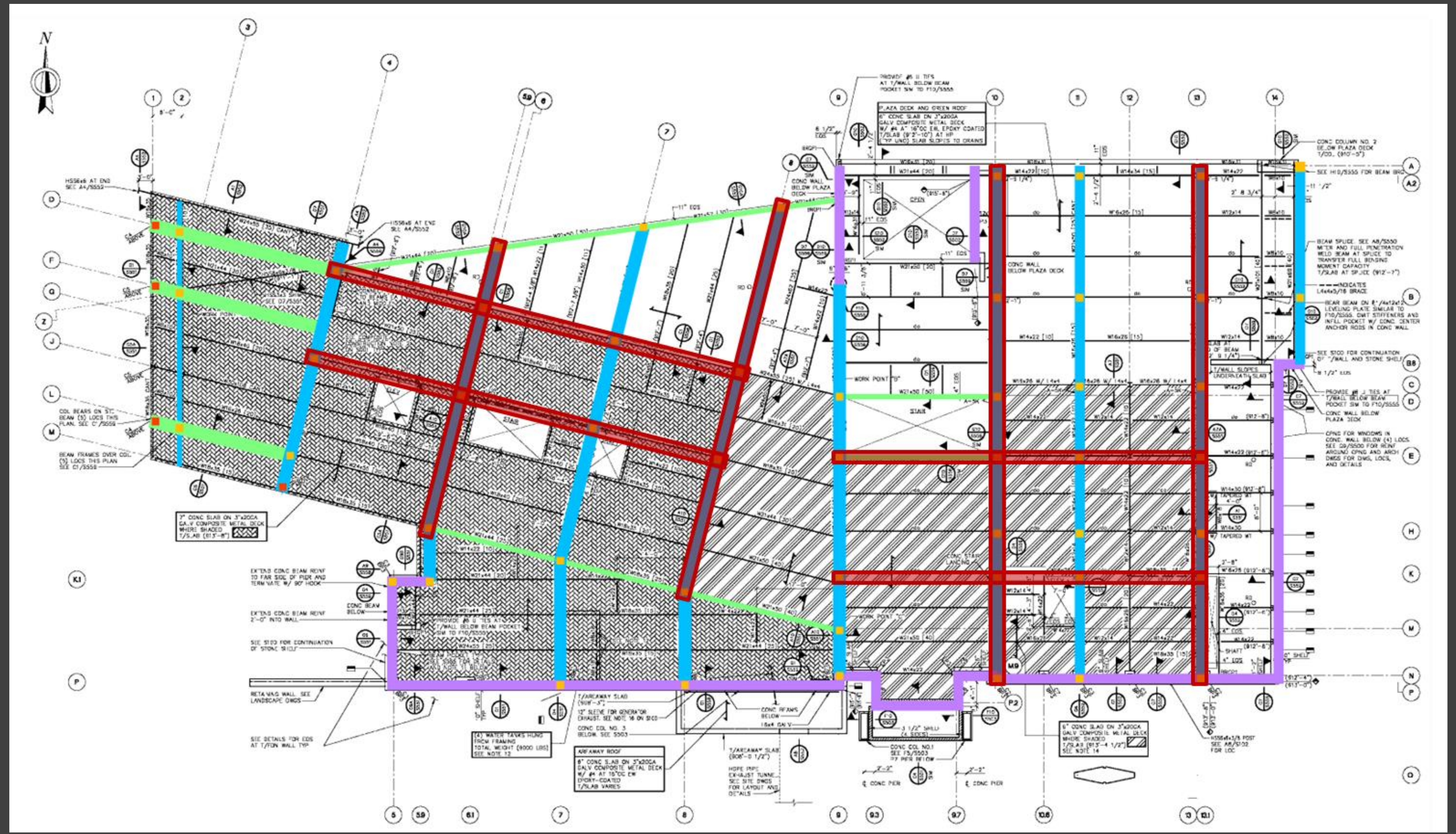
- Analysis was done using 4 frames in both directions
  - By adding frames the system will surely be adequate
- The gravity system of the building doubles as the lateral system



Summary

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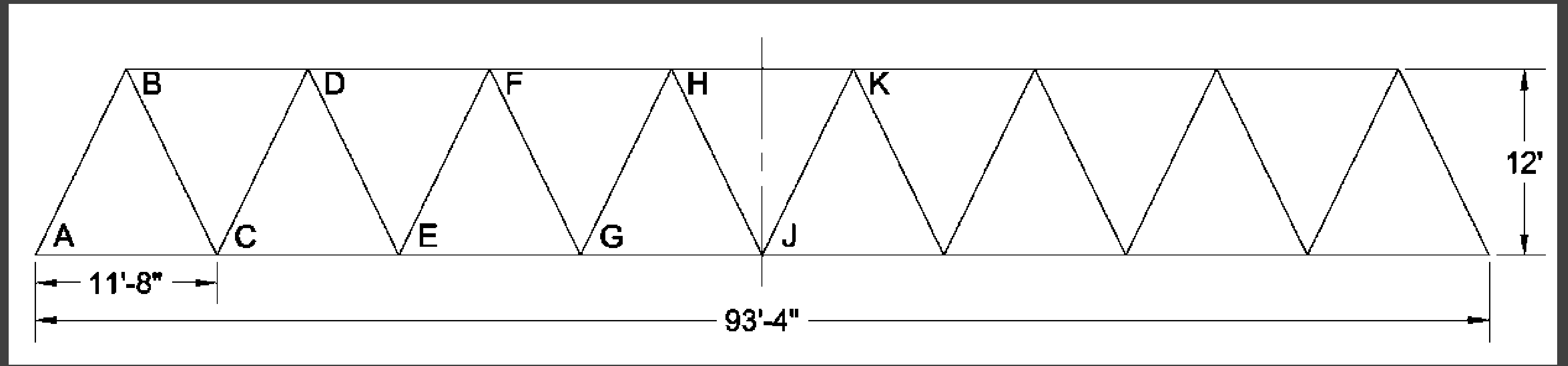
- Sketches were produced to determine which inspiration would be used in the redesign
  - The covered bridge option was chosen
- Box truss design
- Move supports out to open up the space
- Warren Truss



Bridge Introduction

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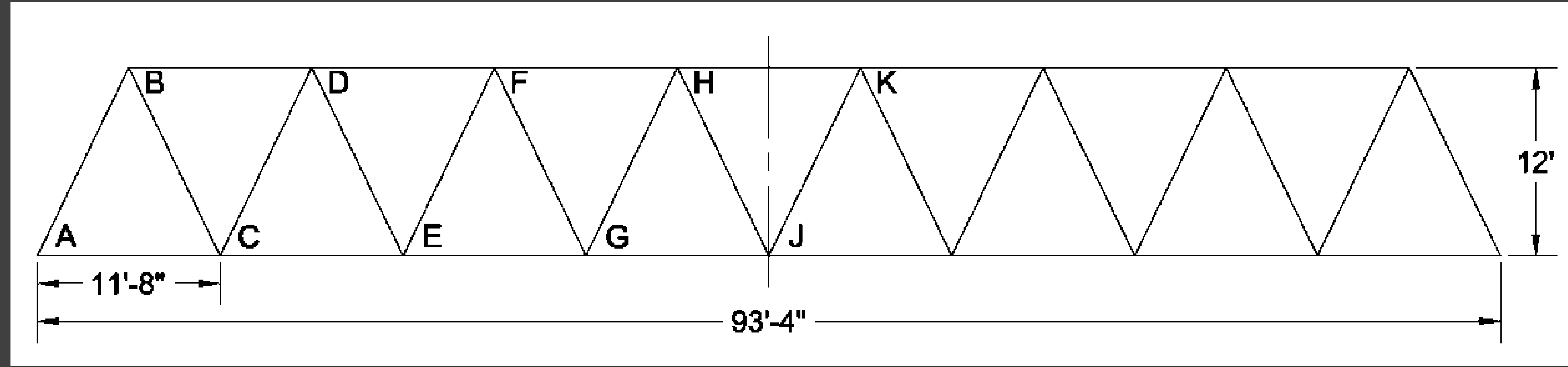
- Only gravity loads were considered for the side trusses
- Panel point loads were determined based on layout
- Controlling Load Combinations:
  - 1.2 D + 1.6 L + 0.5 S
  - 1.2 D + 1.6 S + L



Loads

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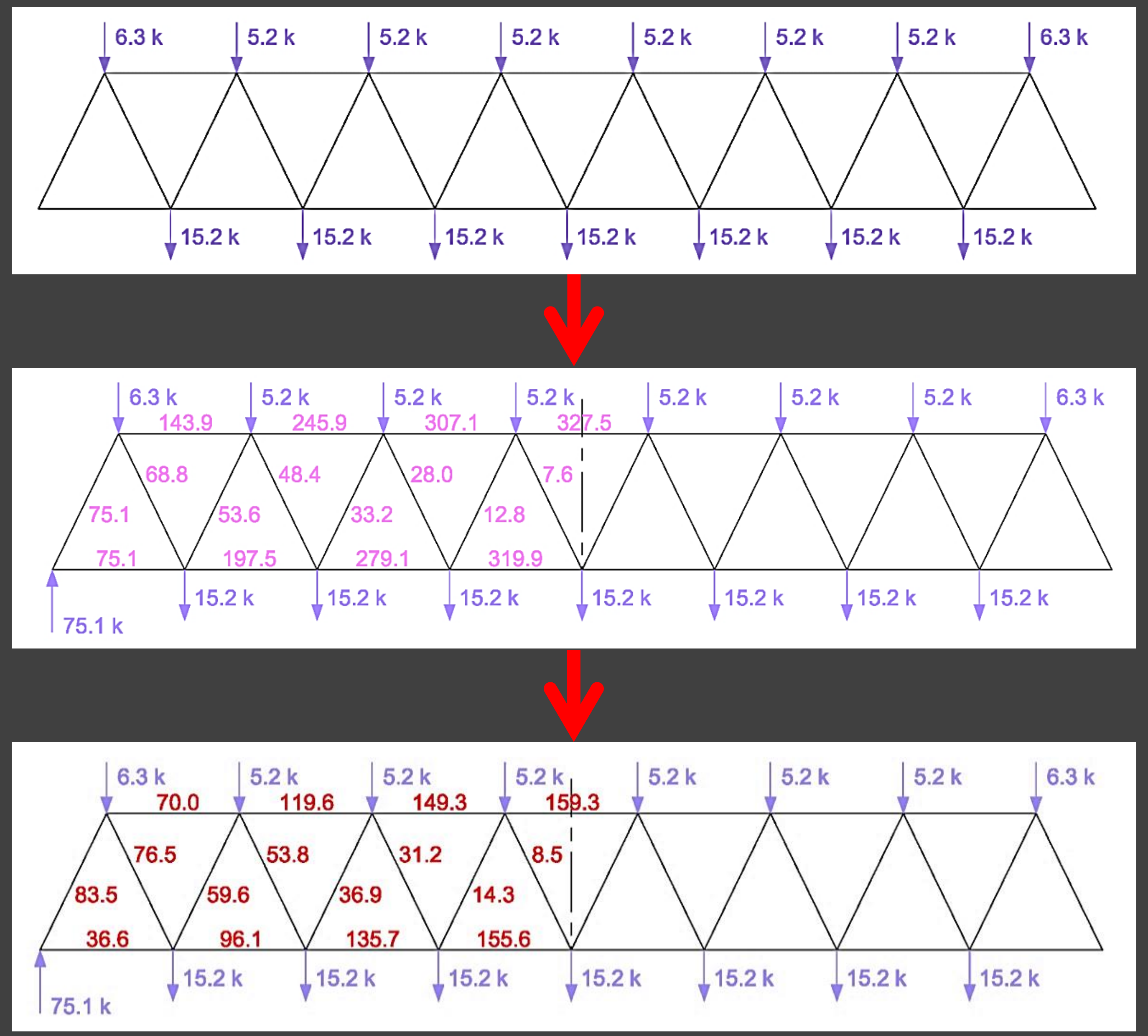
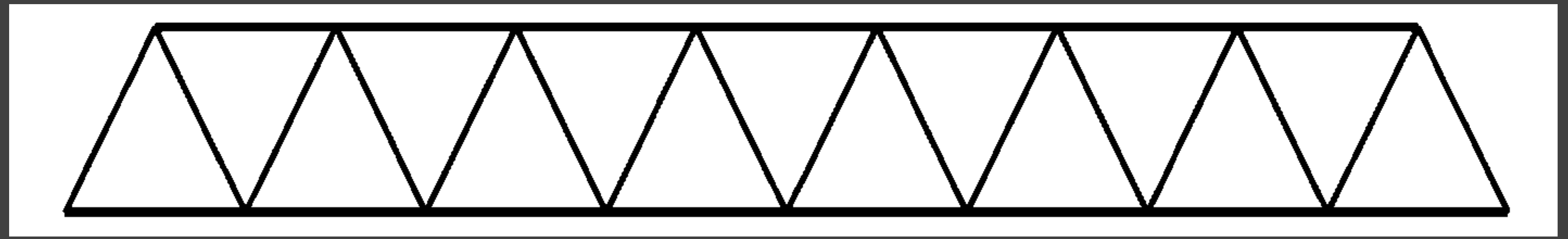
- Indexing Method
- Loading all panel points
  - Produced worst case force in top chord, bottom chord, and far left diagonal
- Use of geometry to determine member forces
- Method of Joints to verify Indexing Method forces
  - Indexing Method is an accurate method of analysis

Member Force Determination

1.2 D + 1.6 L + 0.5 S



- Steel Manual Tables
  - Table 4-4 for top chord and diagonal compression members
  - Table 5-5 for bottom chord tension member



Top Chord: HSS7x7x¼
Bottom Chord: HSS7x7x¼
Diagonals: HSS4x4x½

Member Design

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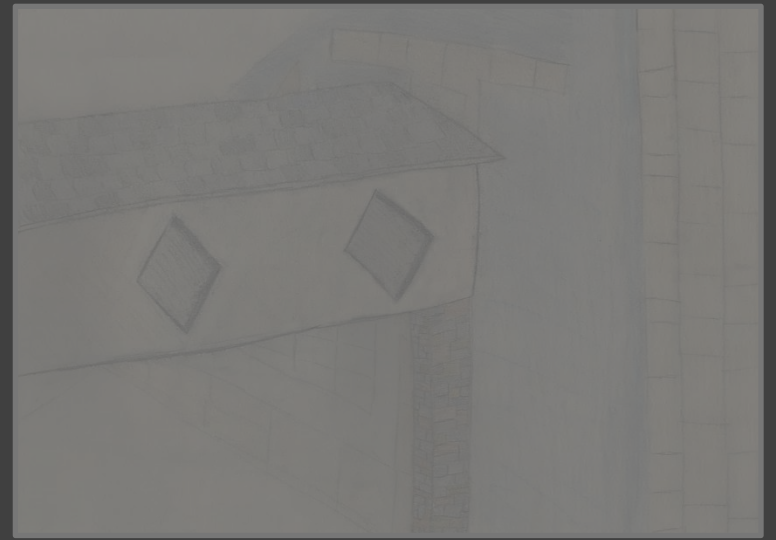
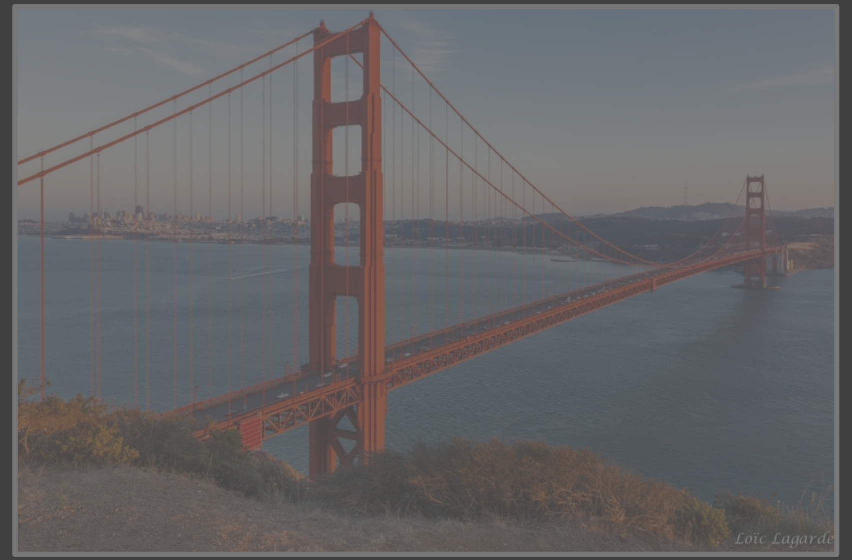
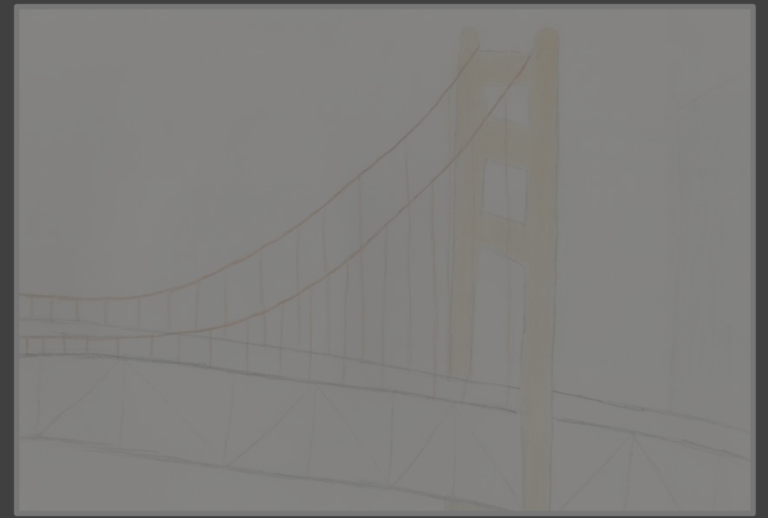


The Newfield Bridge





The Golden Gate Bridge

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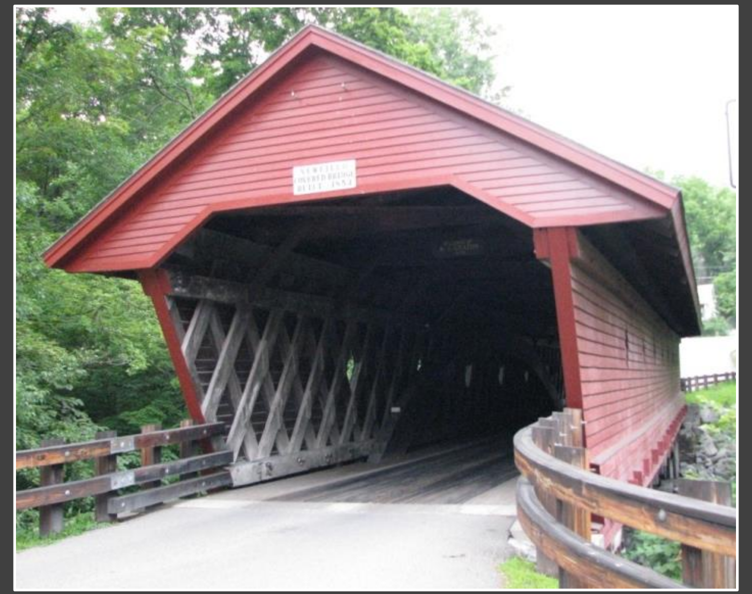

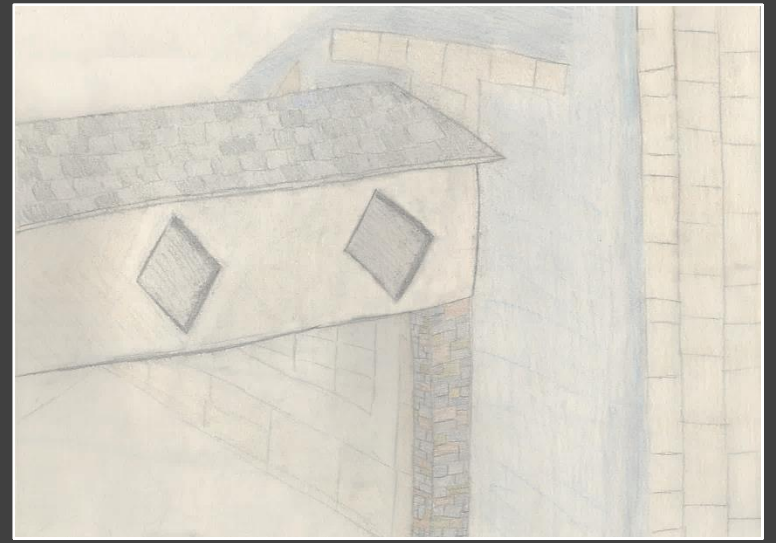

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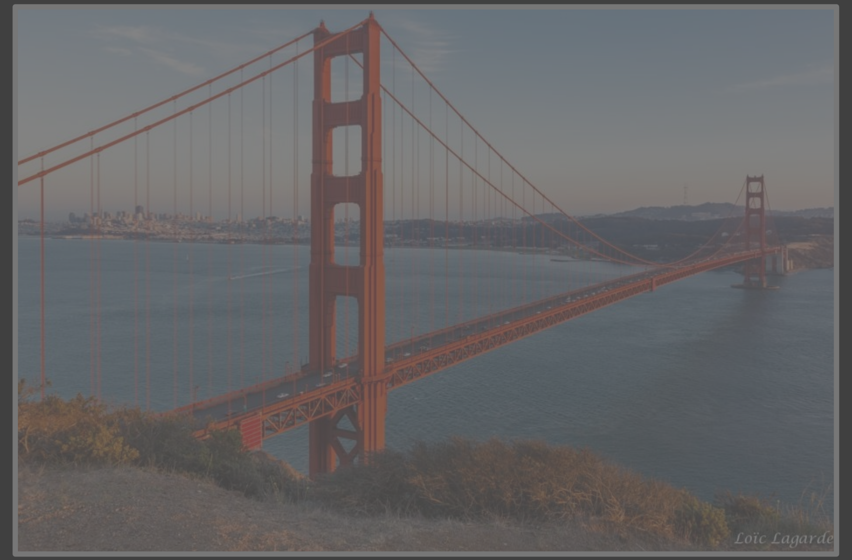

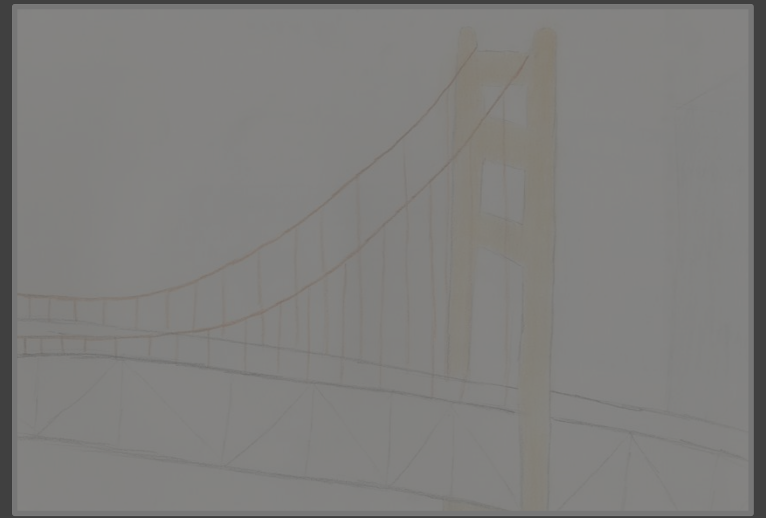

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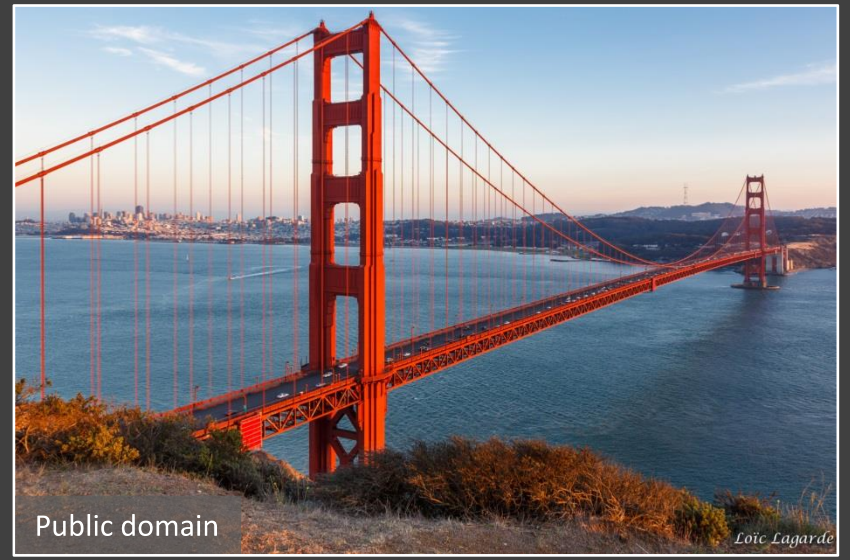

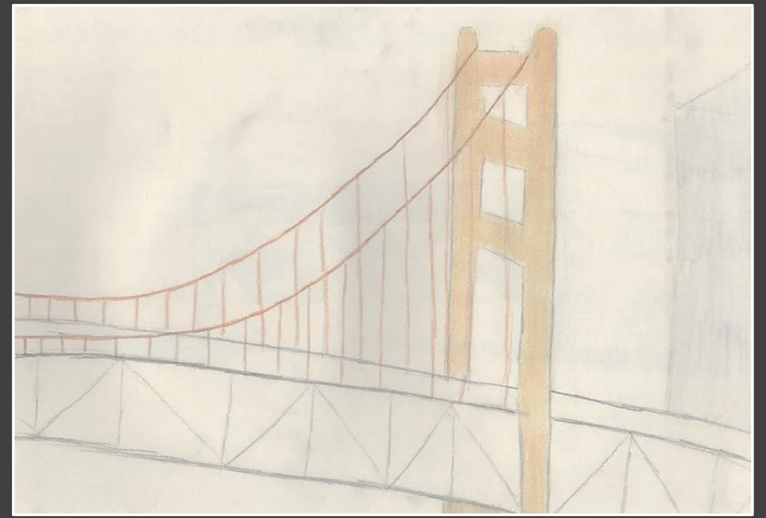

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The Newfield Bridge

Chosen Inspiration

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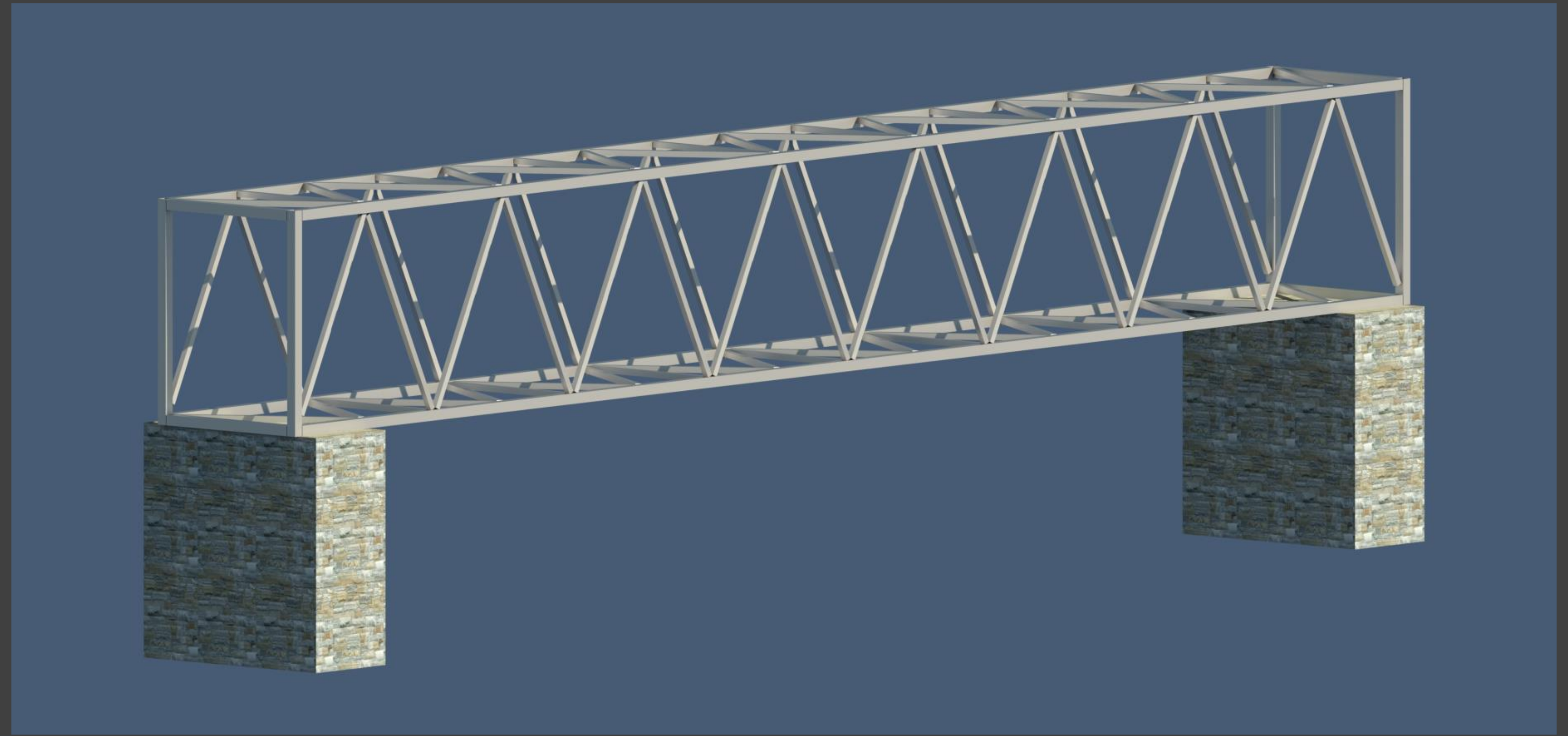
Truss Design



Redesign

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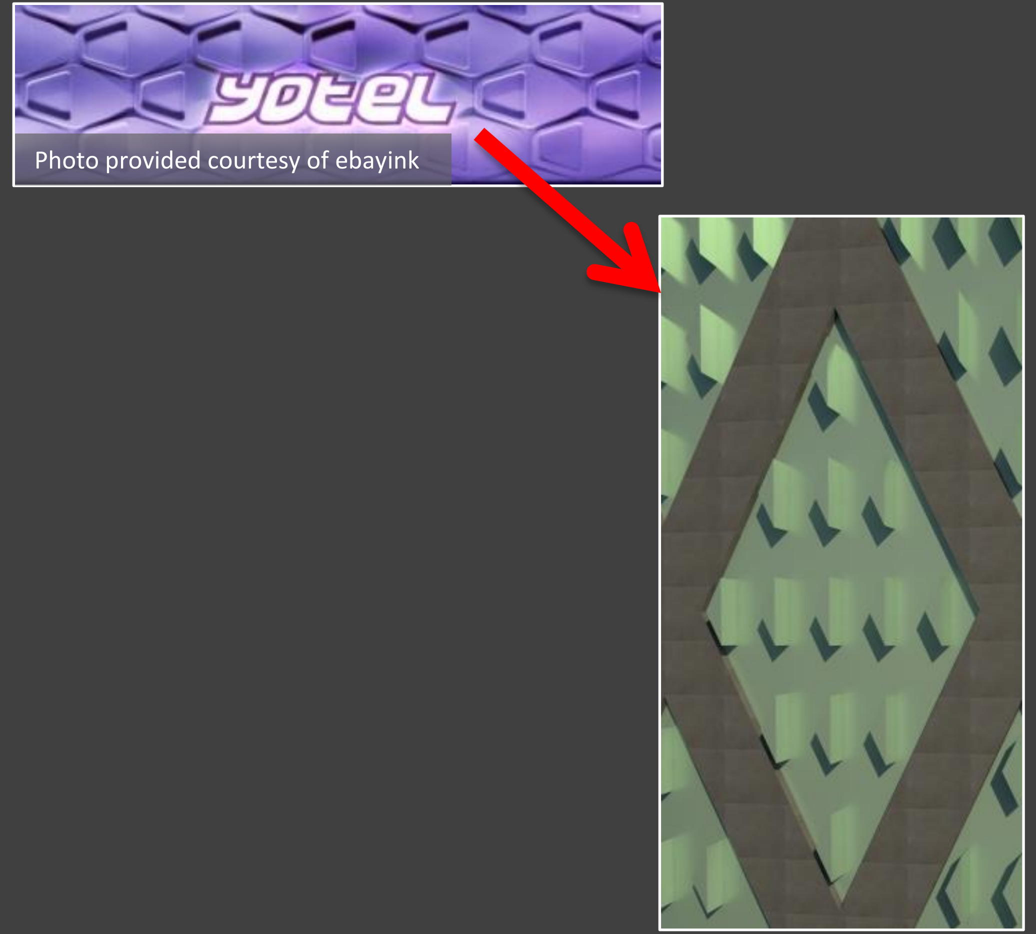
Façade Inspiration



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Façade Comparison

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Façade Comparison

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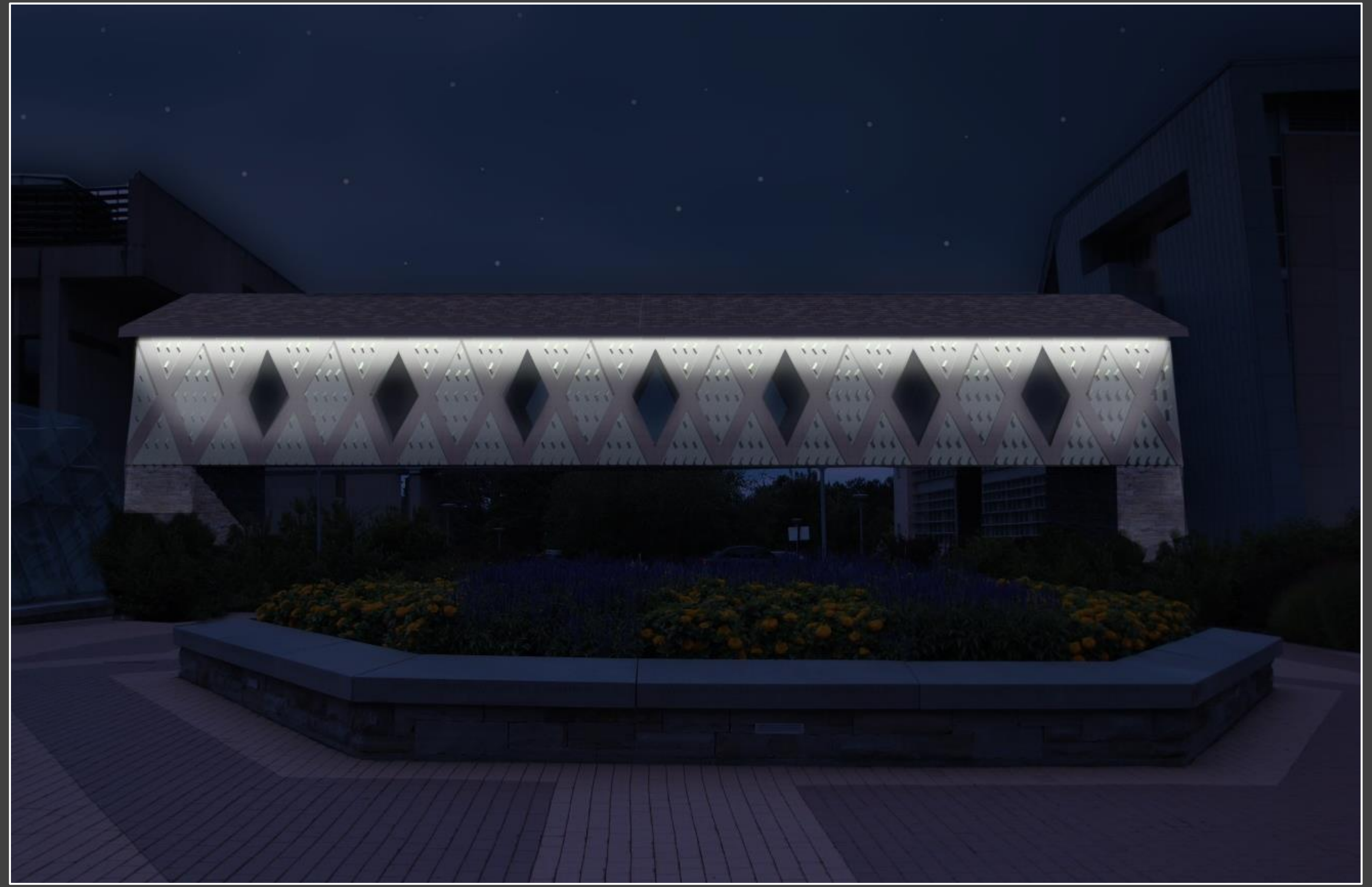

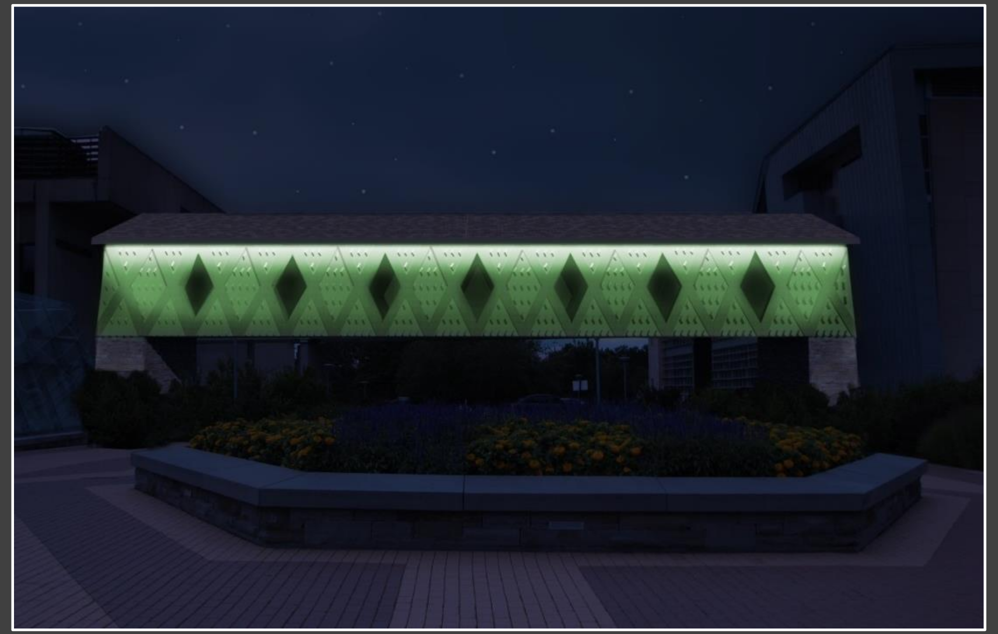

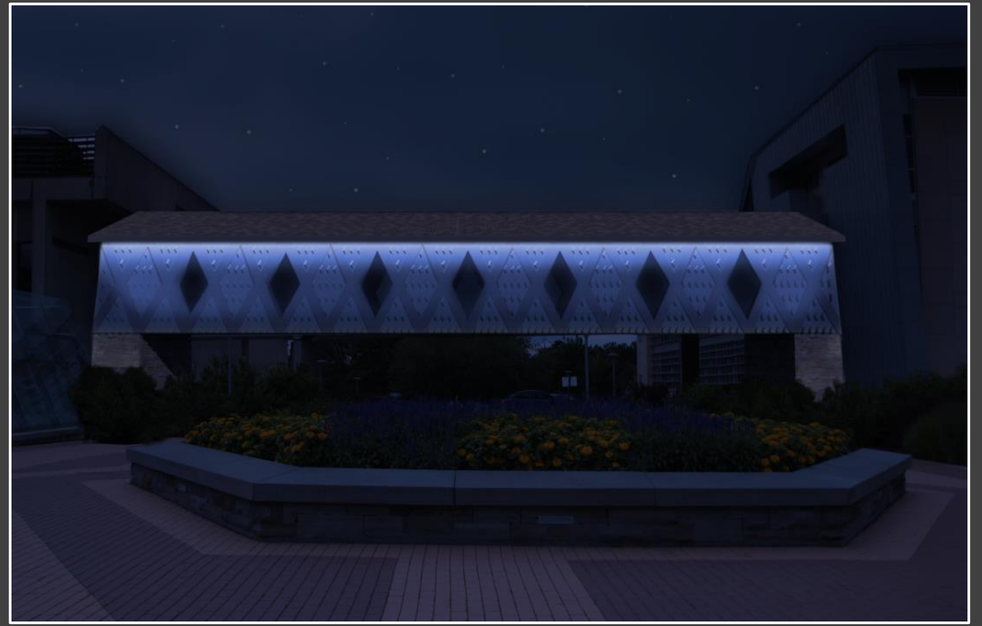

Lighting Breadth

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Building

Goals | Design a one way concrete slab system while:

- Minimizing floor system depth
- Minimize architectural impact

Conclusion | Designed a one way concrete slab system while:

- Floor system depth decreased by 5-⅝ inches
- Decreased number of columns and girders
- Gravity system adequate for Lateral Loads

Bridge

Goals | After considering two redesign options:

- Determine which option to move forward with
- Design one side truss of the bridge

Conclusion | Considered two redesign options:

- Chose the covered bridge option
- Designed side truss using the Indexing Method

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Bridge

Ryan-Biggs Associates
Holt Architects

Entire AE Faculty
Dr. Thomas Boothby
Professor M. Kevin Parfitt

Fellow AE Students

Family and Friends

Acknowledgements

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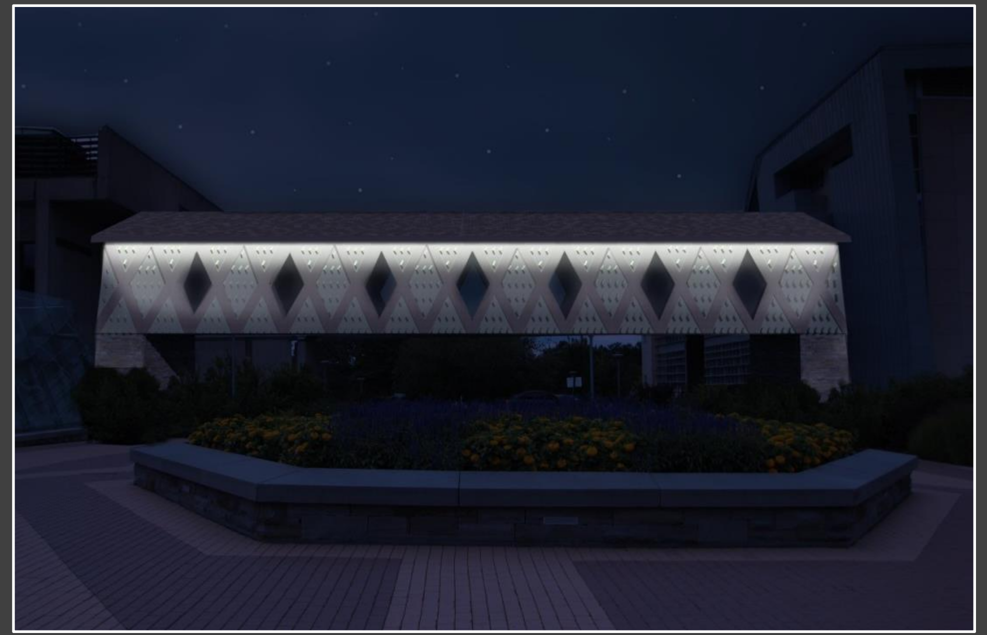

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Questions

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Structural Option

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