

Seth M. Moyer

Structural Option

Advisor: Dr. Thomas E. Boothby

Office Building

Sayre, PA



- › **Building Introduction**
- › Structural Overview
- › Proposal
- › Structural Depth
- › Breadth Studies
- › Conclusion

- › Business/Office Space
- › 85,075 SF
- › Top of Parapet: 74'-5"
- › March 2012 – April 2013
- › \$11 Million
- › Design-Bid-Build



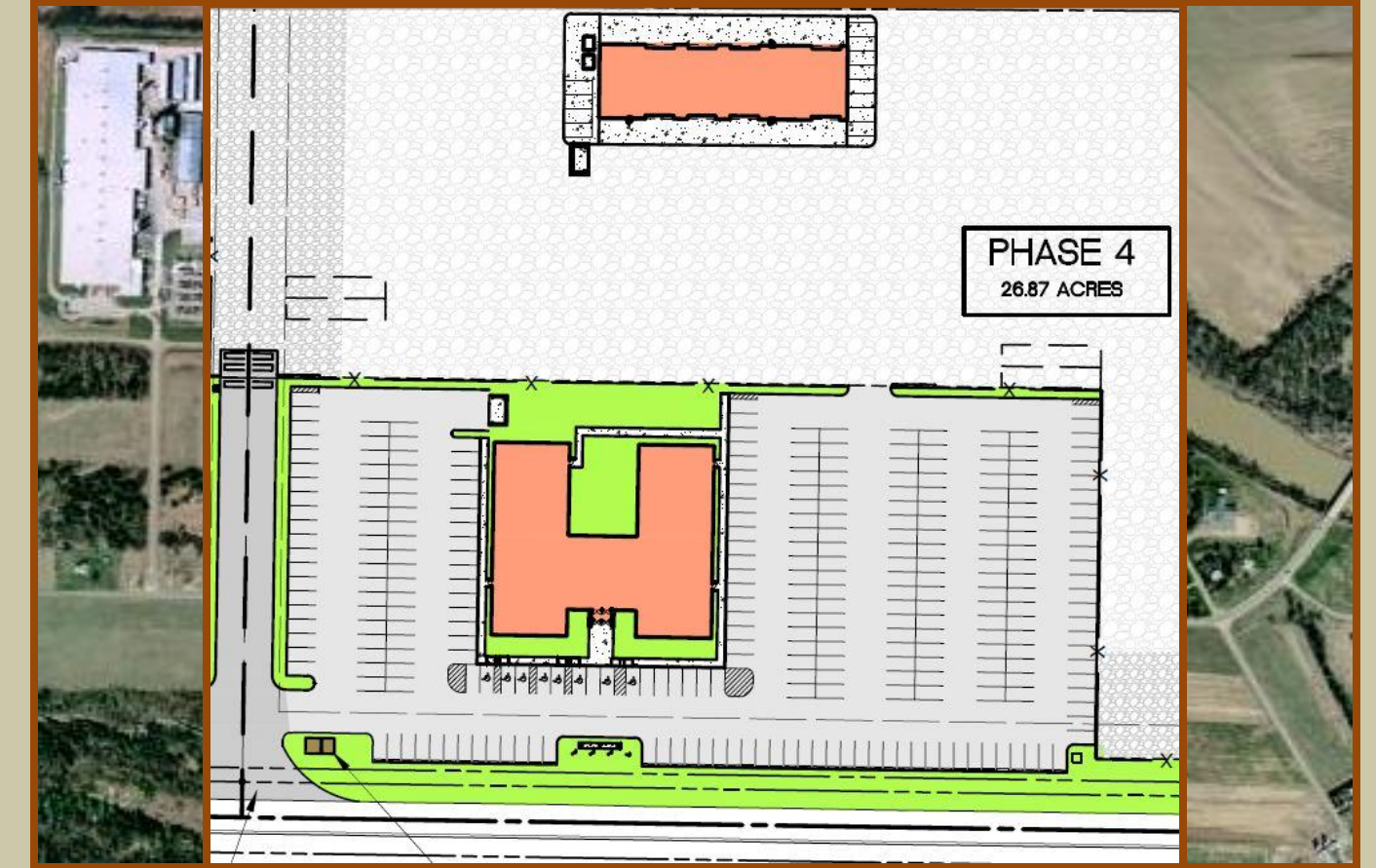
Office Building

- › Building Introduction
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Project Team

- › Architectural Partnership
 - Elliott + Assoc. Architects
- › Architect of Record
 - Silling Assoc., Inc.
- › General Contractor
 - High Construction Co.
- › Structural/MEP/Civil
 - Larson Design Group

Project Site

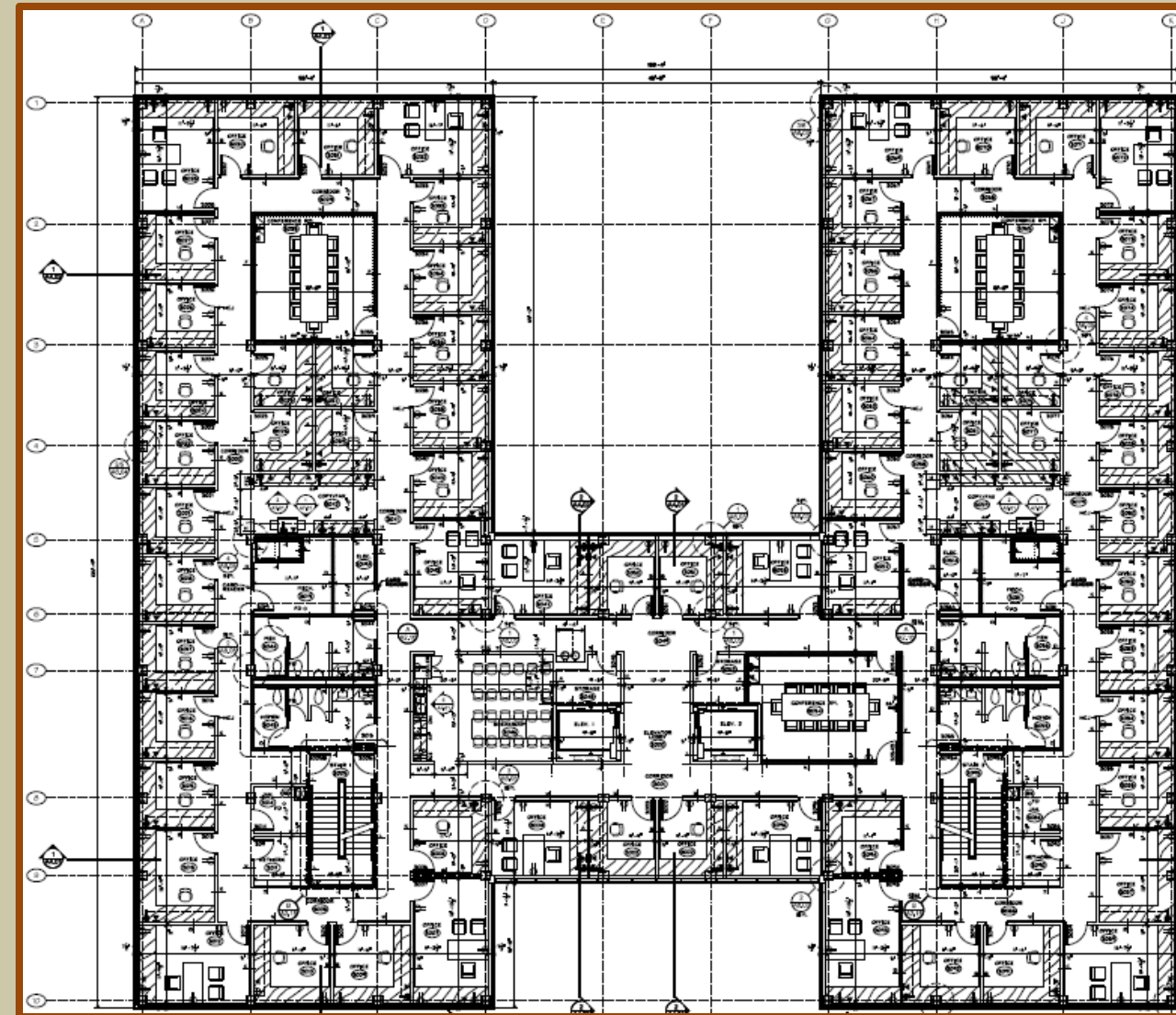


Office Building

Plan Layout

Elevations

- › Building Introduction
- › Structural Overview
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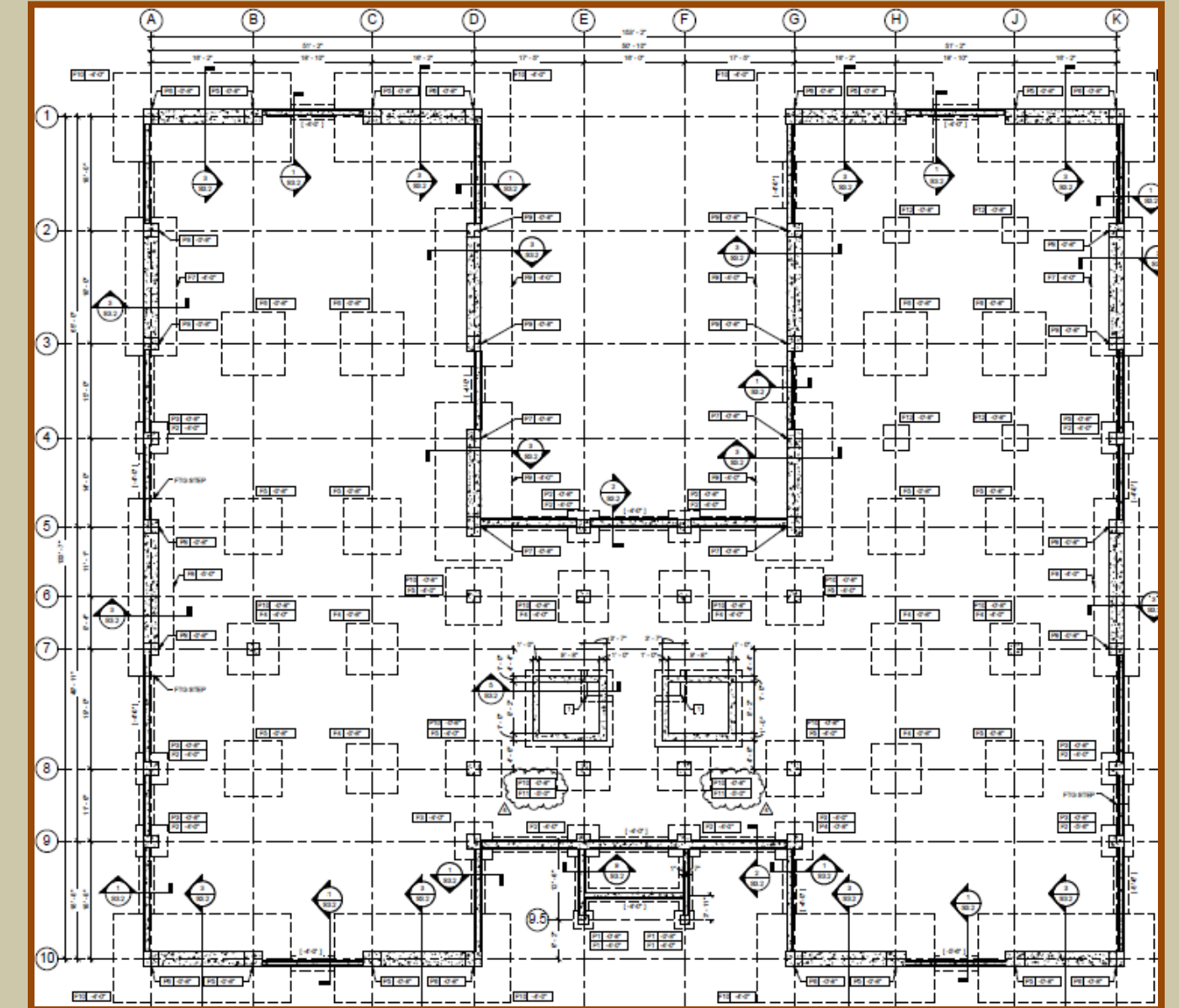
Office Building

- › Building Introduction
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Existing Structure

- › Foundations
 - Spread, Combined and Strip

Foundation Plan



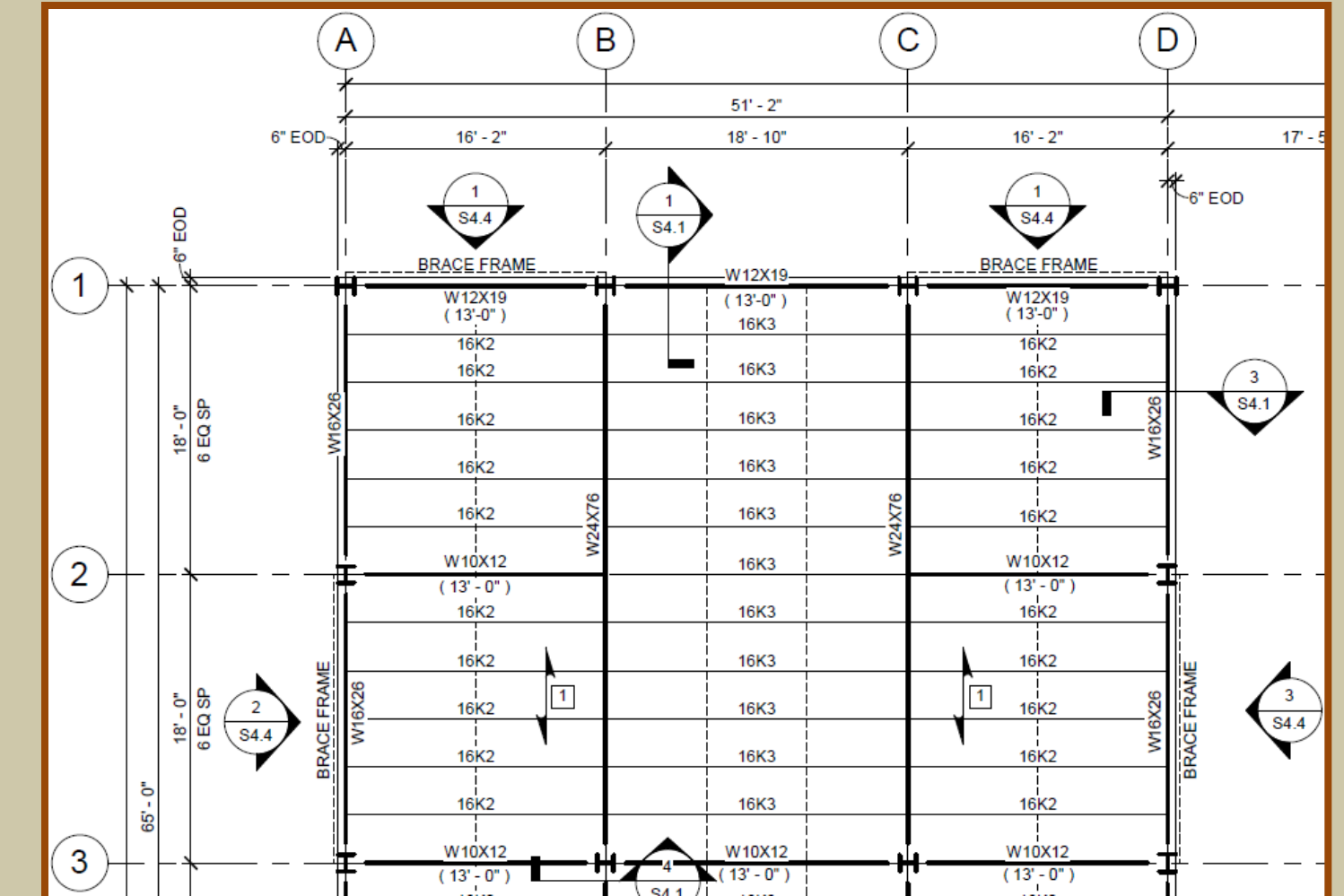
Office Building

Existing Structure

Typical Framing Plan

- › Building Introduction
- › Structural Overview
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- › Foundations
 - Spread, Combined and Strip
- › Framing
 - 4" NWC on Composite Deck on Open Web Steel Joists
 - Wide Flange Beams and Columns



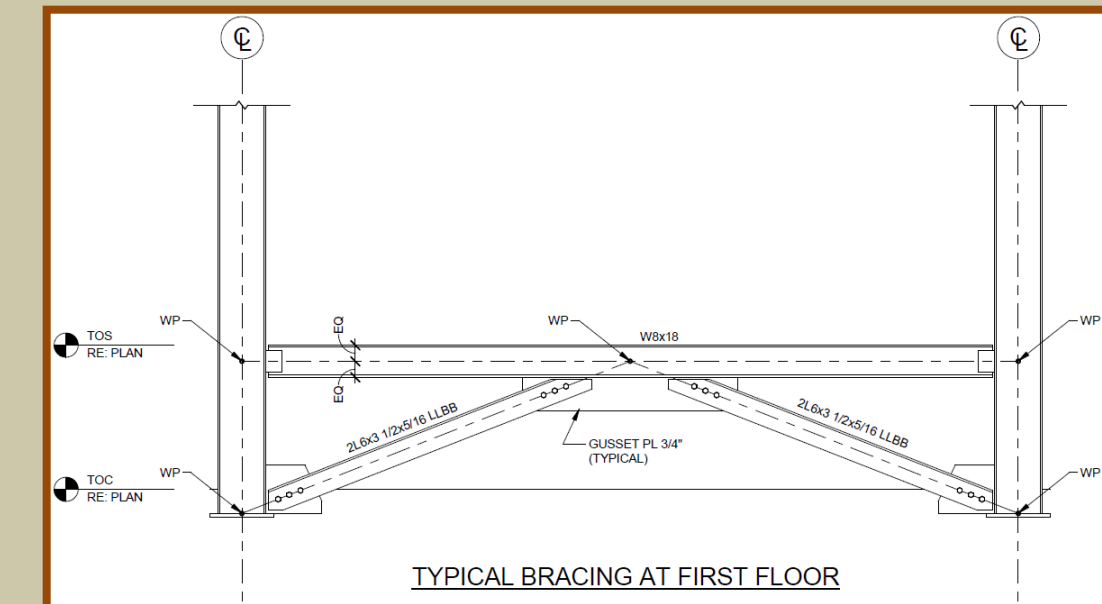
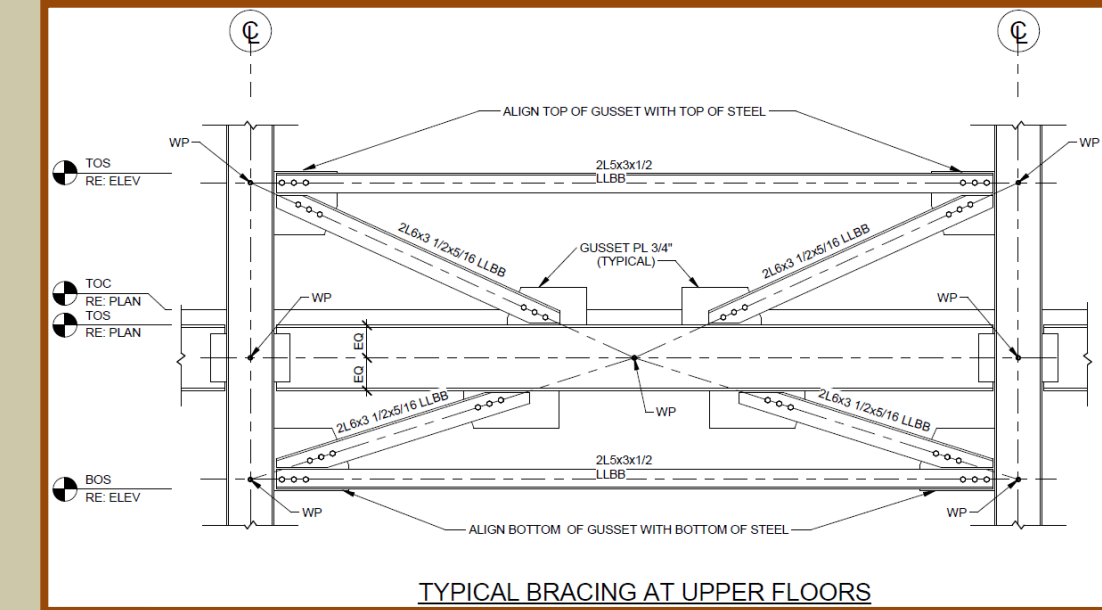
Office Building

Existing Structure

Bracing Details

- › Building Introduction
- › Structural Overview
- › Proposal
- › Structural Depth
- › Breadth Studies
- › Conclusion

- › Foundations
 - Spread, Combined and Strip
- › Framing
 - 4" NWC on Composite Deck on Open Web Steel Joists
 - Wide Flange Beams and Columns
- › Lateral System
 - 16 "K" Braced Frames



Office Building

Depth Study Background

Proposal

- › Building Introduction
- › Structural Overview
- › **Proposal**
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- › Bracing not Fully Triangulated
- › Bending Moments in Columns
- › Effectively Act as Moment Frames

- › Replace Braced with Moment Frames
- › Design Frame Members for Drift and Check for Strength Requirements
- › Design/Detail FR Moment Connections

Office Building

Breadth Studies Background

Proposal

- › Building Introduction
- › Structural Overview
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- › Conclusion

- › No Braces Above/Below Windows
- › Options for Façade
- › Opportunity to Open Building Up

- › Enclosure Redesign
- › Analyze Barrier Performance
- › Assess Mechanical Loads and Systems Impact

Office Building

Preliminary Drift Considerations

Serviceability Wind Loading

- › Building Introduction
- › Structural Overview
- › Proposal
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- › Potentially Very Flexible System
- › Pinned Column Bases
- › H/500 Drift Limit

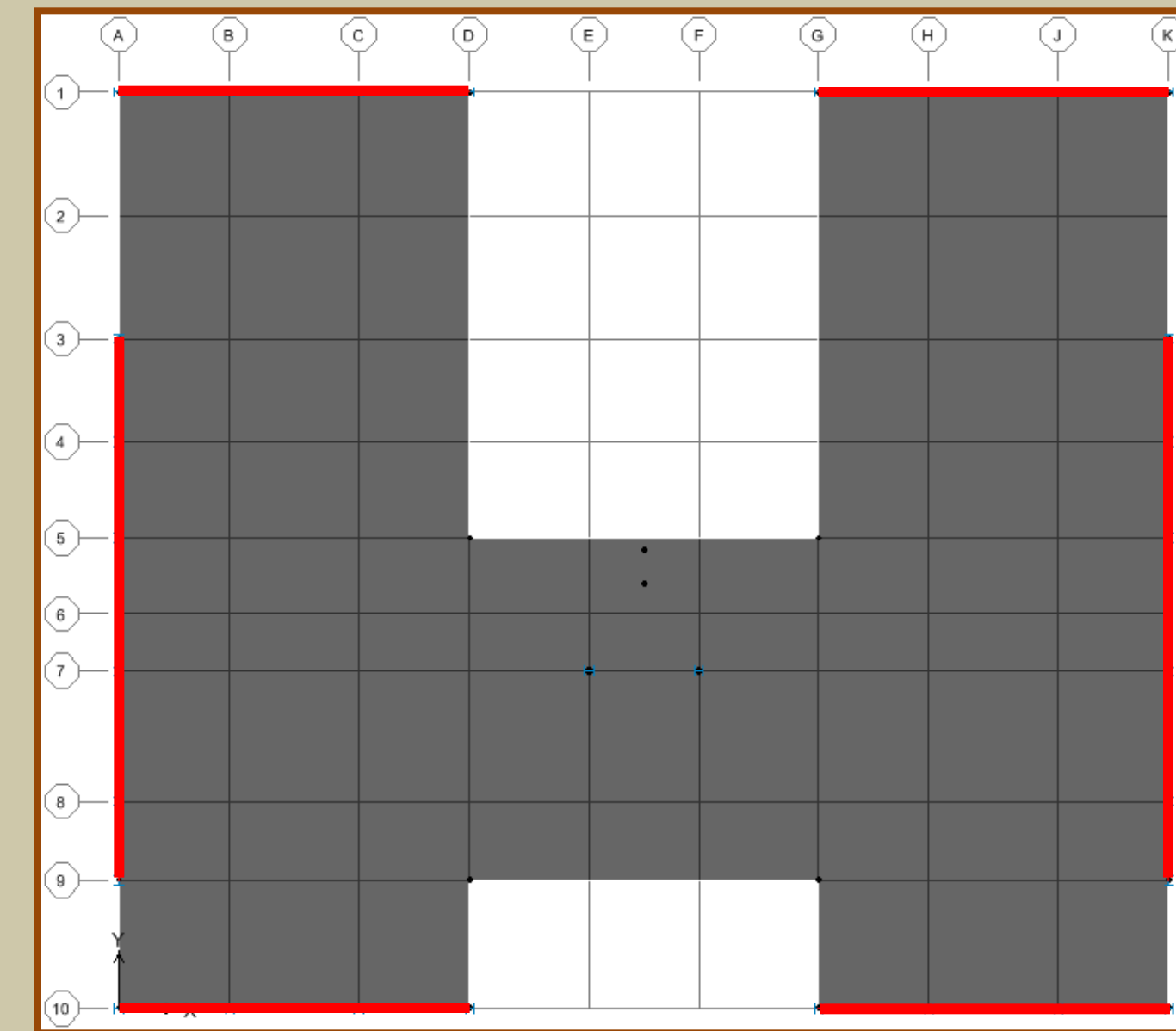
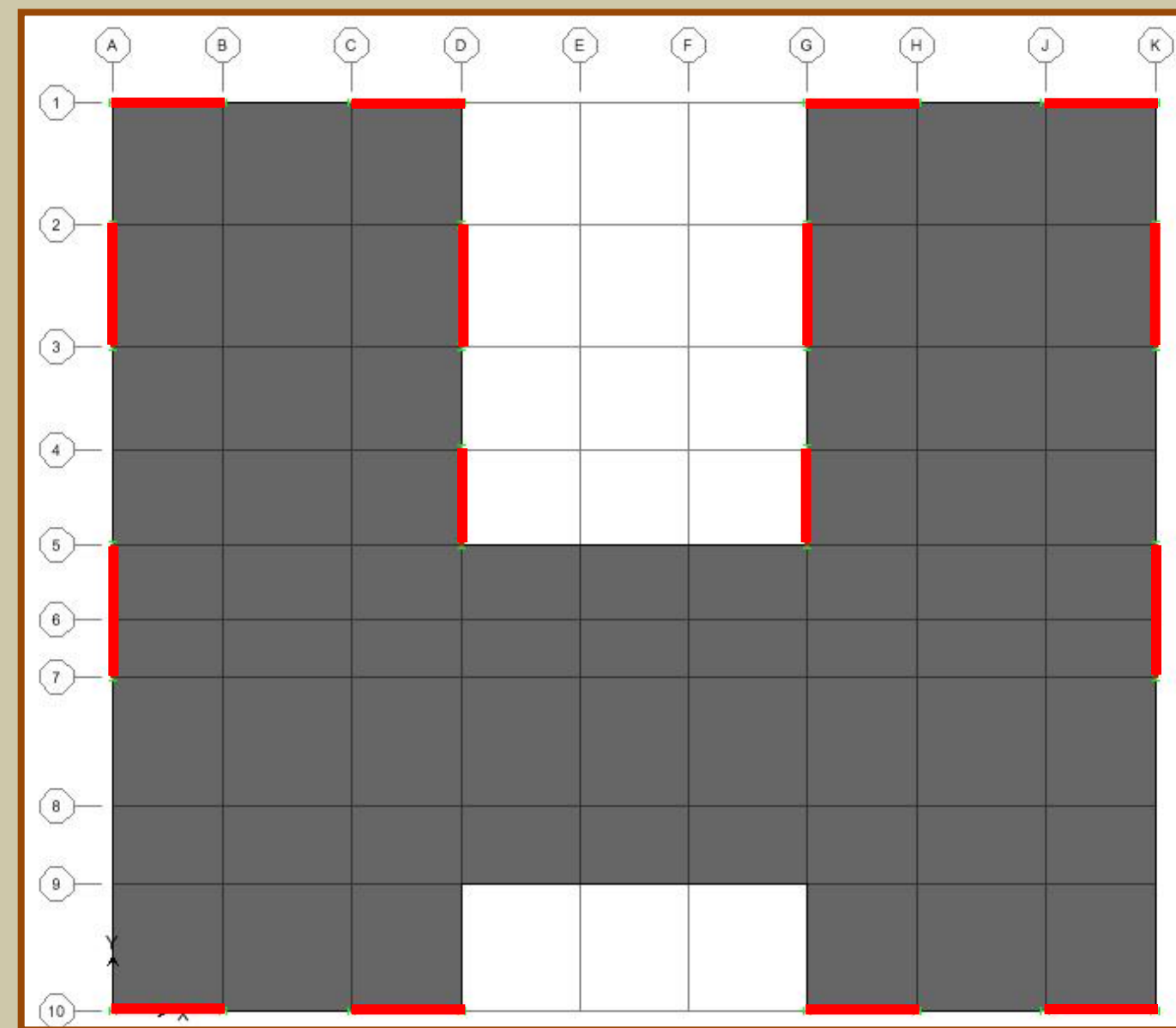
- › 10-year vs. 700-year MRI Wind Speeds
- › Force Multiplier:
 - $(76\text{mph}/115\text{mph})^2=0.44$
- › $D + 0.5L + 0.44W$

Office Building

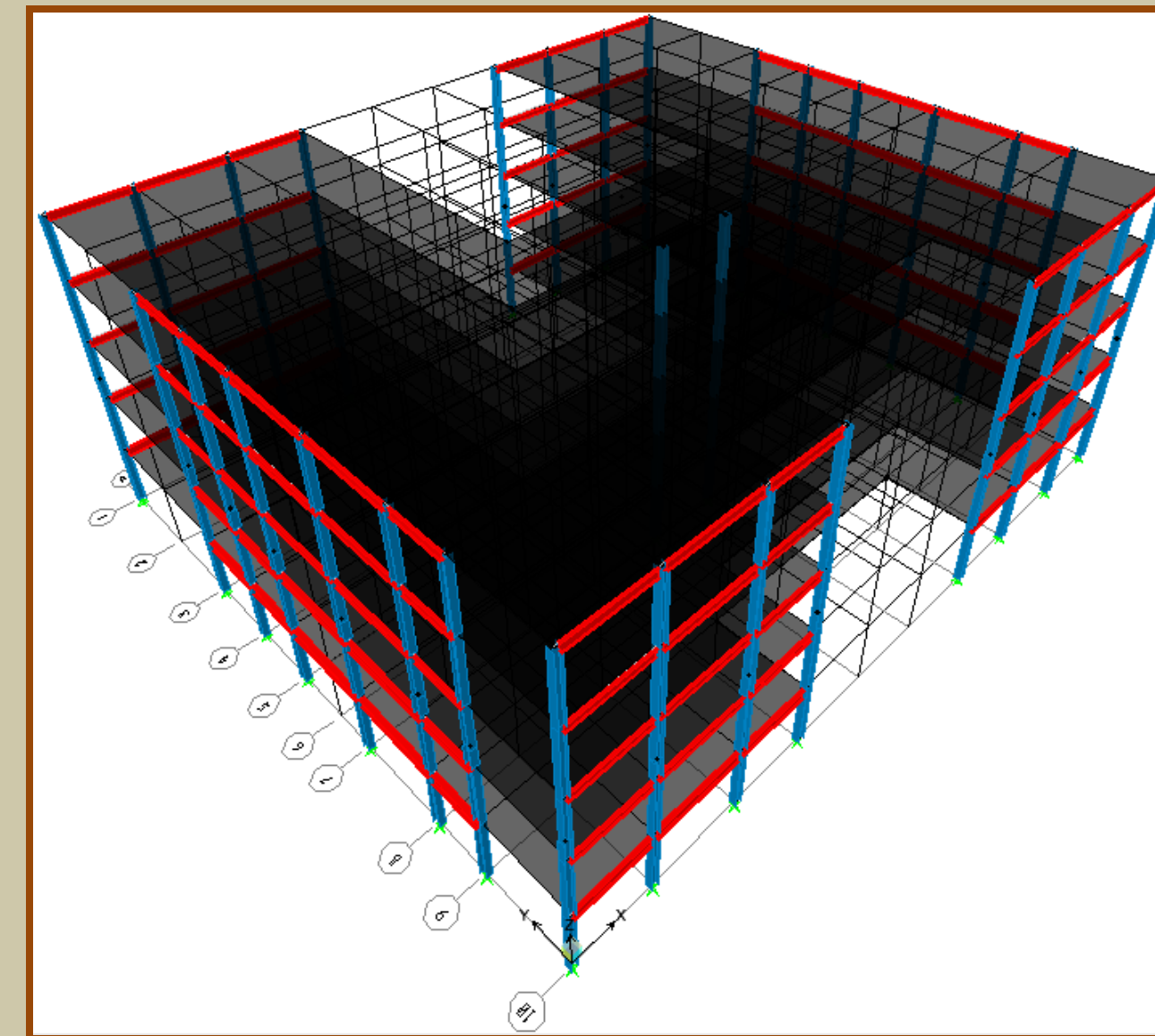
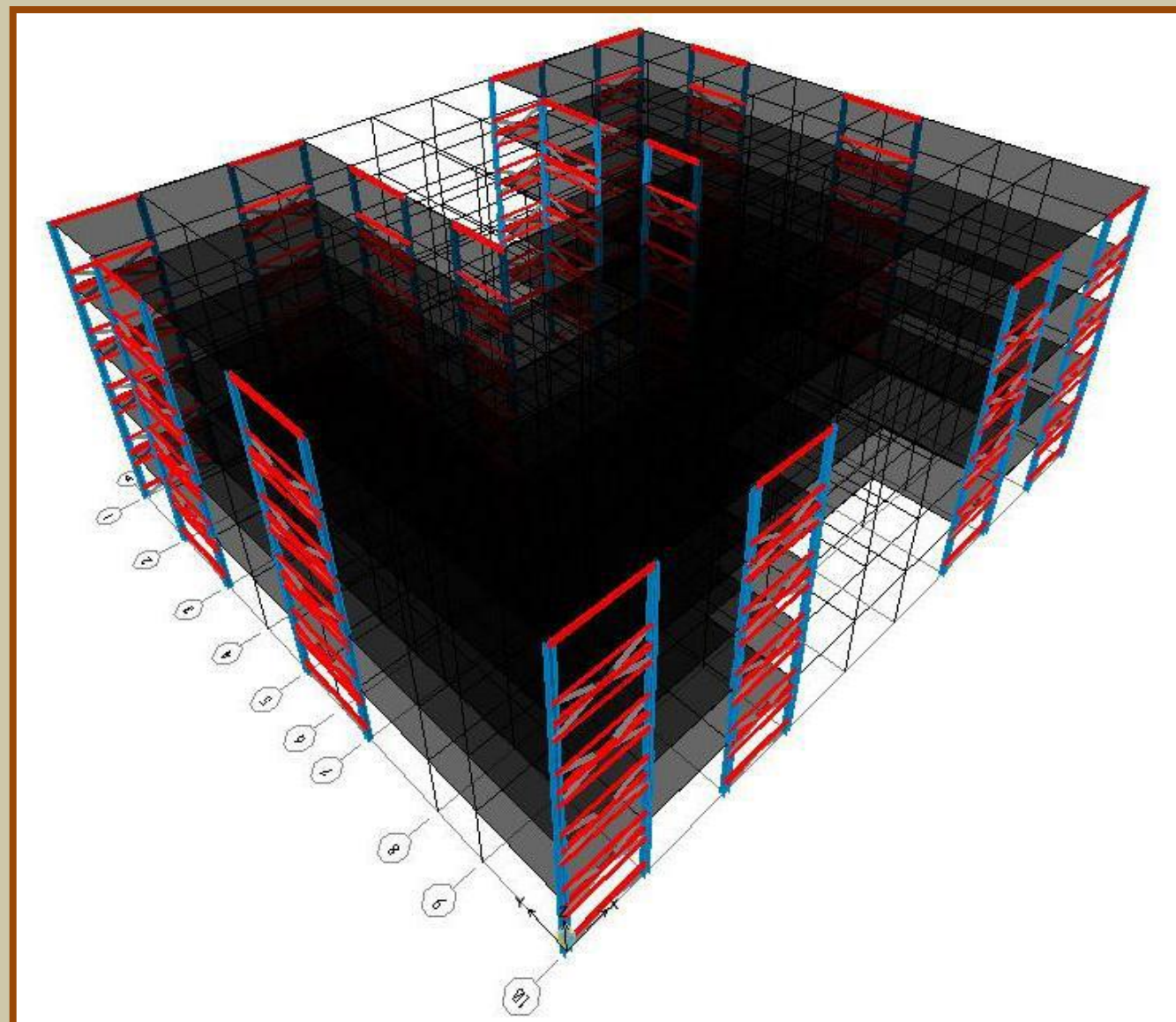
Existing Braced Frame Layout

Proposed Moment Frame Layout

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- › Building Introduction
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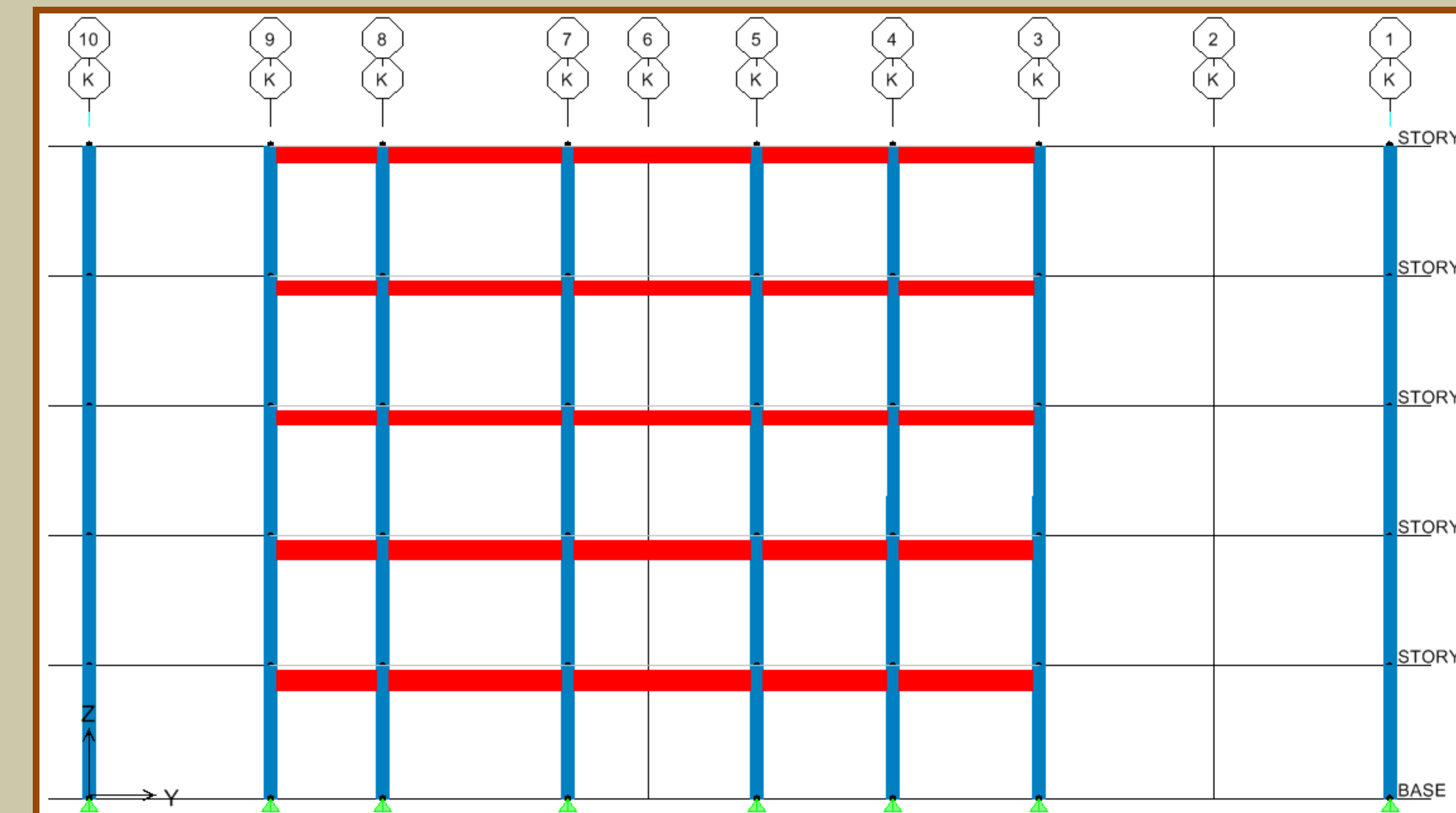
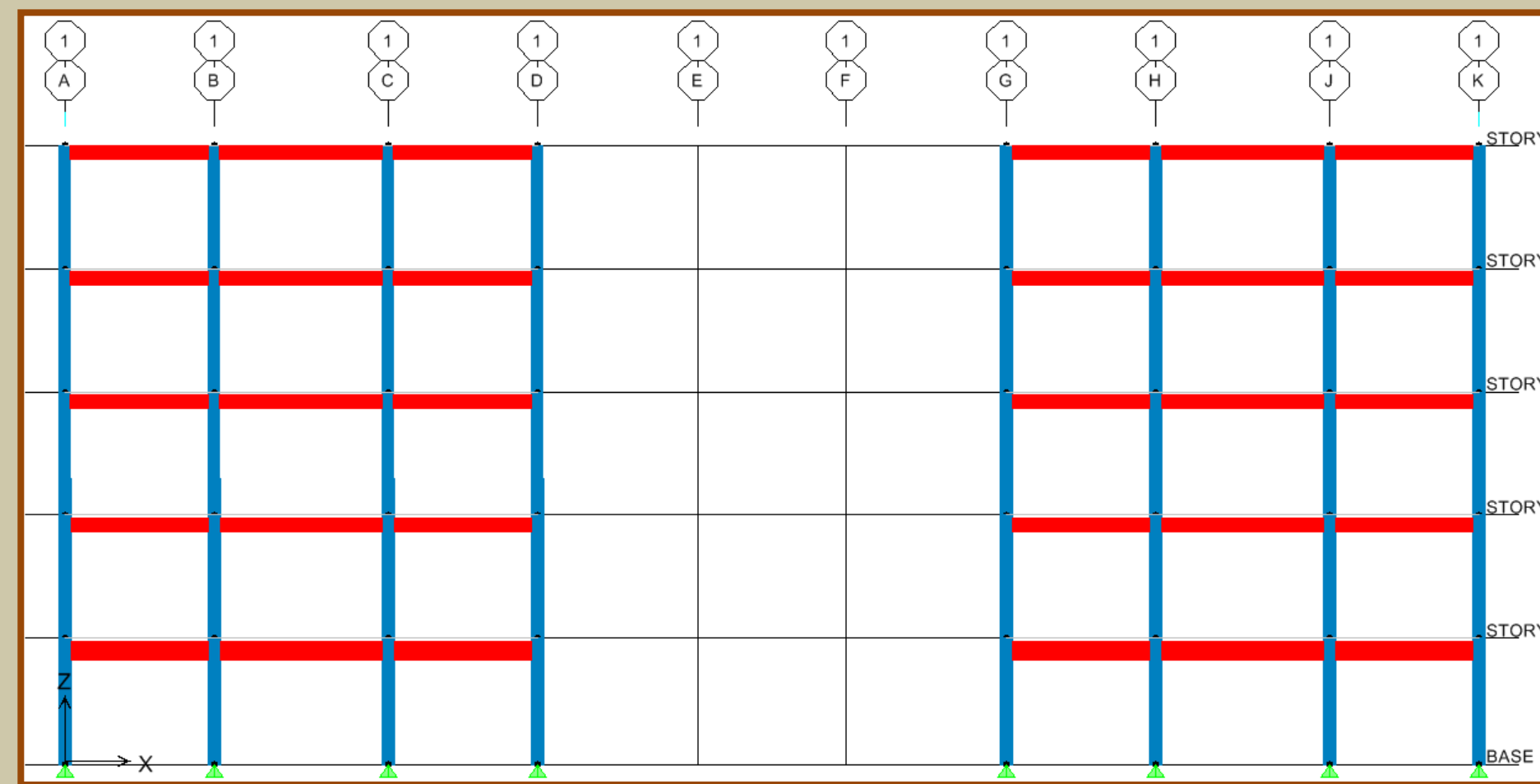


Office Building

E-W Frames at Grids 1 and 10

N-S Frames at Grids A and K

- › Building Introduction
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- › Building Introduction
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- › Building Periods Shortened:

Office Building Modes		
Mode	Period (s)	Direction
1	0.4125	N-S (Y)
2	0.3998	E-W (X)
3	0.3238	Rotation (Z)

- › **22% Increase in Seismic Base Shear**
- › Wind Still Controls Lateral

- › Direct Analysis Method in ETABS
- › Iterative Based on P- Δ Combo:
- **1.2D + 0.5L + 0.5S**
- › **20% Stiffness Reduction**
- › $\Delta_{2nd}/\Delta_{1st} < 1.7$

Office Building

Moment Connection Design

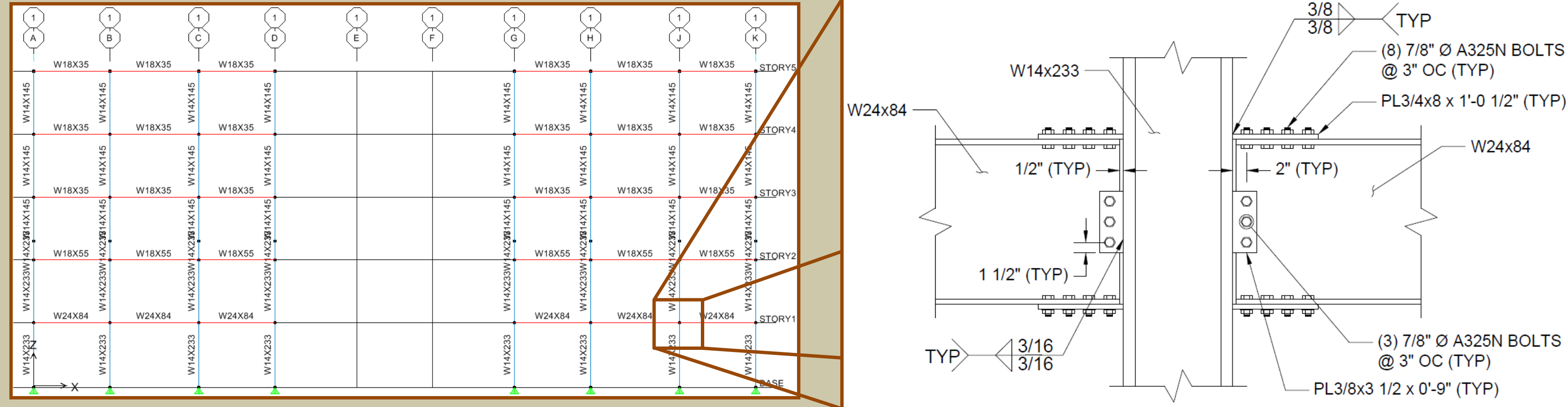
Column Stiffening Checks

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- › Breadth Studies
- › Conclusion

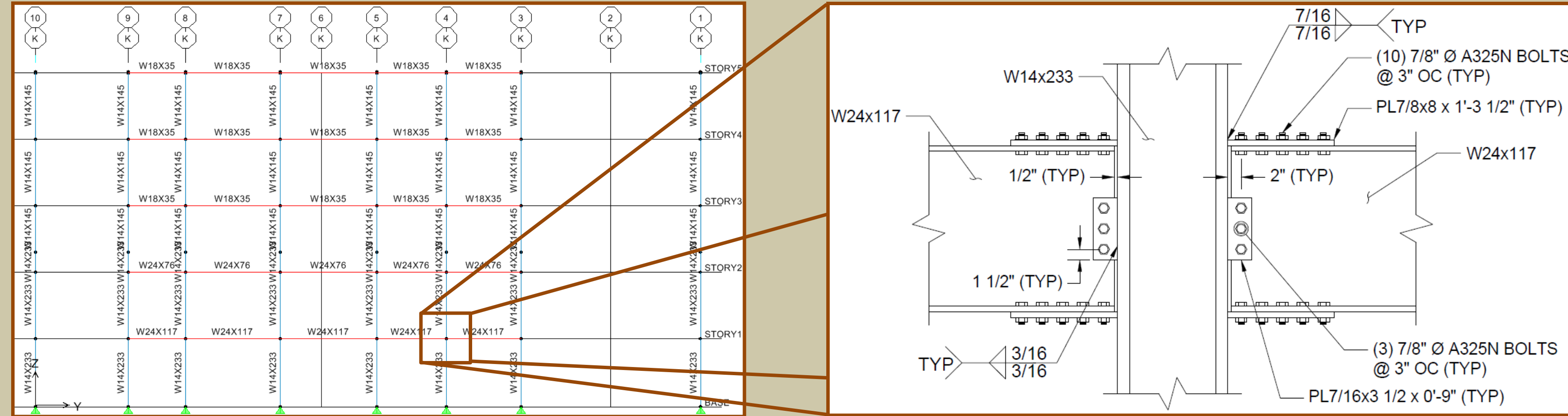
- › FR Bolted Flange-Plated Connections
- › Bolted Single-Plate Shear Tabs
- › Several Critical/Representative Joints Selected for Design and Detailing

- › Local Flange Bending
- › Local Web Yielding
- › Local Web Crippling
- › Panel Zone Shear Yielding

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- › Building Introduction
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- › Conclusion



Office Building

Building Enclosure Redesign

View of Southern Facade

- › Building Introduction
- › Structural Overview
- › Proposal
- › Structural Depth
- › Breadth Studies
- › Conclusion

- › Replace IMPs with All-Glazed Curtain Wall System
- › Analyze Barrier Performance
- › Assess Impact on Mechanical Loads and Equipment



- › Building Introduction
- › Structural Overview
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- › **Breadth Studies**
- › Conclusion

- › Compared Kawneer Trifab VG 451T, Kawneer 1600 Wall System 1 and Others
- › Selected Kawneer 1600 Wall System 1 with 1" Vision and Spandrel IGUs:

Product Description
1/4" Oldcastle BuildingEnvelope™ SunGlass® Low-E #2
1/2" Black Anno Spacer, Argon Filled
1/4" Clear Float
1/4" Oldcastle BuildingEnvelope™ SunGlass® Low-E #2
1/2" Black Anno Spacer, Argon Filled
1/4" Clear Float with Ceramic Frit #4



Office Building

System Layout/Configuration

Glazing Layout

- › Building Introduction
- › Structural Overview
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- › Structural Depth
- › **Breadth Studies**
- › Conclusion

- › Kawneer 1600 Spans 13'-4" b/w Floor Elevations in Original Layout
- › C&C Corner Zone Max Pressure: -42.7psf
- › 2'-8" OC Max Vertical Aluminum Mullion Spacing

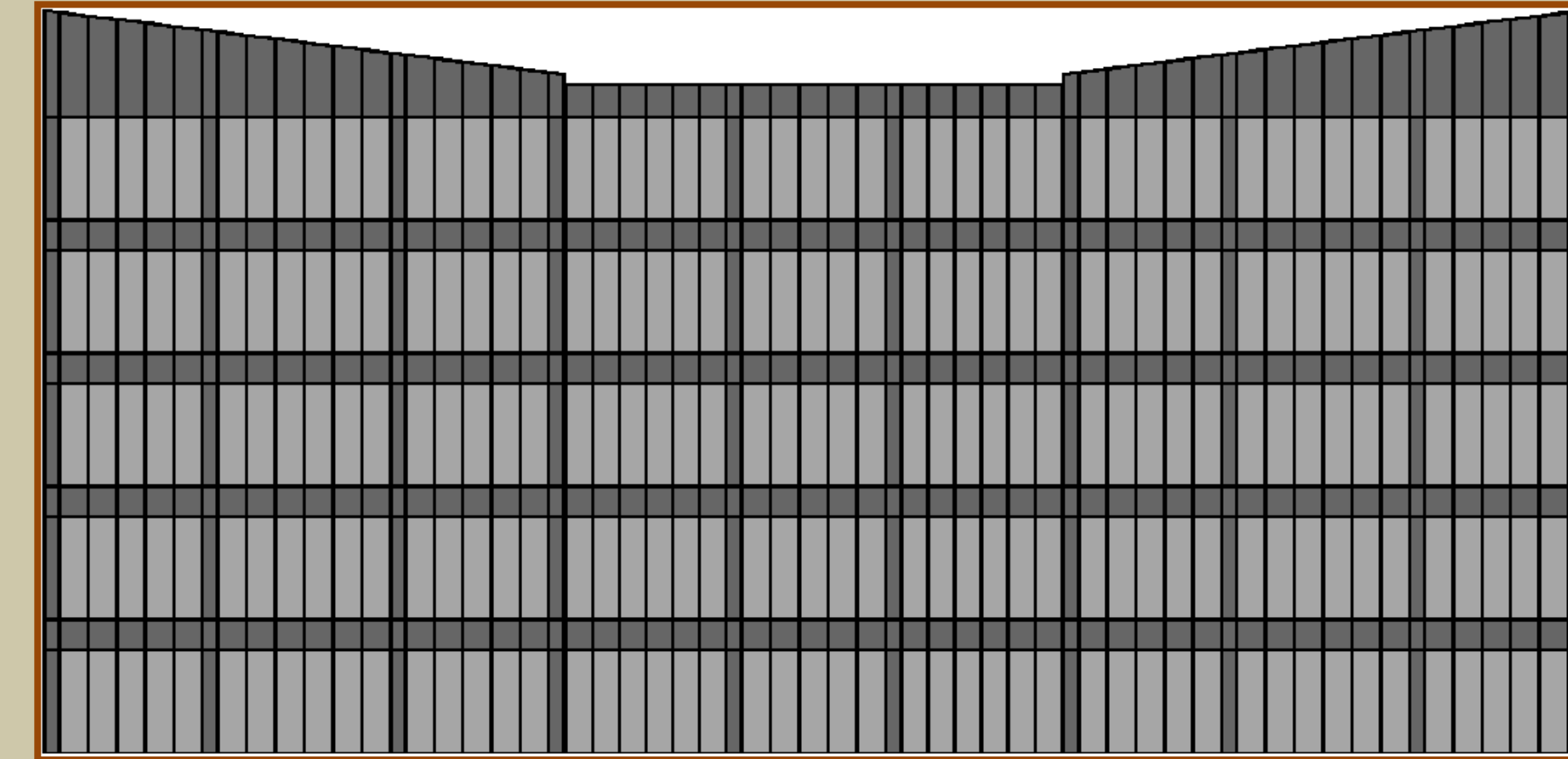
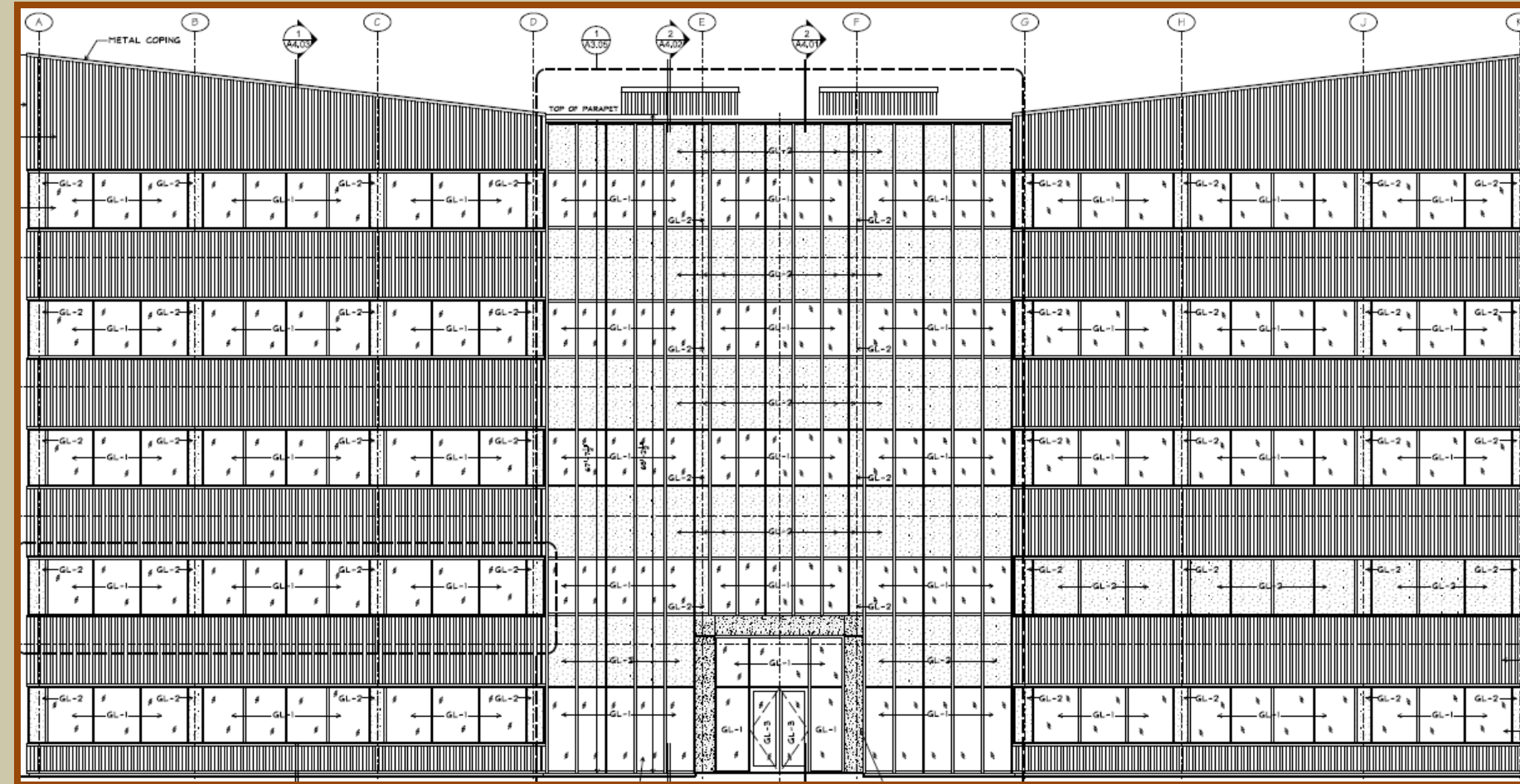
- › 18" Wide Vertical Spandrel Strips at Grids Conceal Columns Beyond
- › 3'-0" Tall Horizontal Spandrel Strips Hide Floor System and Large MF Beams
- › Rows of SunGlass Tinted Vision Glass Extend Vertically 10'-4" from Floors

Office Building

Existing Front Facade

Proposed Enclosure Layout

- › Building Introduction
- › Structural Overview
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- › Structural Depth
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- › Conclusion



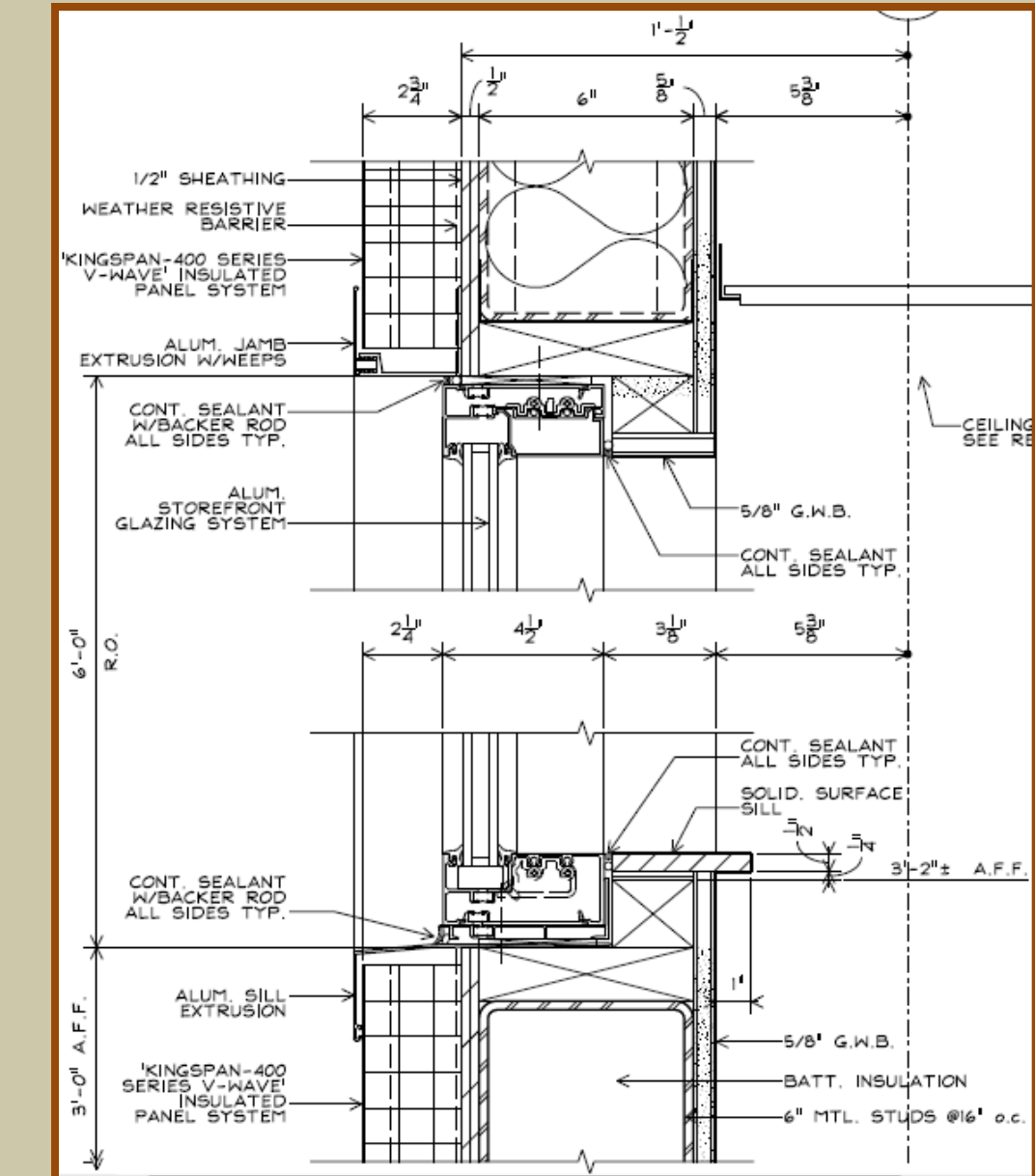
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- › Conclusion

› Kingspan 400 V-Wave IMPs Wall Section

- R_T : 26.3 hr-ft²-°F/Btu

› Kawneer 451T - Vision Glass Wall Section

- R_T : 3.85 hr-ft²-°F/Btu



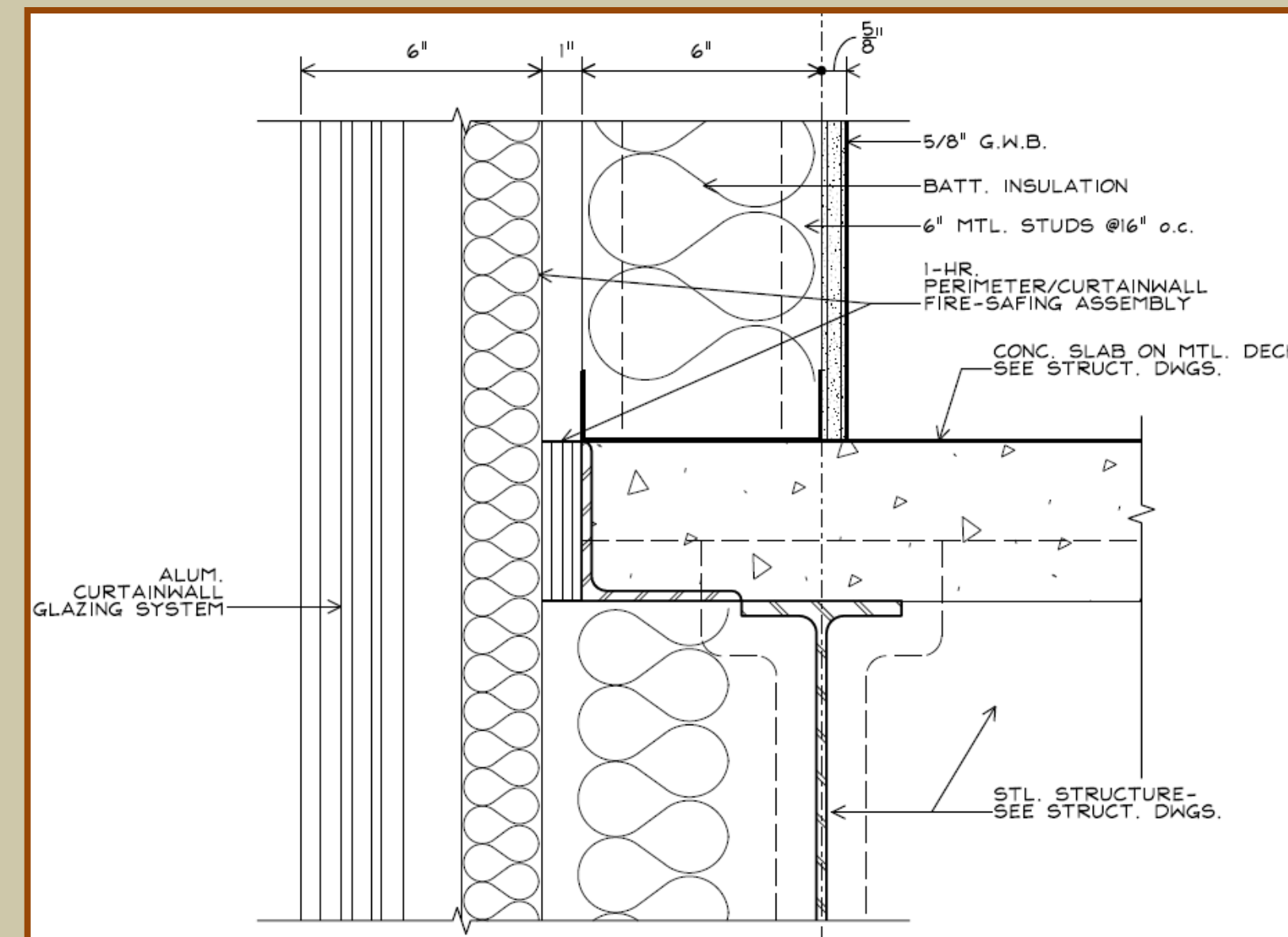
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› Kawneer 1600 – Spandrel Glass Wall Section

- R_T : 17.9 hr-ft²-°F/Btu

› Kawneer 1600 – Vision Glass Wall Section

- R_T : 3.35 hr-ft²-°F/Btu



Office Building

Enclosure Areas

Mechanical Systems Impact

- › Building Introduction
- › Structural Overview
- › Proposal
- › Structural Depth
- › **Breadth Studies**
- › Conclusion

- › Existing:
 - IMPs: 23,649 SF
 - 451T: 19,175 SF
 - 1600 Spandrel: 3,457 SF
 - 1600 Vision: 3,355 SF
- › Proposed:
 - 1600 Vision: 38,276 SF
 - 1600 Spandrel: 11,359 SF

- › 70% Increase in Conductive Enclosure and Solar Loads
- › 10 20-Ton Condensing Units with 174 Tons of Demand
- › Existing Enclosure Portion of Total Load is 55%
- › Redesign Causes 40% Increase in Total Demand

Office Building

Structural Depth Study

Enclosure Breadth Studies

- › Building Introduction
- › Structural Overview
- › Proposal
- › Structural Depth
- › Breadth Studies
- › **Conclusion**

- › Additional Steel Frame Weight: 168,000 lbs
- › \$61,000 Added to Cost of Lateral System
- › Potential Cost Saving Opportunities:
 - Fix Column Bases
 - Relax Drift Limit
 - PR vs. FR Moment Connections

- › 40% Increase in Total Demand Requires an Additional 80 Tons of Capacity
- › Minimum Additional Mechanical Equipment Cost of \$240,000
- › Significant Impact of Redesign on Building's Mechanical Systems