

Simmons College School of Management Boston, MA



Kevin Wigton
AE Senior Thesis 2010

Simmons College School of Management
Expansion Design Scenario Study

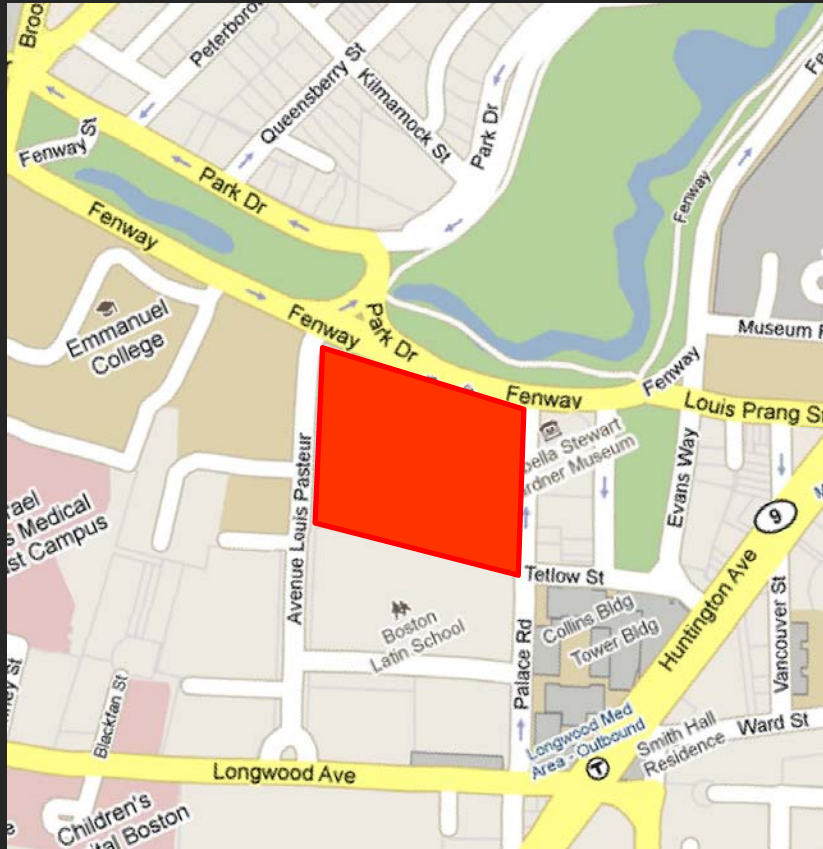
Presentation Outline

- Building Information
- Existing Structural System
- Problem Statement
- Structural Depth Study
- Façade Study
- Construction Staging Study
- Conclusions and Recommendations



Building Information

Building Location



Building Information

Building Statistics

- Educational Facility
- 5 Story Below Grade Garage
- 5 Story Above Grade building
- 66,500 sf
- Completed: Fall 2008
- Cost: \$63 Million



Building Information

Project Team

- Owner: Simmons College
- Construction Manager
 - Lee Kennedy
 - Payton Construction
- Cannon Design Team
 - Architectural Design
 - Structural Engineering
 - Mechanical Engineering
 - Plumbing Engineering



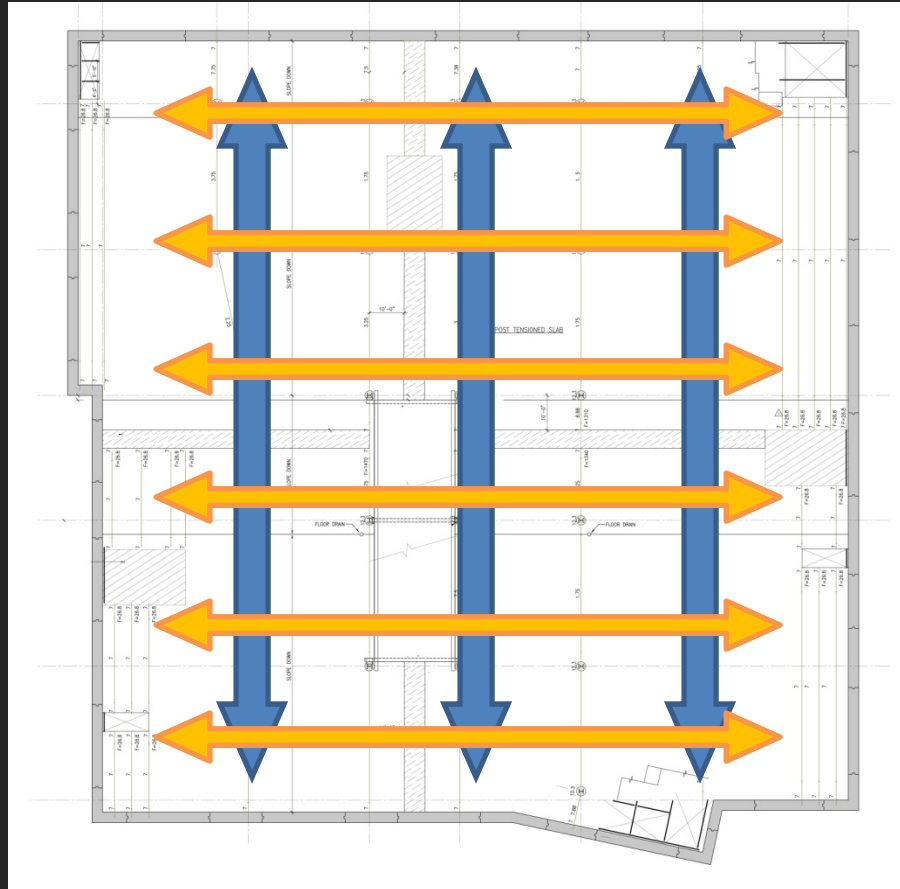
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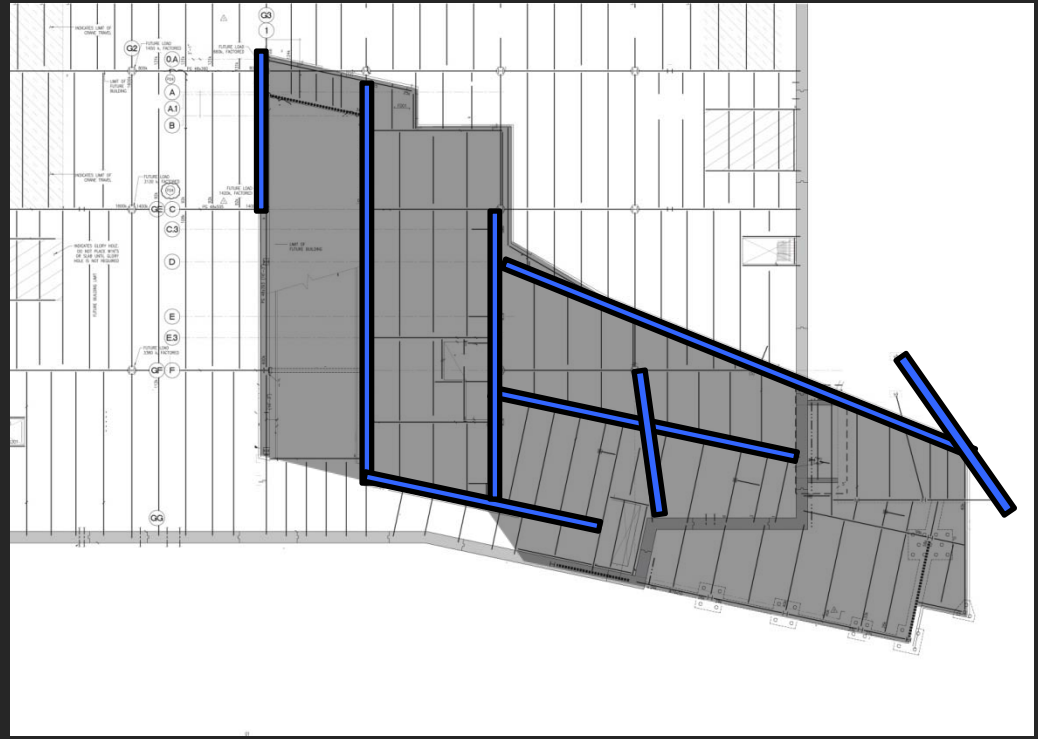
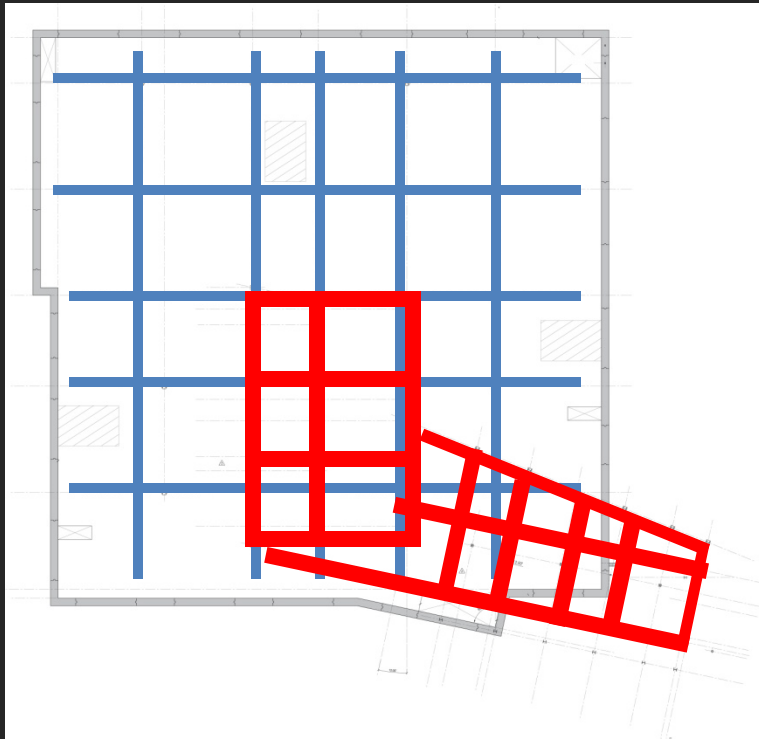
Existing Structural System

Parking Garage



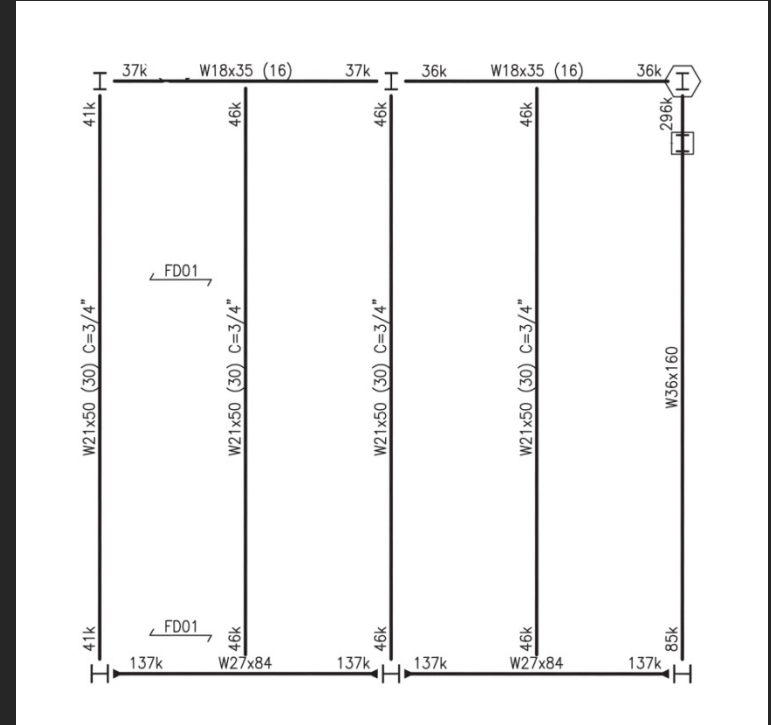
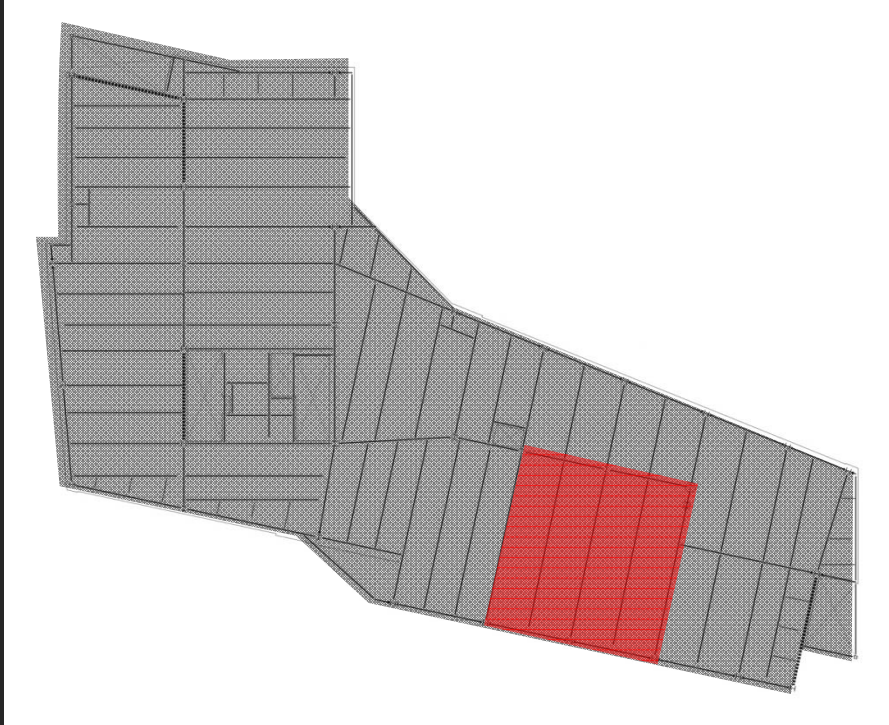
Existing Structural System

Plaza Level Transition



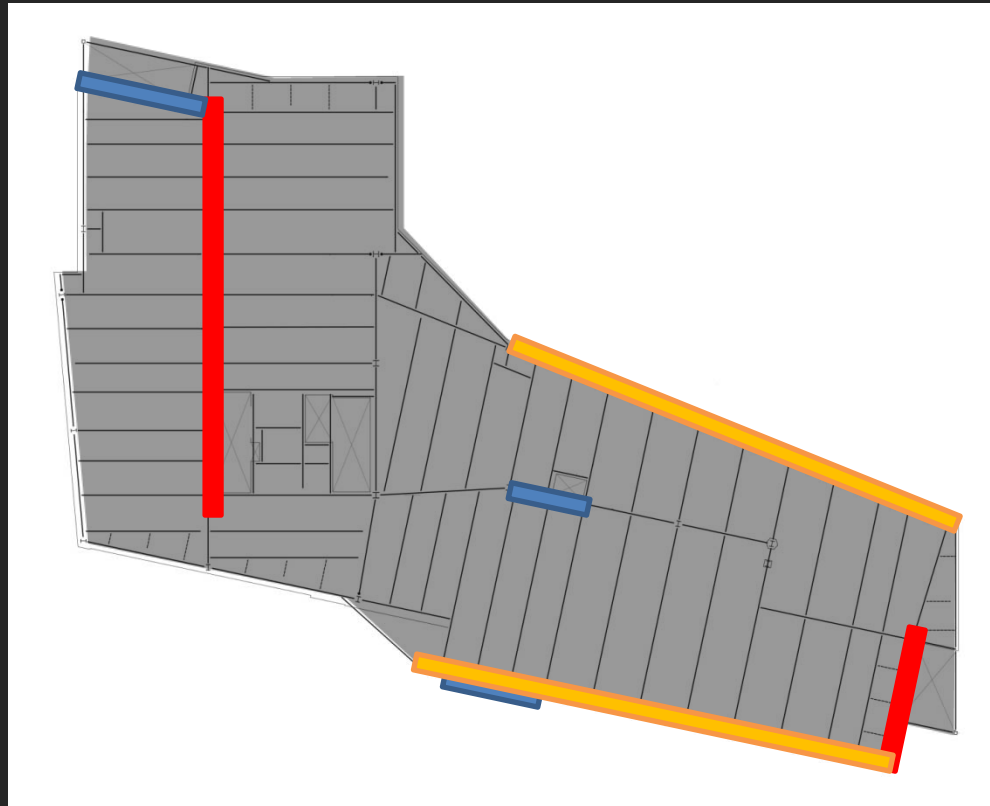
Existing Structural System

Above Grade Building: Gravity System



Existing Structural System

Above Grade Building: Lateral System



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Problem Statement

Building Expansion: Criteria and Provisions



Problem Statement

Building Expansion: Criteria and Provisions



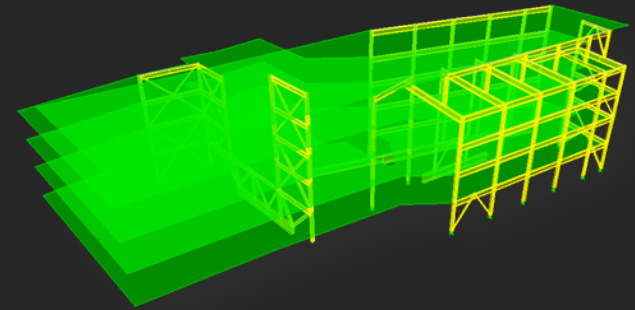
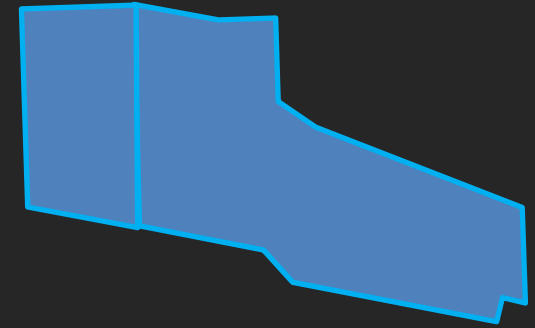
Problem Statement

Building Expansion: Additional Design Scenario



Project Goals

- Provide an Additional Design Option for the Building Expansion
- Implement Structurally Tied Expansion Layout
- Revise Lateral System to Resist Load Effects for Base and Expanded Building
- Ensure that the Base Building and Current Expanded Options are Not Compromised
- Provide a Constructable and Cost Effective Solution



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Structural Depth Study

Design Criteria

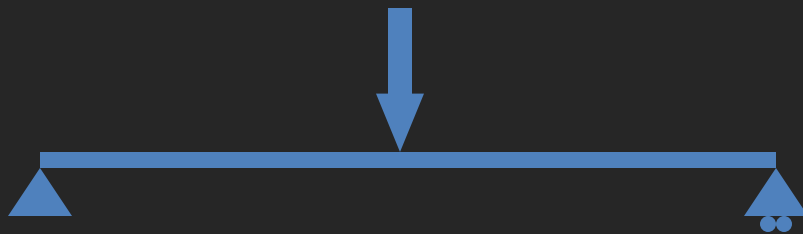
- Resist Additional Loading Demands with Existing Lateral System Arrangement
- Reduce Torsional Effects Induced by Increased Eccentricity
- Reduce Accidental Torsional Effects Required in Load Analysis
- Design Expanded System to Meet Drift Requirements
- Meet All Structural Requirements for the Base and Expanded Systems



Structural Depth Study

Base Condition Modeling: Options

- Pinned Conditions
- Explicit Modeling of Entire Parking Garage
- Modeling of Key Transfer Elements with Vertical Stiffness Modifiers



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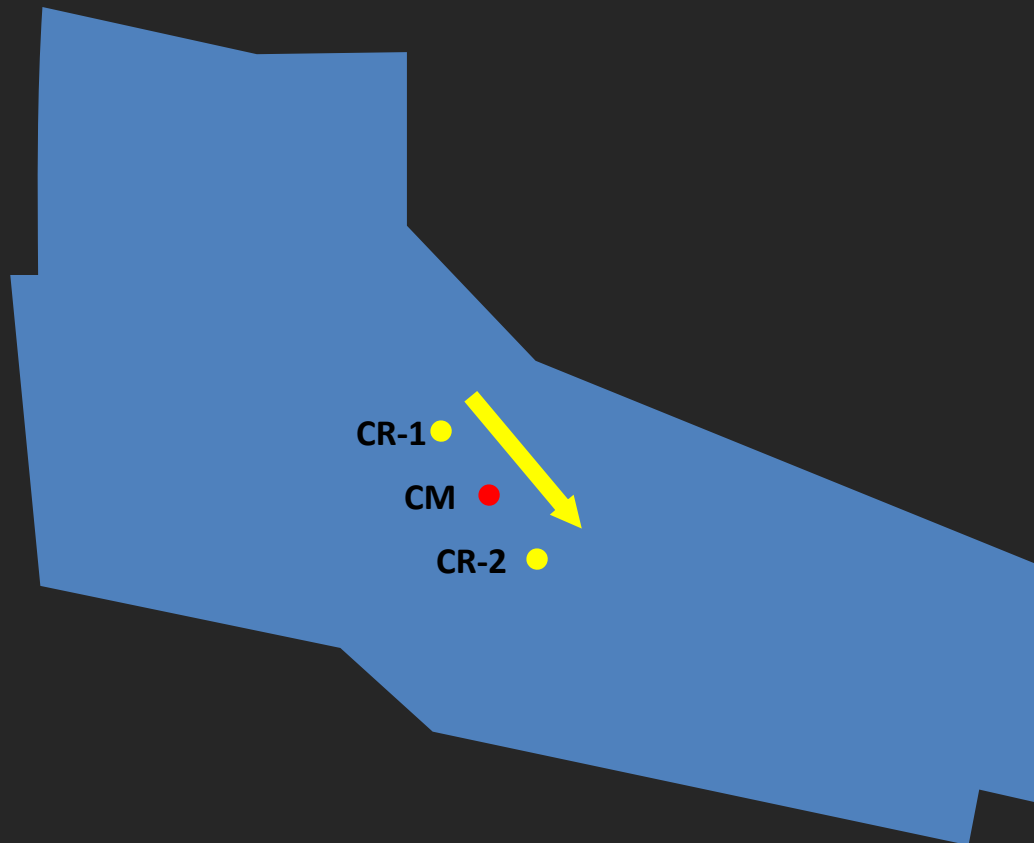
Structural Depth Study

Base Condition Modeling: Implementation



Structural Depth Study

Base Condition Modeling: Result

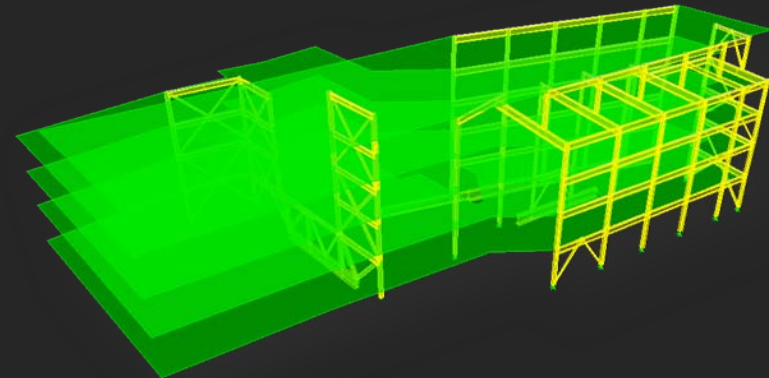
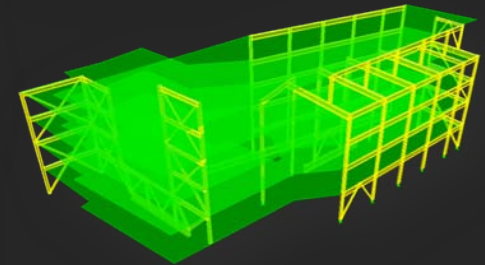
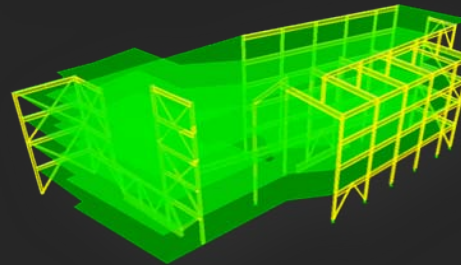


Structural Depth Study

Lateral System Study

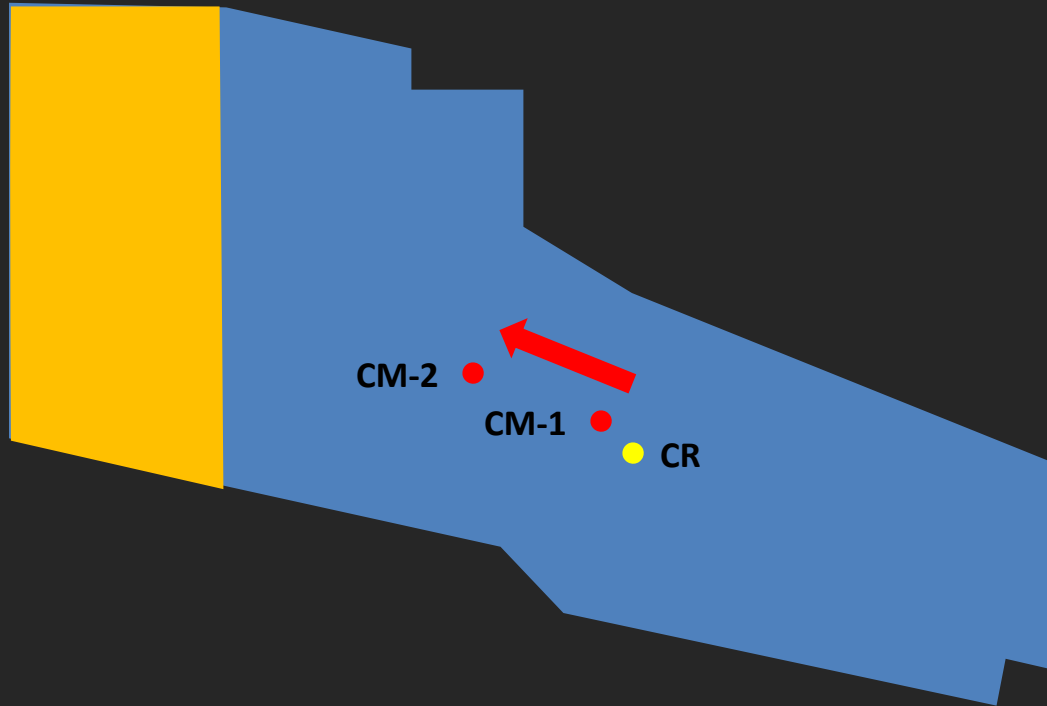
Three Conditions To Consider

- Existing Structure
- Expanded System
 - Iterative Design Approach
- Revised Lateral System in Base Building Configuration



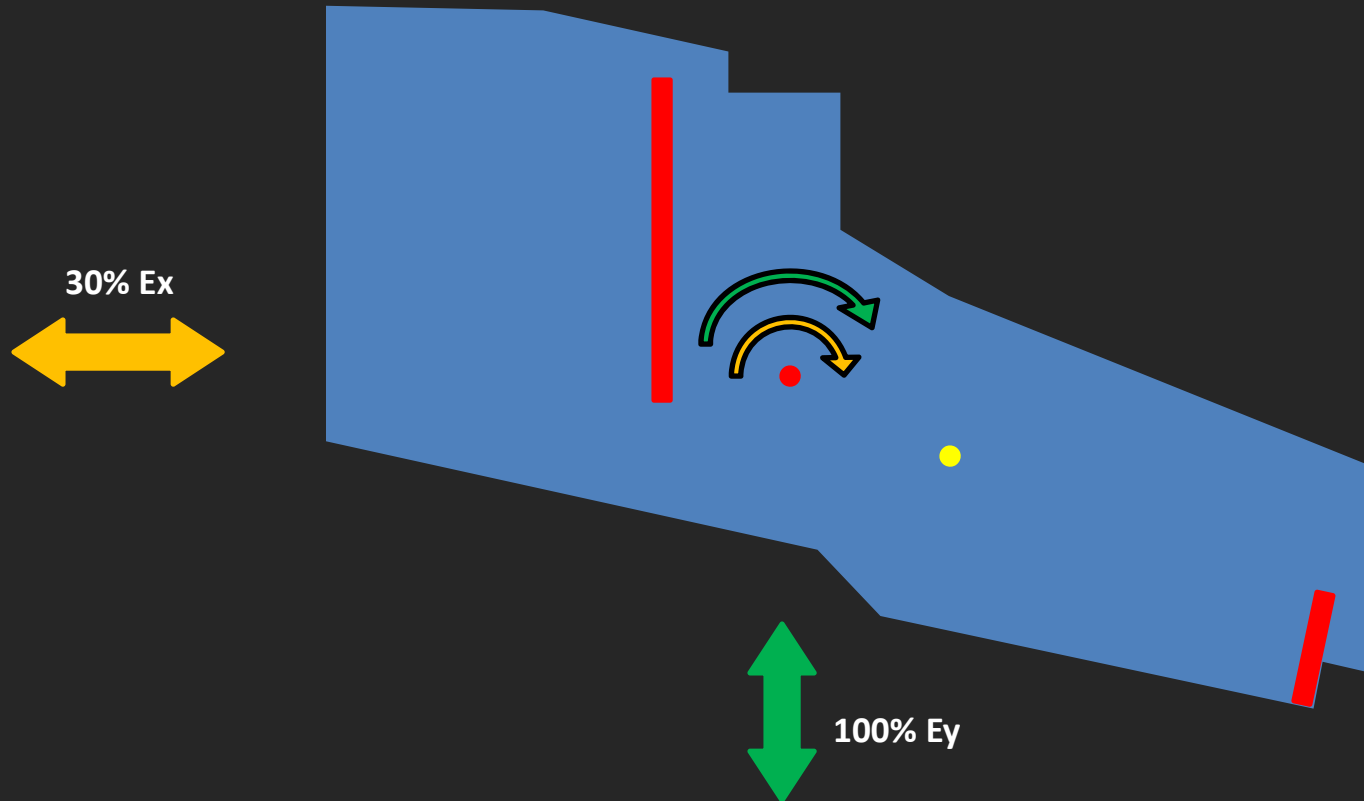
Structural Depth Study

Expanded Building System Properties



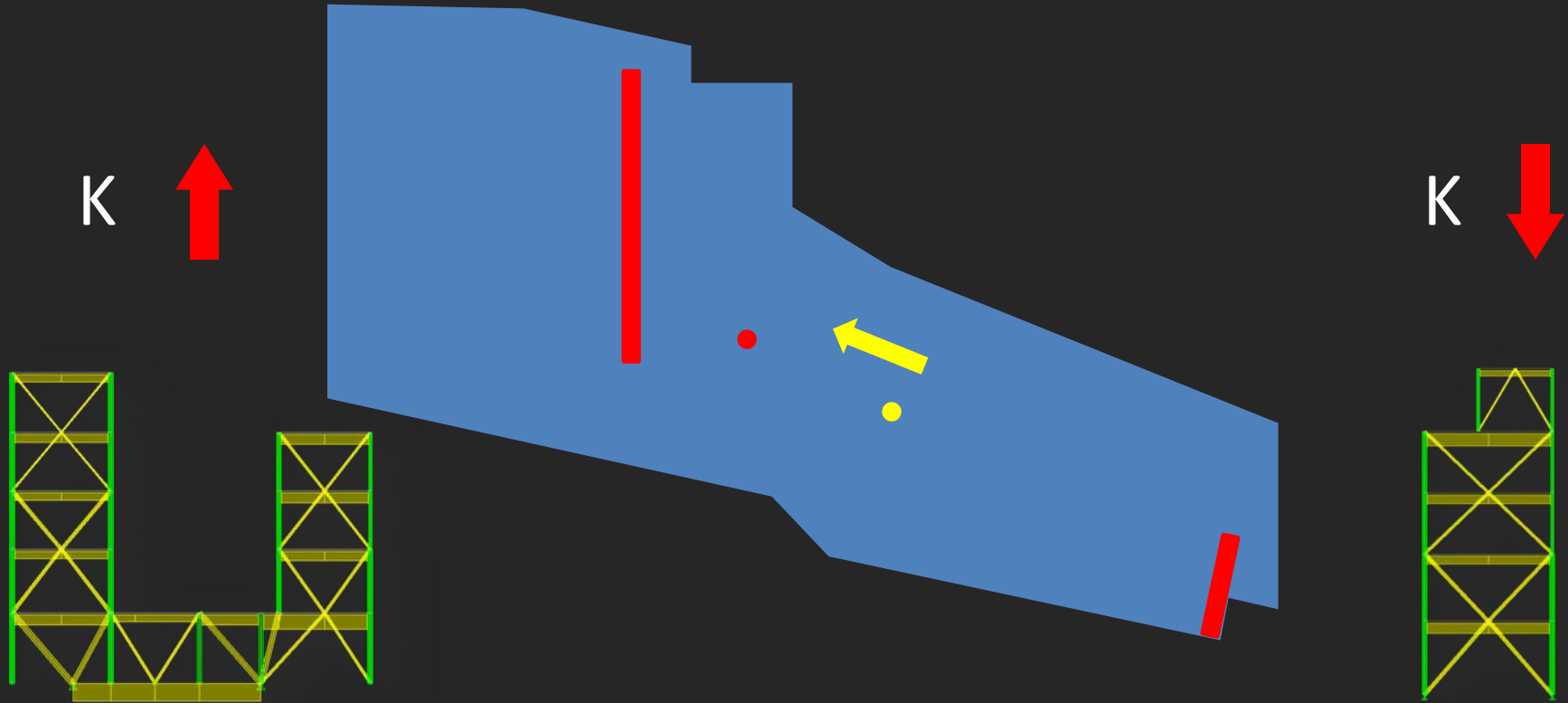
Structural Depth Study

Critical Loading on the Expanded Building



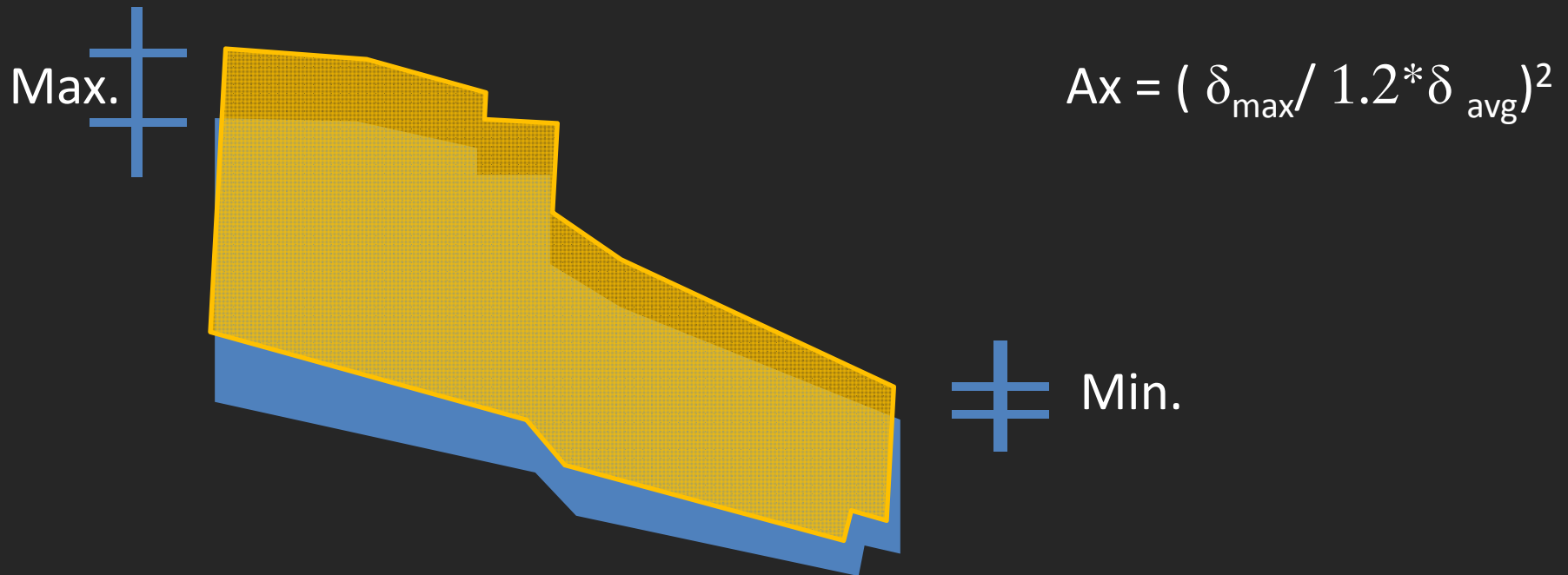
Structural Depth Study

Solution Method



Structural Depth Study

Altered Load Effects Based on Revised Layout



Structural Depth Study

Center of Mass vs.
Center of Rigidity
Summary (ft)

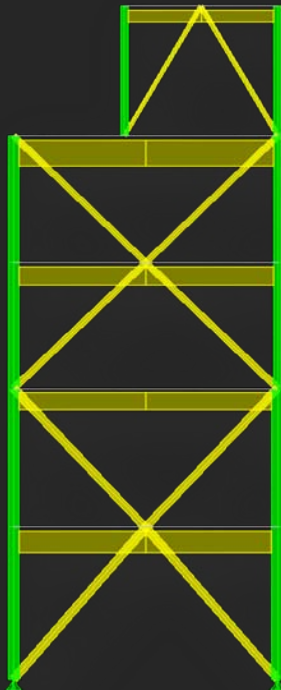
Story	Expanded System	New Expansion Design	Percent Reduction
5	30.4	24.8	18.2
4	49.7	38.7	22.2
3	45.2	34.0	24.9
2	40.8	24.8	39.2
1	20.8	7.4	64.3
		Average	33.8

Amplified Torsional
Moment Factor

Story	Expanded System	New Expansion Design	Percent Reduction
5	2.46	2.34	4.9
4	2.49	2.34	6.0
3	2.47	2.32	6.1
2	2.46	2.27	7.7
1	2.39	2.14	10.5
		Average	7.0

Structural Depth Study

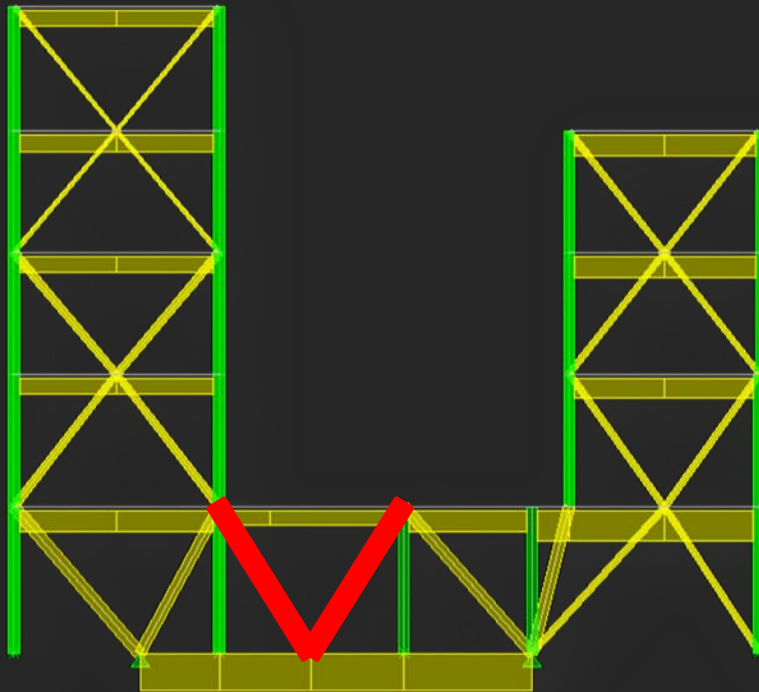
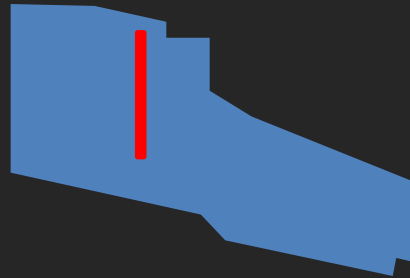
Solution Summary



HSS6x6x3/8	to	HSS6x6x1/4
HSS8x8x3/8	to	HSS6x6x1/4
HSS8x8x3/8		Unchanged
HSS10x10x3/8	to	HSS8x8x1/2
HSS10x10x3/8	to	HSS8x8x1/2

Structural Depth Study

Solution Summary

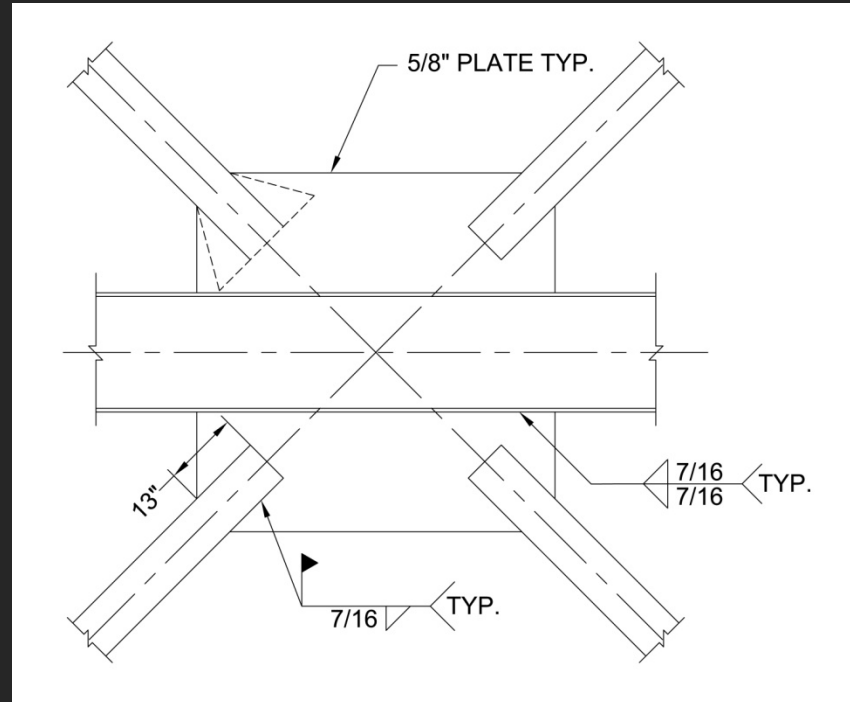
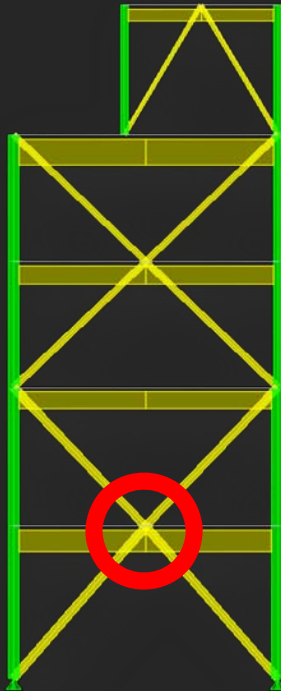


Original Design
HSS8x8x5/8

New Design
HSS10x10x5/8

Structural Depth Study

Connection Requirements



Structural Depth Study

Seismic Drift Summary: X-Direction

Story	Base Building	Expansion Design	Revised Base	Limit
5	0.45	0.59	0.54	1.5
4	0.50	0.82	0.58	1.5
3	0.51	0.78	0.60	1.5
2	0.48	0.71	0.55	1.5
1	0.28	0.41	0.30	1.5

Structural Depth Study

Seismic Drift Summary: Y-Direction

Story	Base Building	Expansion Design	Revised Base	Limit
5	0.54	1.23	0.69	1.5
4	0.53	1.19	0.68	1.5
3	0.50	1.14	0.65	1.5
2	0.43	0.97	0.54	1.5
1	0.19	0.31	0.23	1.5

Structural Depth Study

Final Note: Diaphragm Forces



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Façade Study

Drift Limitation Check

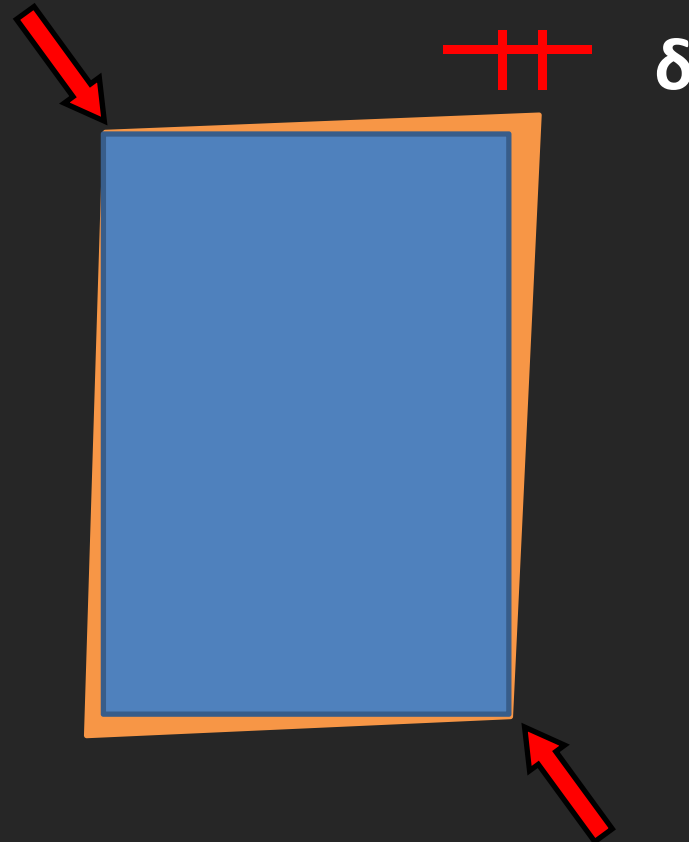
New Max Drift = 1.23%

2' x 11' Window

Clearance = 1/4"

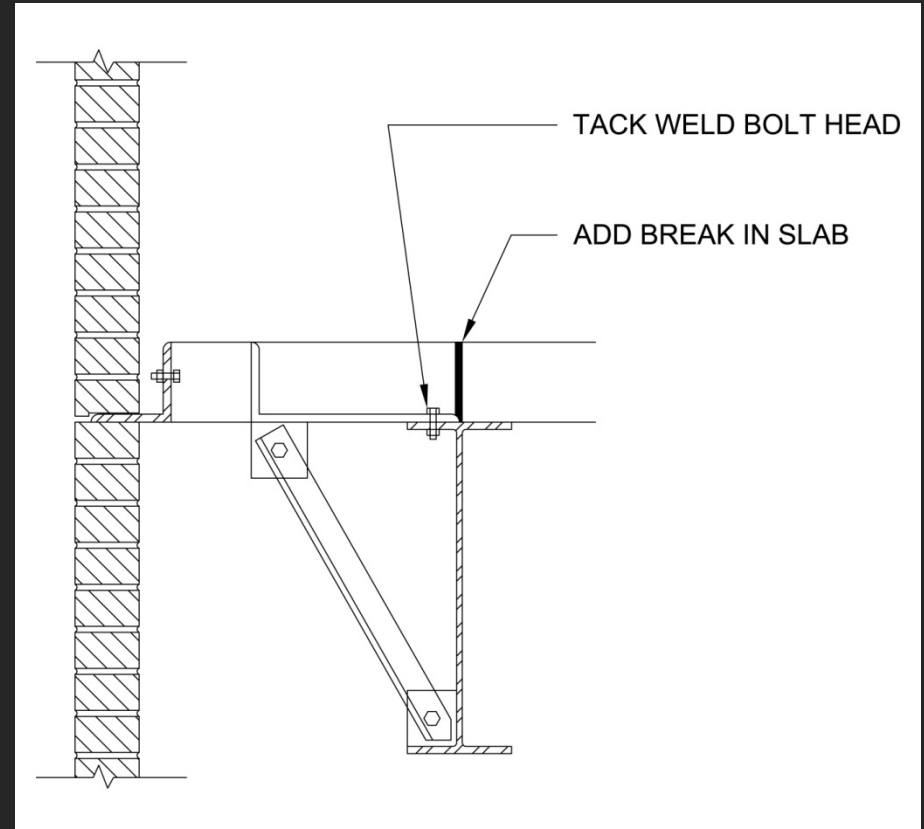
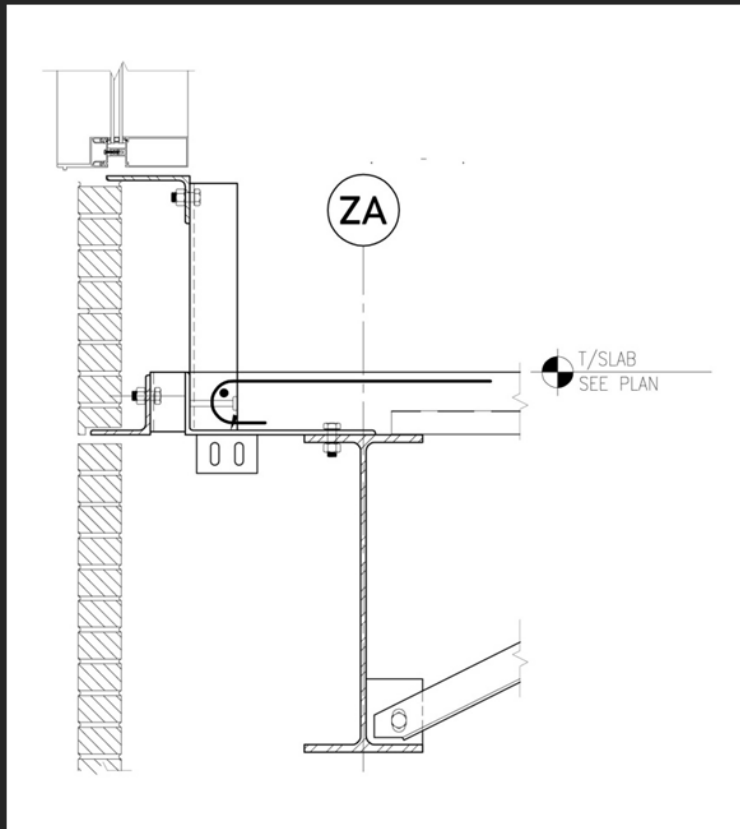
4' x 13' Window

Clearance = 3/8"



Façade Study

Façade Connection West Wall



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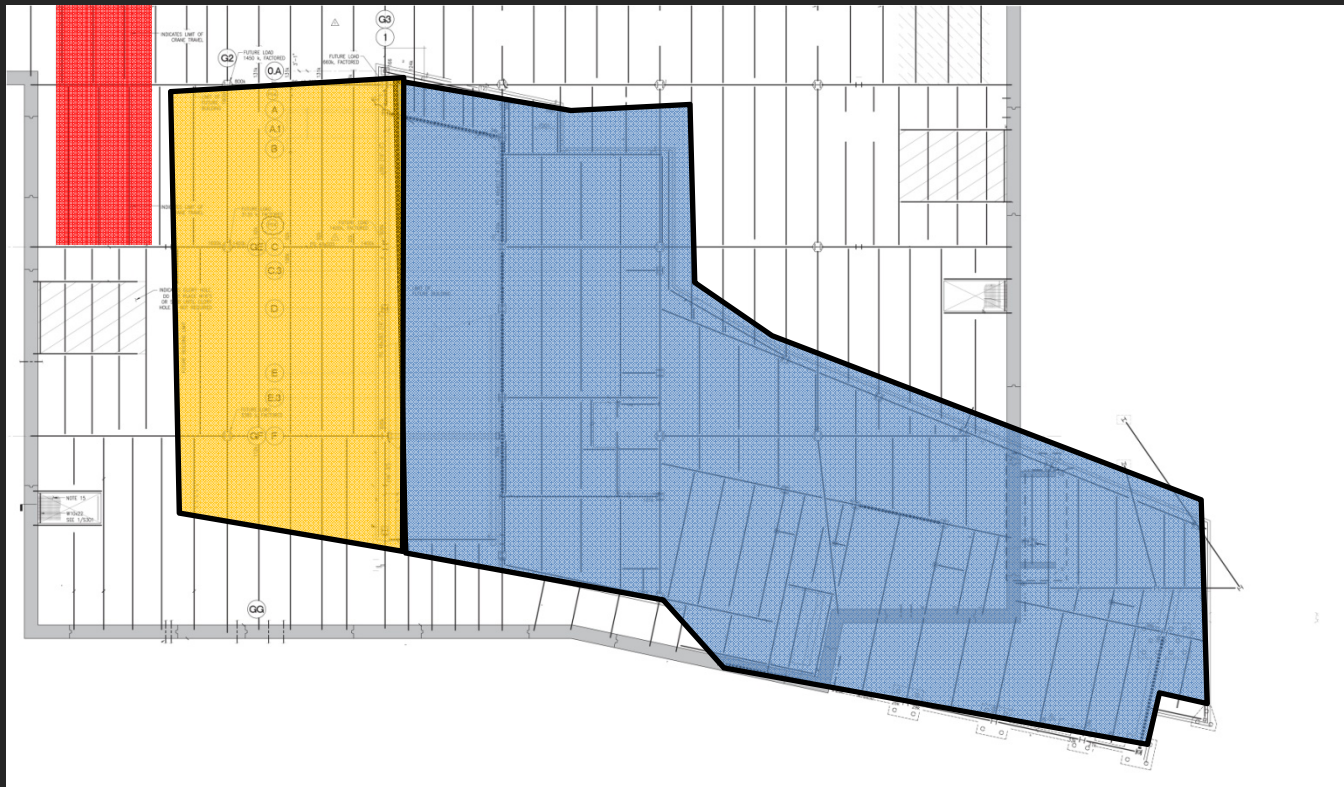
Construction Study

Site Constraints



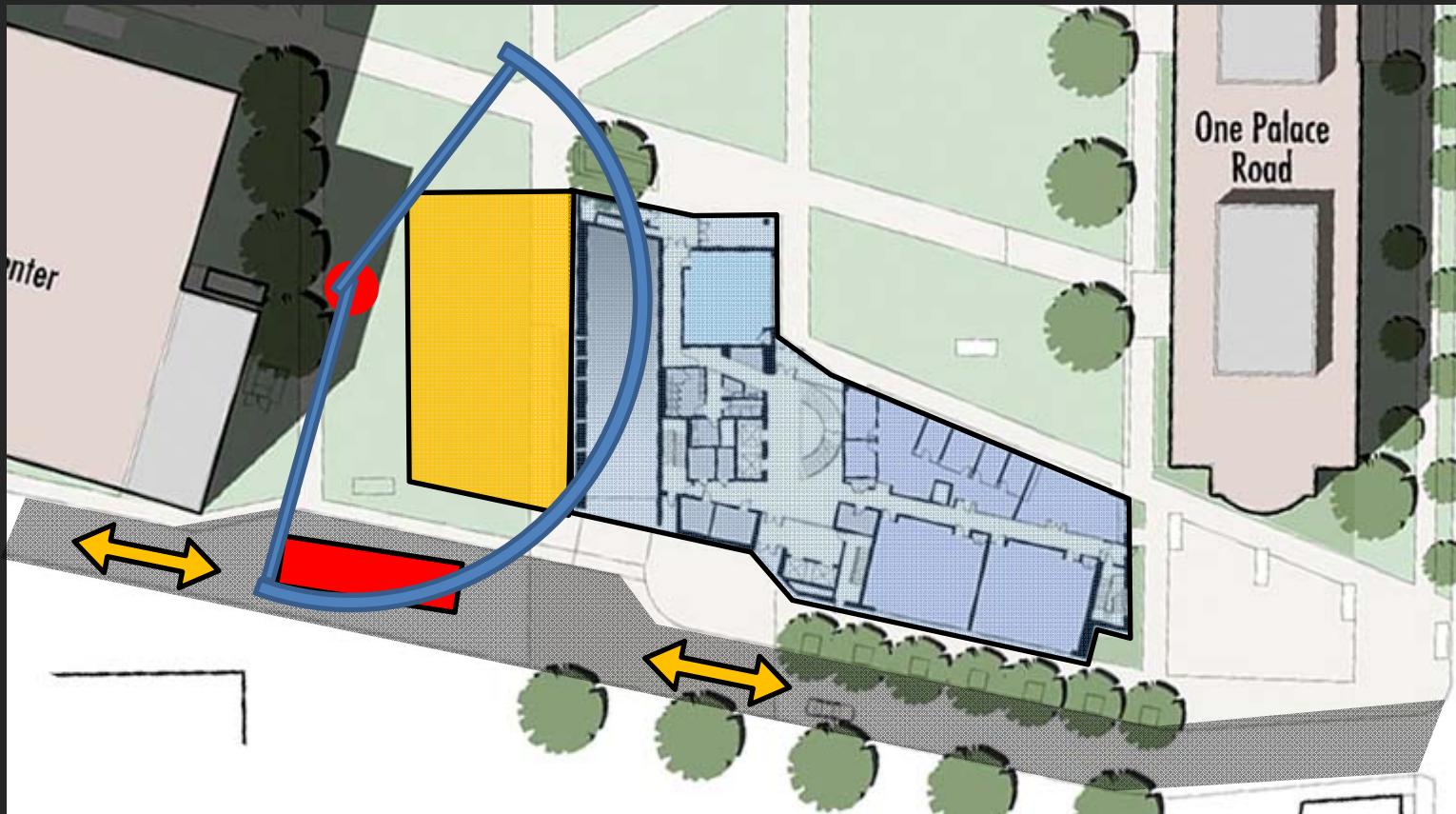
Construction Study

Site Constraints



Construction Study

Site Layout and Requirements



Presentation Outline

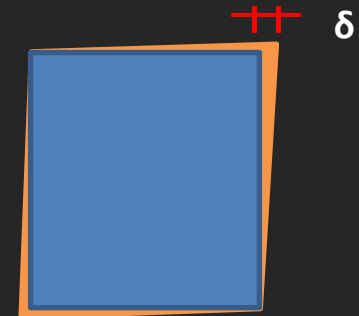
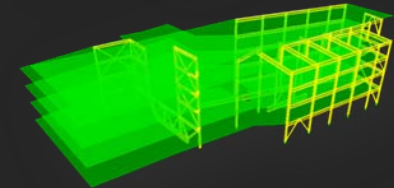
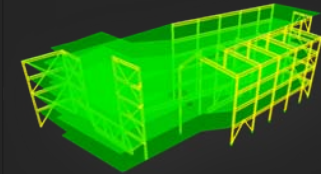
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Conclusions and Recommendations

Conclusion

- Redesigned Structural System Meets Structural Code Requirements in both Base and Expanded Structure
- Façade Detailing Necessary to Accommodate Increased Seismic Story Drift in Expanded Layout
- Modified Façade Connection Detail Allows System Constructability
- Construction Staged within Current Site Conditions
- Additional Expansion Scenario Feasible



Acknowledgements

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Questions



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