LOCKWOOD PLACE
BALTIMORE, MARYLAND

Monica Steckroth- Structural Option

Presentation Outline

- Project Introduction & Building Background
- Existing Conditions
- Objectives & Measure of Success
- Structural Redesign
  - Two-Way Post-Tensioned Floor System
  - Concrete Columns & Shear Walls
- Mechanical Retrofit
- Cost & Schedule Analysis
- Conclusions & Recommendations

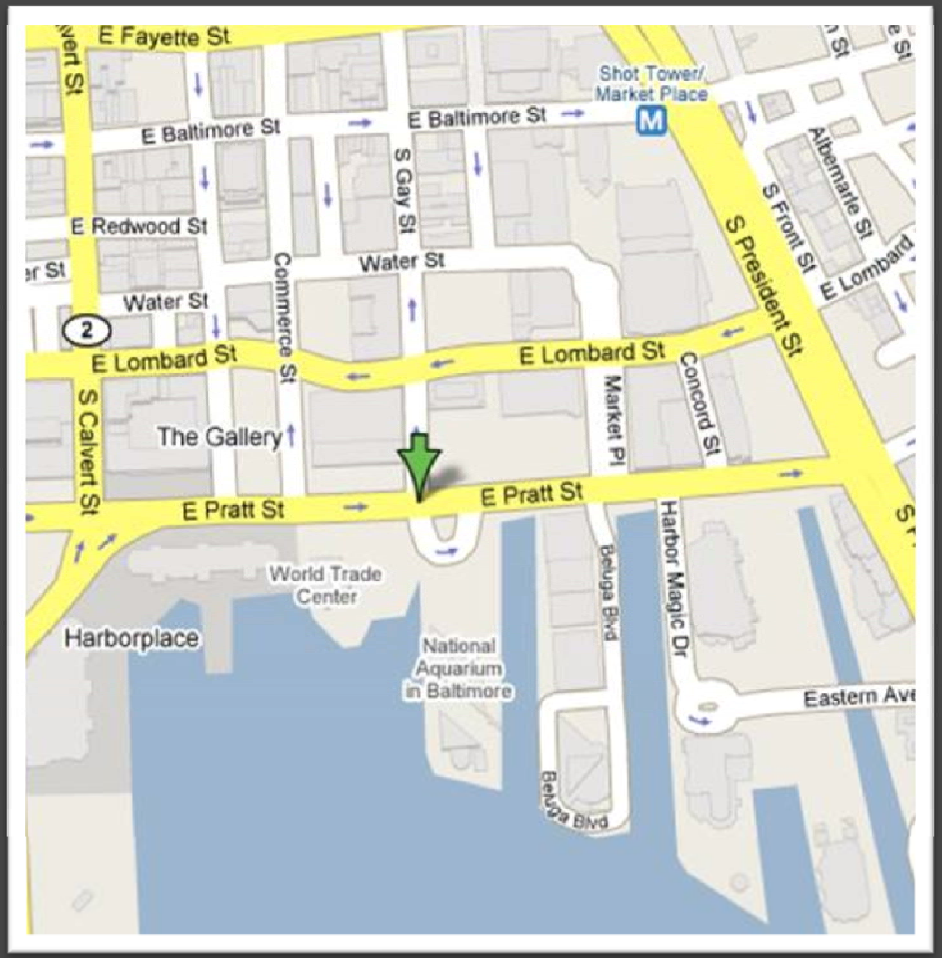
Lockwood Place

Use:
Mixed-Use Development

Location:
Baltimore, Maryland

Construction:
June 2003 -September 2004

Envelope:
Glass Curtain Wall
Abuts a Covered Mall and Adjacent Parking Deck

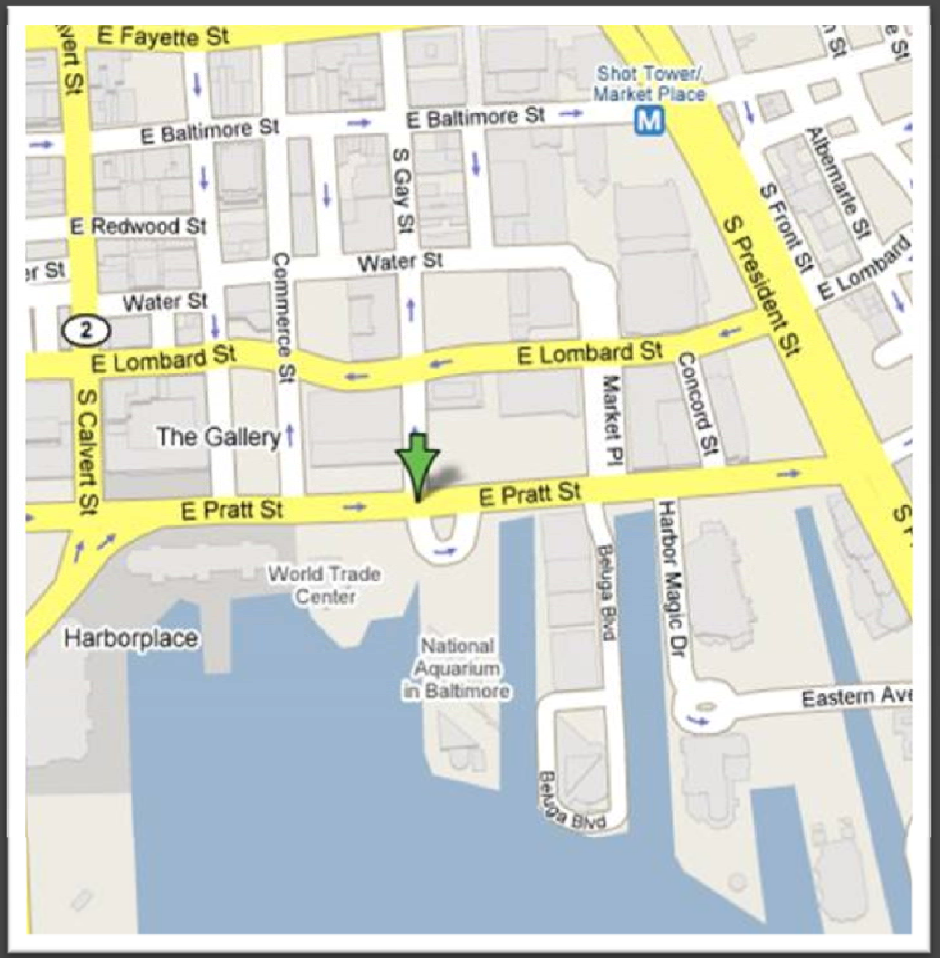


Lockwood Place

Size:
302,348 sq.ft.

Height:
13 Stories
13.5' Typical Story Height
194' tall

Cost:
$28 million base cost
$8 million change orders



Lockwood Place

- Owner: TC MidAtlantic Inc.
- Managing Partner: Kravco Company
- Developer: Lockwood Associates, LLC
- Vertical Transportation Consultant: Lerch Bates & Associates
- Lighting Design Consultant: The Lighting Practice, Inc.
- Structural Engineer: Hope Furrer Associates, Inc.
- MEP Engineer: B&A Consulting Engineers
- Civil Engineer: STV Incorporated
- General Contractor: Helix Construction Services, Inc.

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  - Air Distribution System Resized
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Existing Conditions

Gravity System:

Composite Steel

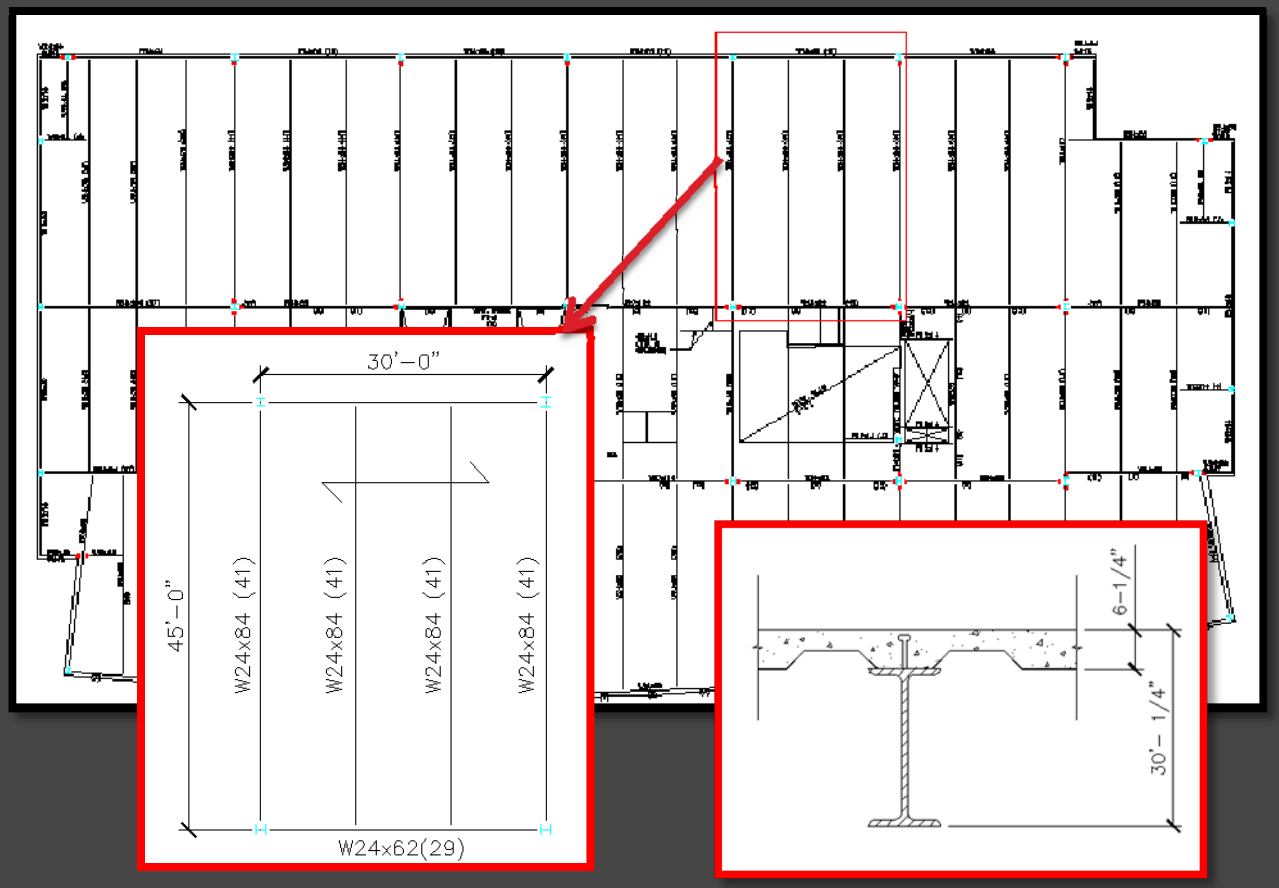
Typical Bay Size:
30'-0" x 45'-0"
30'-0" x 30'-0"

f'c= 3500psi
fy= 50ksi

Lightweight Concrete

6-1/4" slab
3", 20 gage
Composite Deck

3/4" Ø,
5-1/2" long shear studs

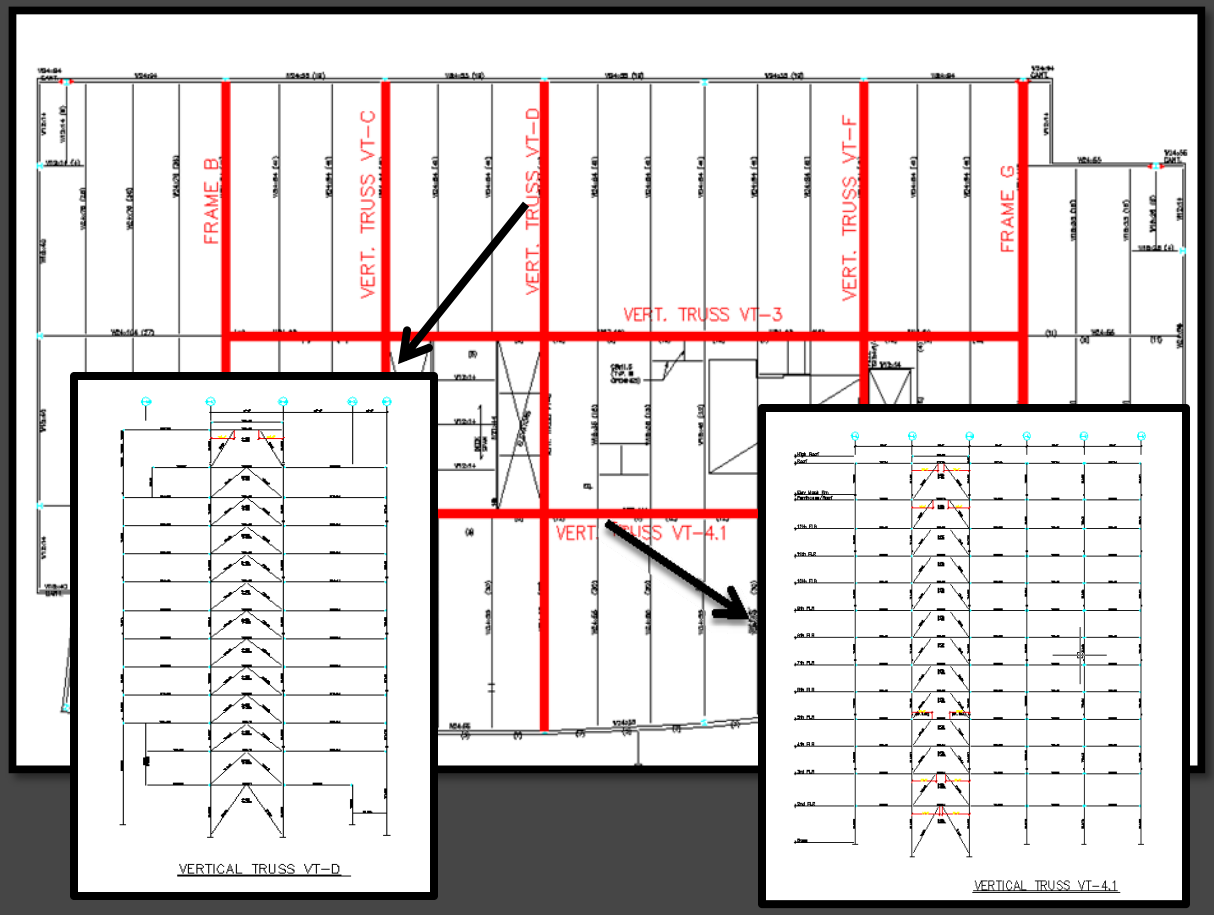


Existing Conditions

Lateral System:

Eccentric Braced Frames:
W14x90 – W8x31

Moment Frames

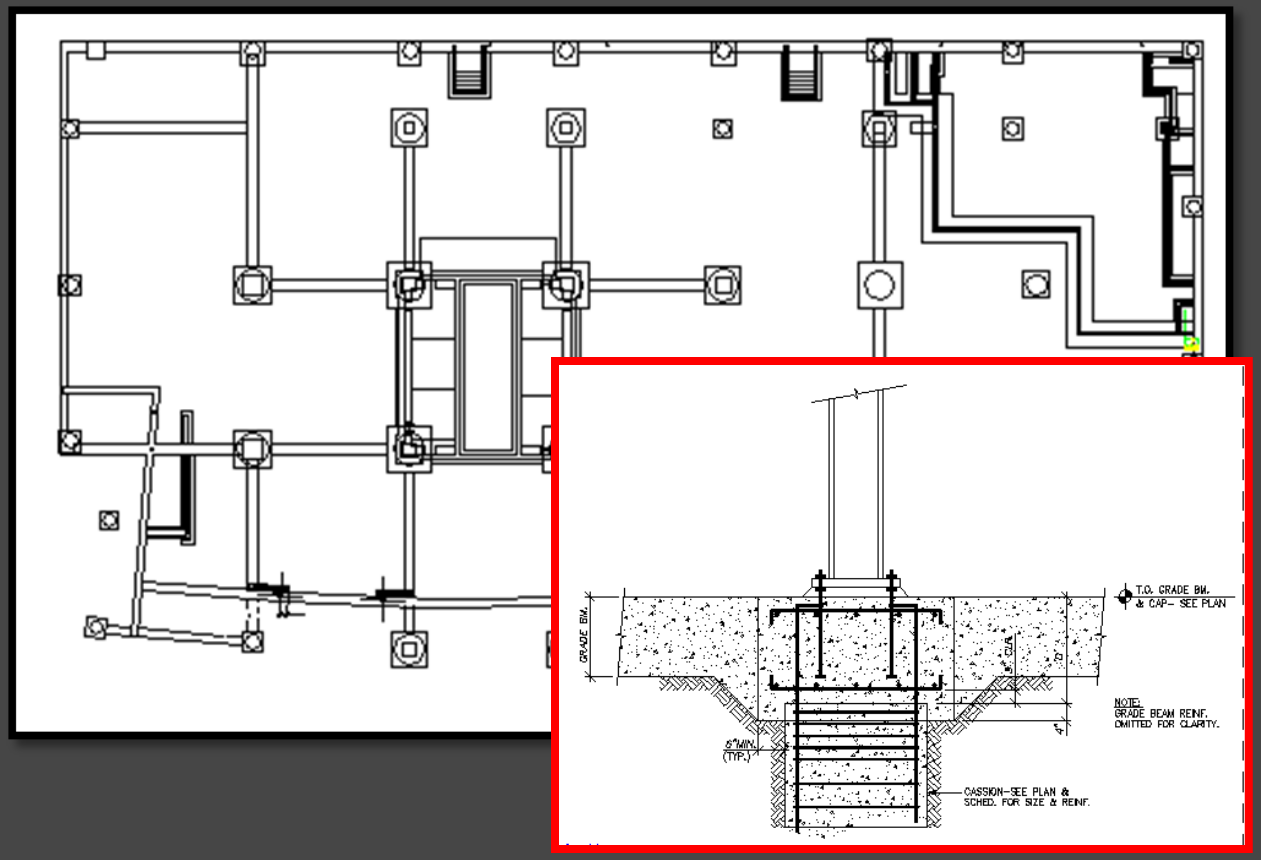


Existing Conditions

Foundation:

Drilled Caissons:
2-6" to 6'-0"
f'c= 4500psi
Drilled 1'-0" to 5'-0"
into Gneiss Bedrock

Grade Beams:
Between Pile Caps
18"x24" to 24"x42"



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  - Lateral System
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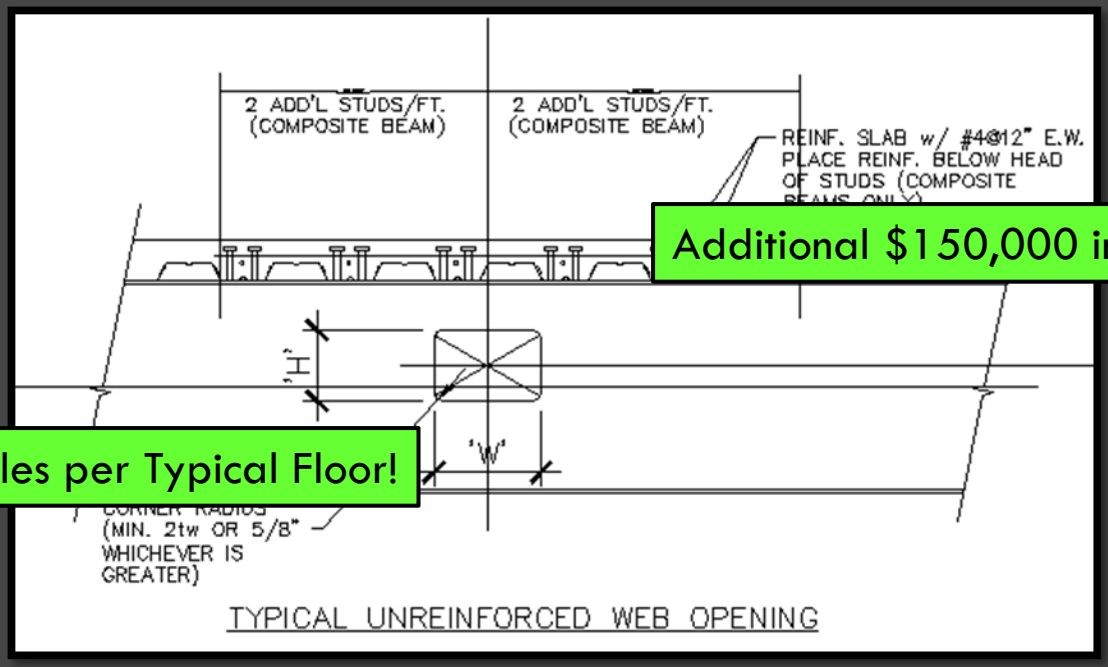
Objectives

- Eliminate Cost and Labor Created by Holes
- Allow More Mechanical Flexibility



Additional $150,000 in Cost of Steel!

Over 200 Holes per Typical Floor!

Measure of Success

Decrease Structural Floor Depth with Concrete System

Larger Air Duct and Smaller Fan Size Requiring Less Energy

Reasonable Cost & Schedule Differences

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Structural Redesign

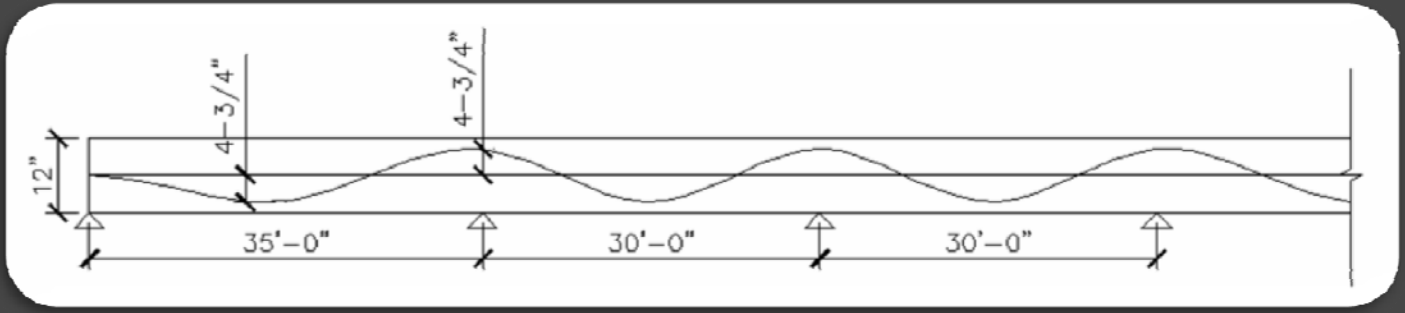
General Parameters

- Typical Span= 30'-0"x45'-0"
- Class U System
- 12" Flat Plate
- Normal Weight Concrete
- f'c= 5000psi
- Balance Dead Load= 60-70%
- ½" 270ksi strands

Code Allowances

- f_b @ Jacking= 1800psi
- f_t @ Jacking= 164psi

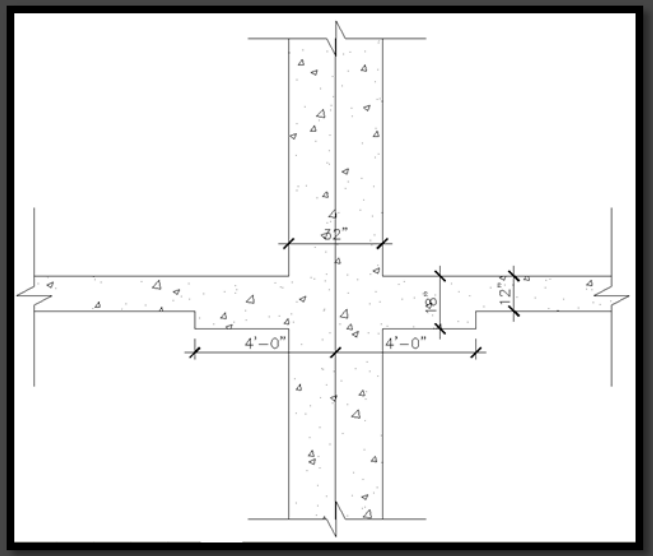
- f_b @ Service= 2250psi
- f_t @ Service= 424psi



Structural Redesign

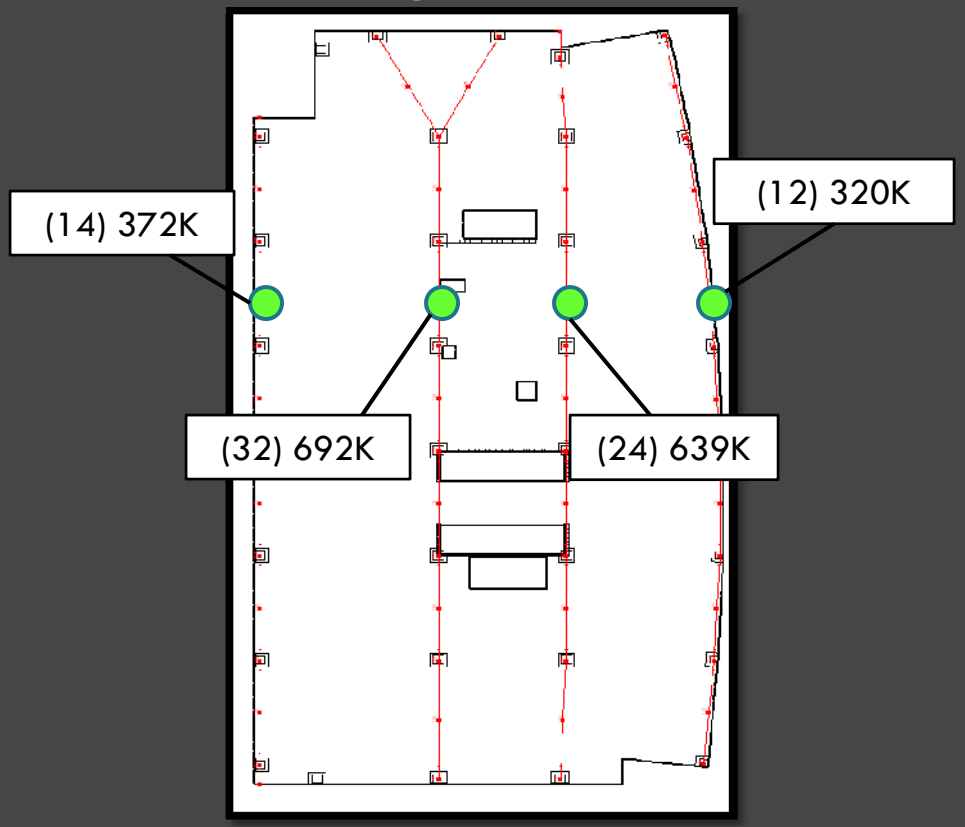
	Loading
Self-weight	150psf
Dead	15psf
Live	100psf

- Shear Resistance
- 18” Column Capitals
- 8’-0” x 8’-0”

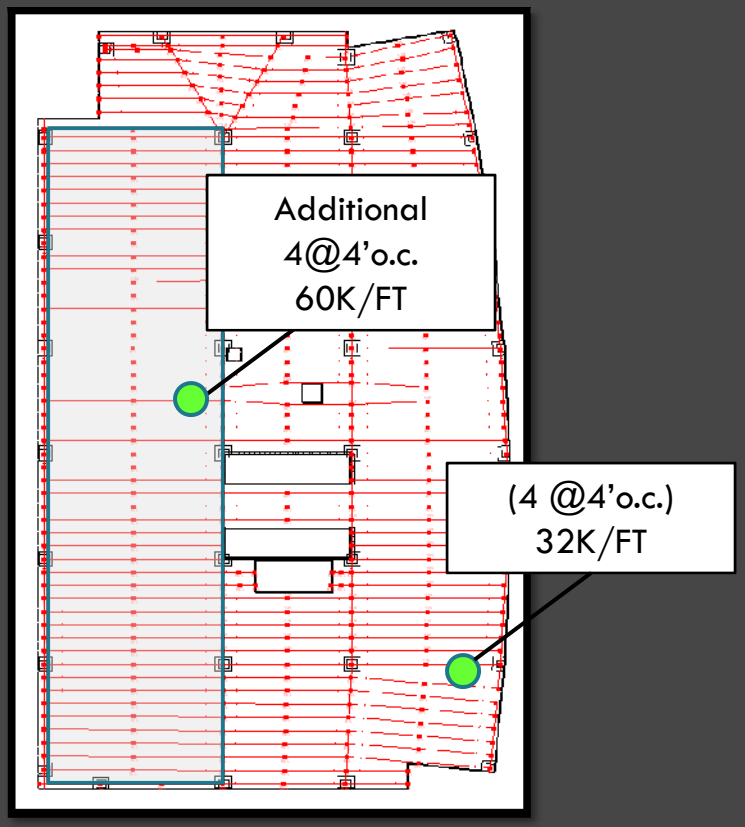


Structural Redesign

- Tendon Layout



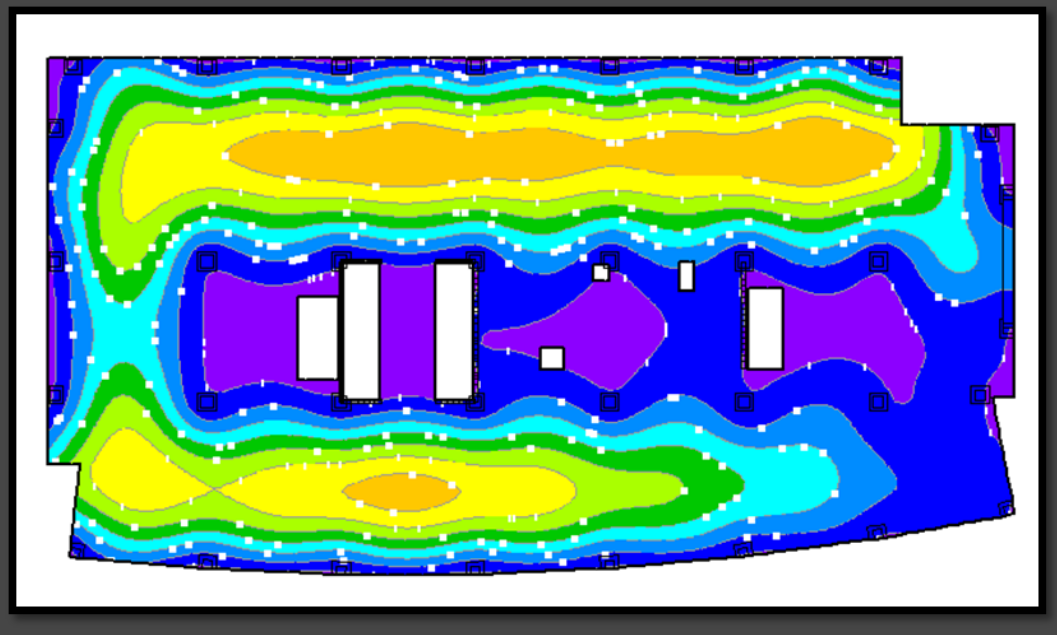
East/West Large Banded Tendons



North/South Small Banded Tendons

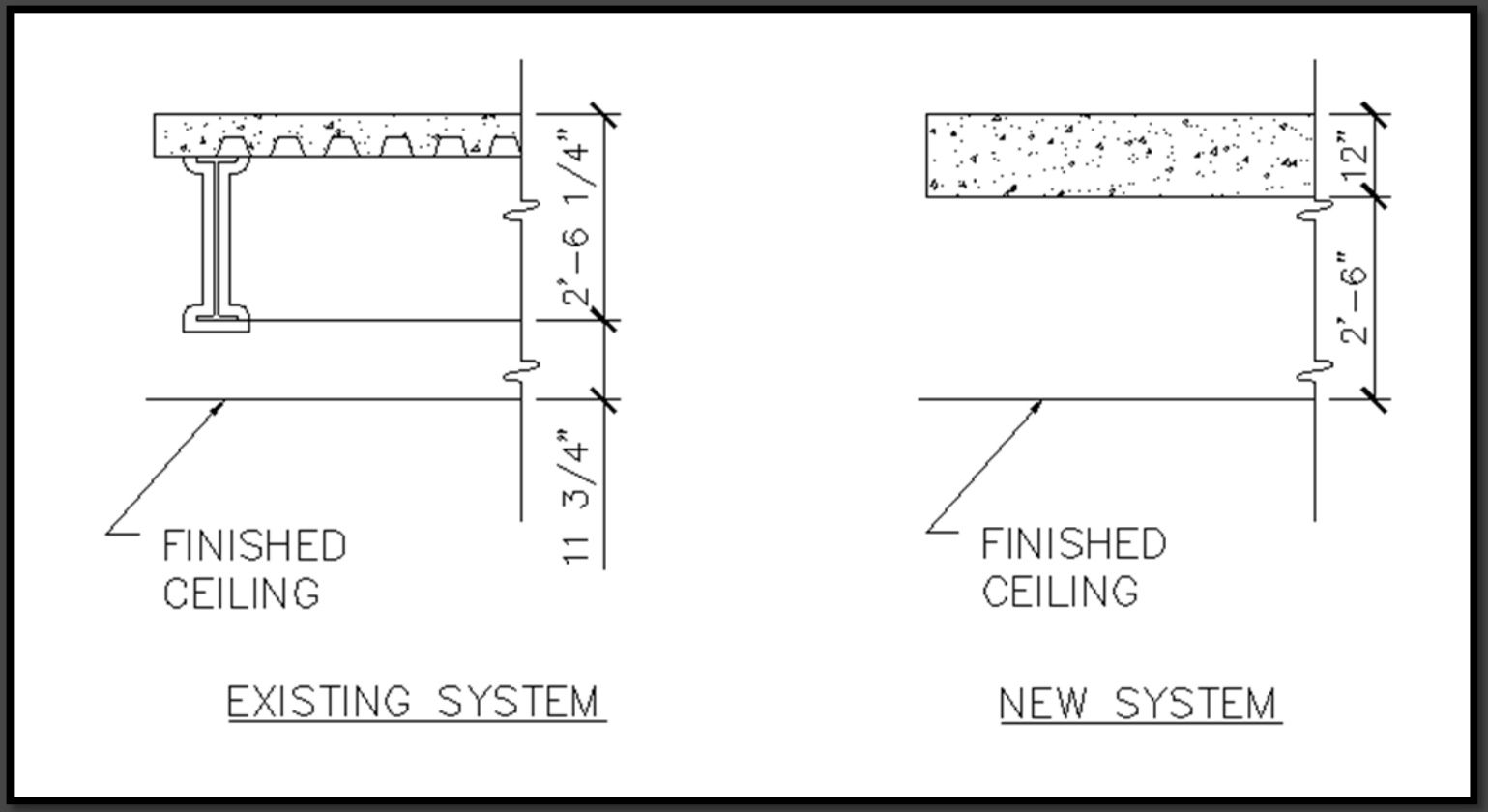
Structural Redesign

- Floor Deflection



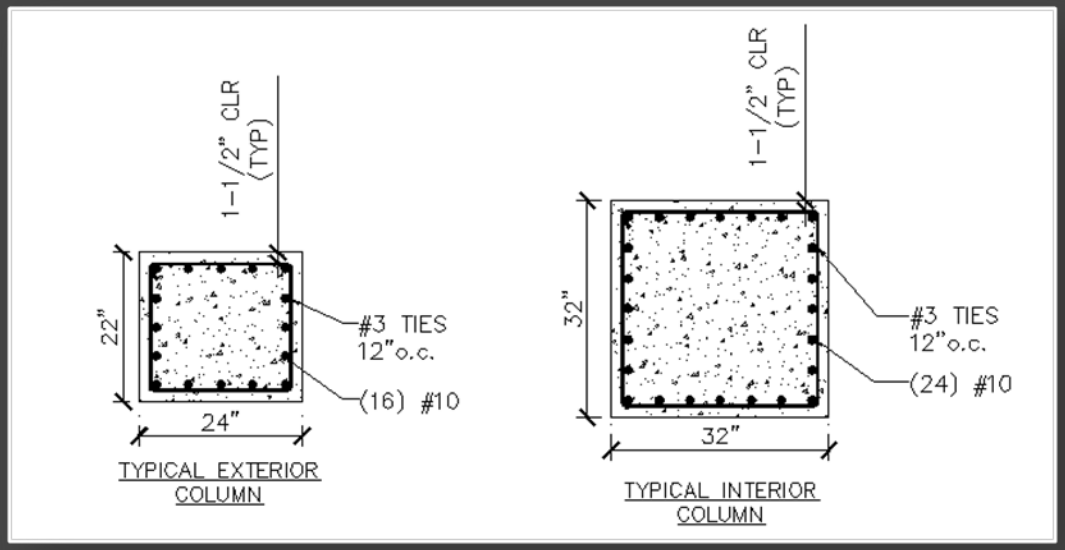
	Long Term Deflection	Equivalent Deflection
Positive	1.40”	L/386
Negative	0.36”	L/1000

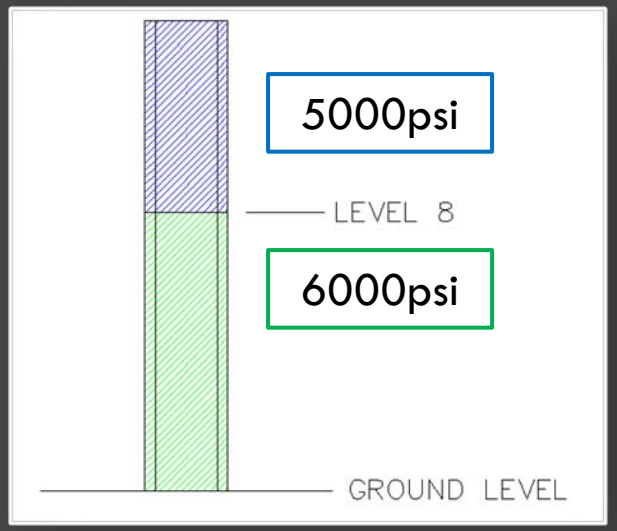
Structural Redesign



Structural Redesign

- Typical Column

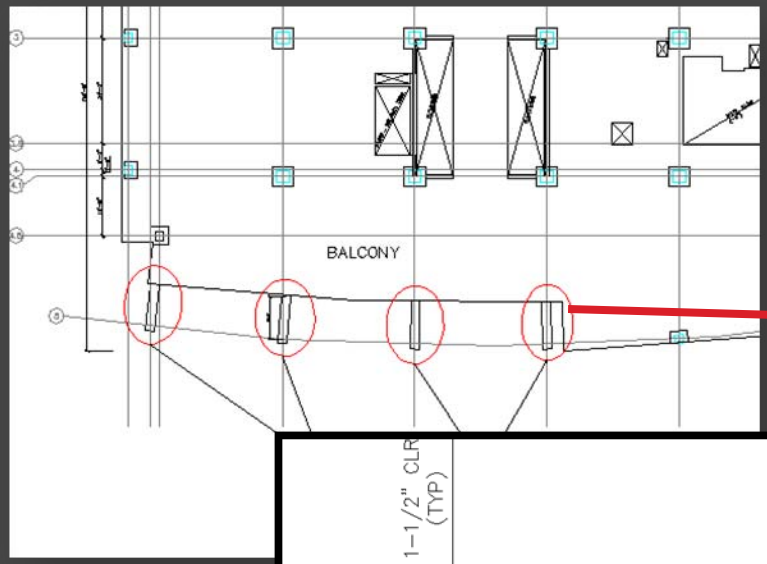


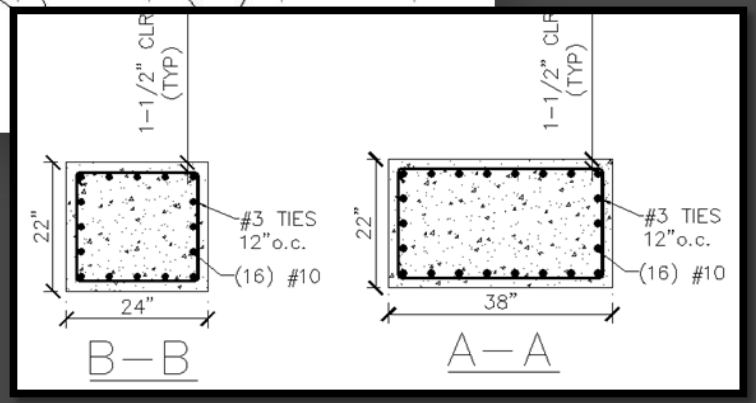


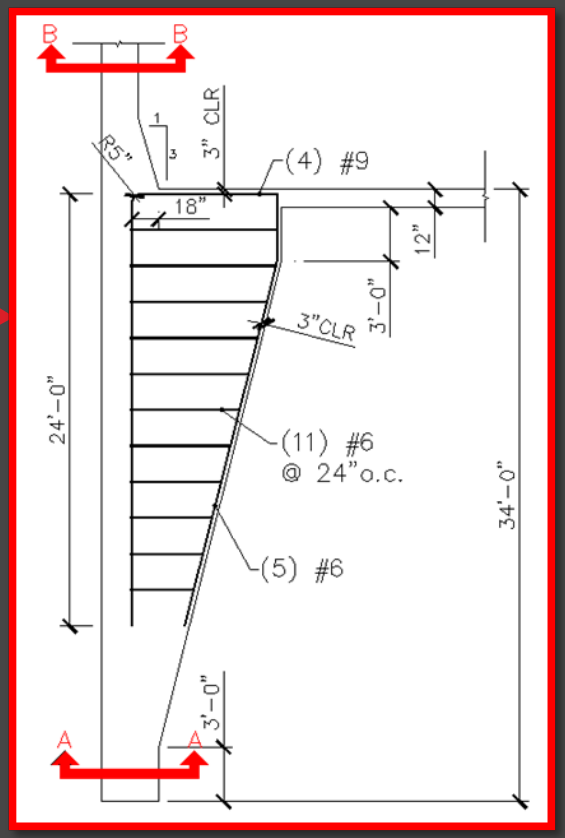
	Exterior Column			Interior Column			f'c
Level	Ties	Reinf.		Ties	Reinf.	rho	psi
1	#3@12"	(16) #10	3.85	#3@12"	(24) #11	2.98	6000
8	#3@12"	(8) #10	1.93	#3@12"	(12) #11	1.49	5000

Structural Redesign

- Front Column Design

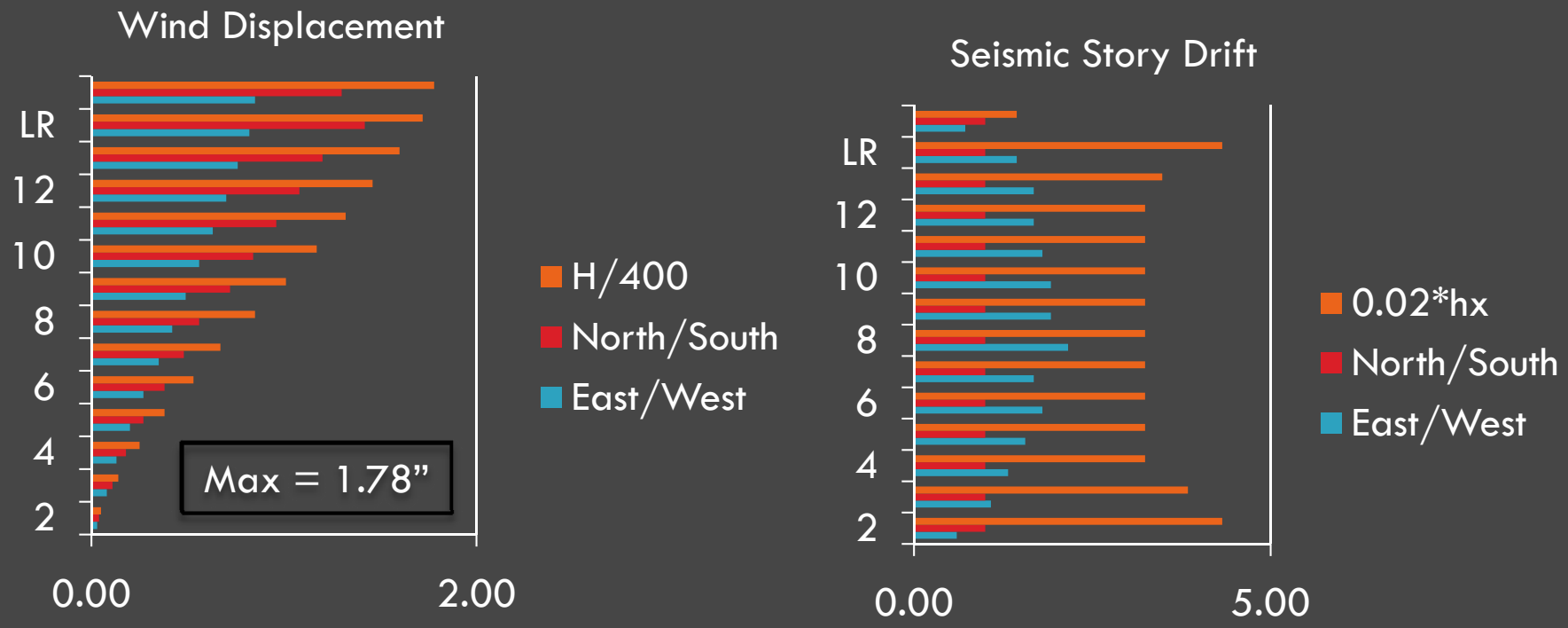






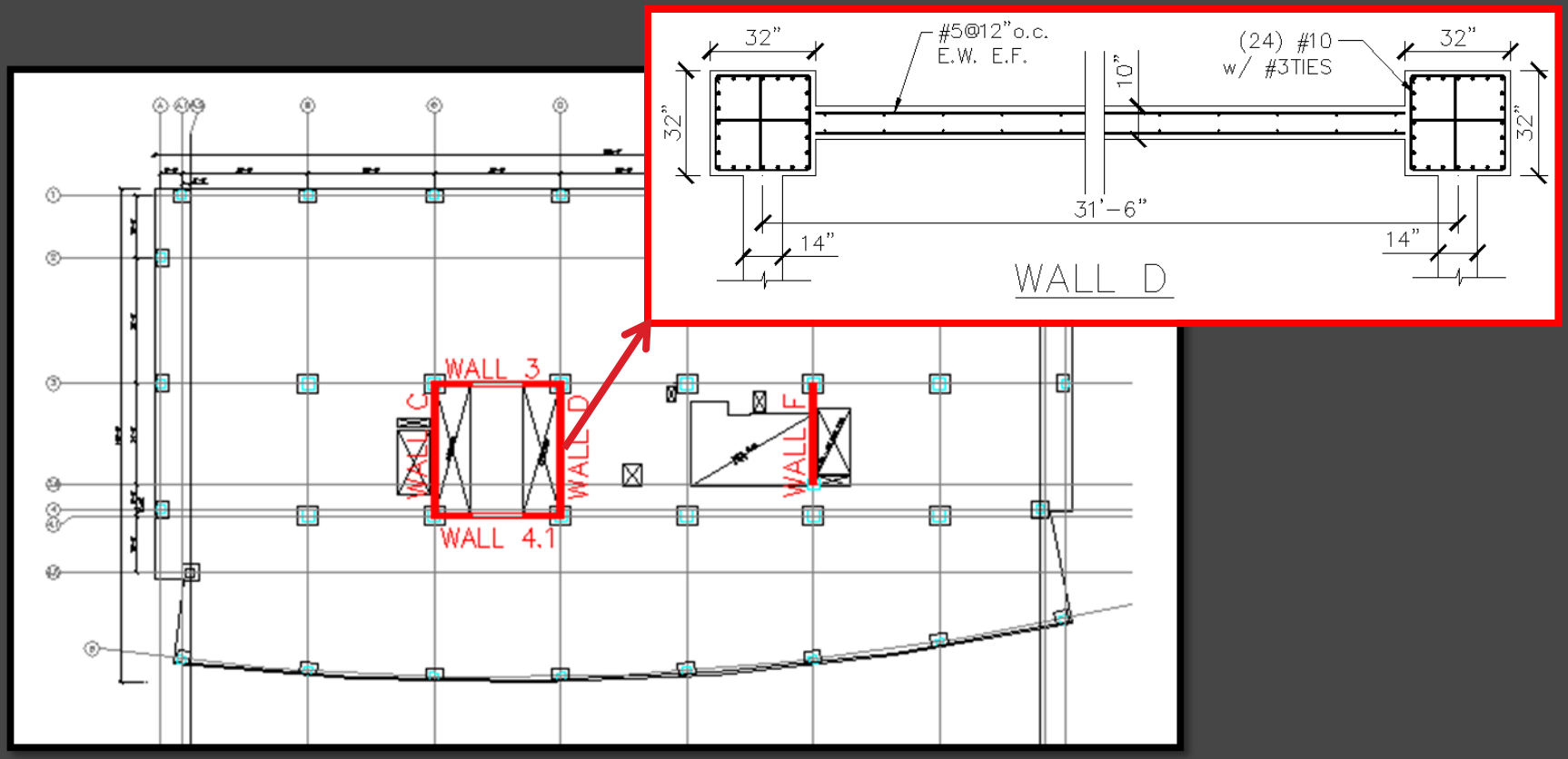
Structural Redesign

- Shear Wall Thicknesses: 10” N/S, 14” E/W
- Controlling Lateral Load Combination: 0.9D+1.6W



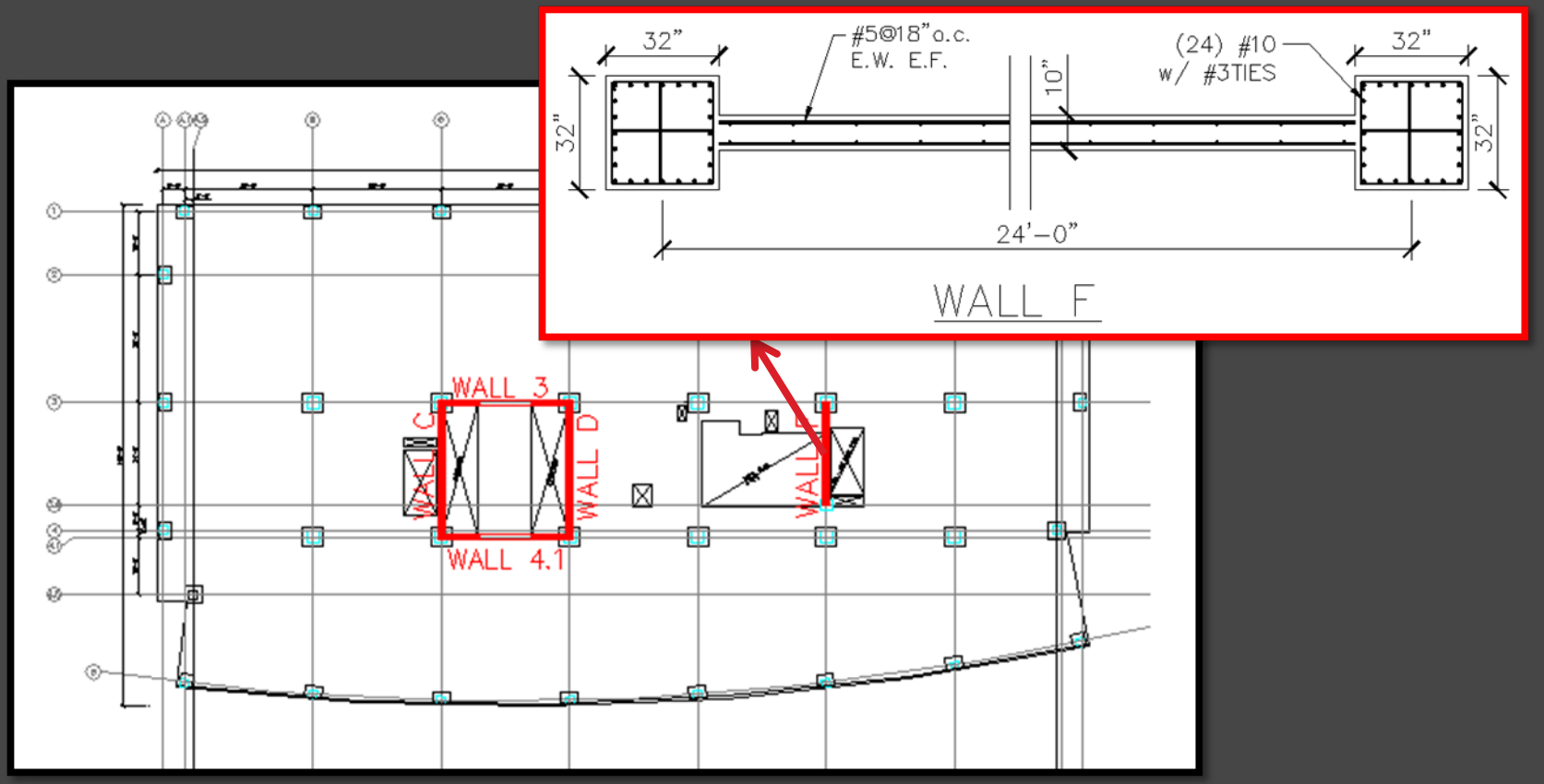
Structural Redesign

- Shear Wall Design



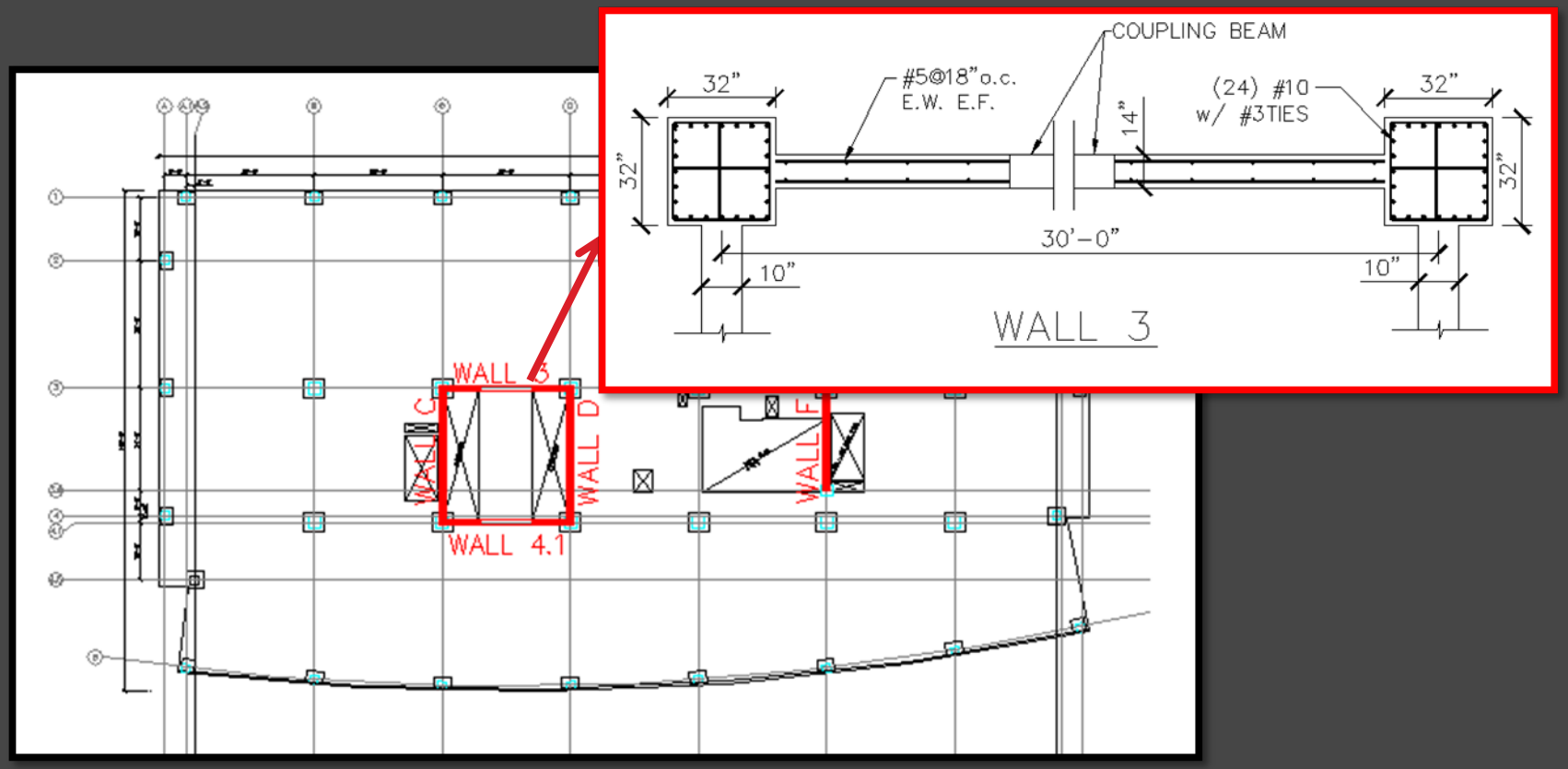
Structural Redesign

- Shear Wall Design



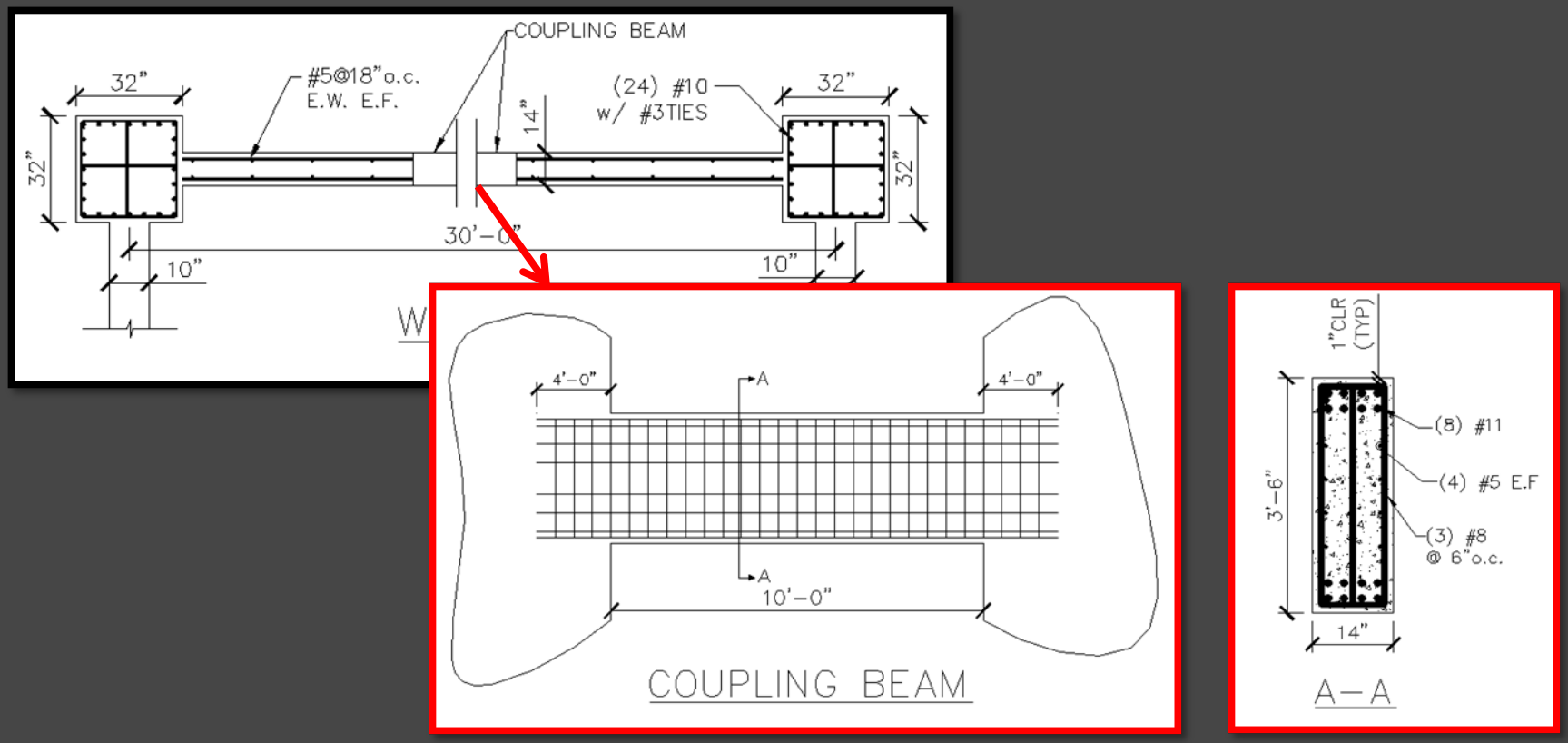
Structural Redesign

- Shear Wall Design



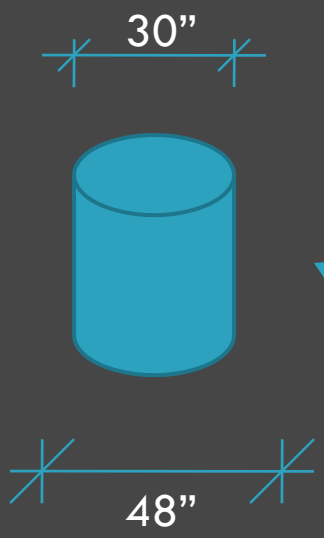
Structural Redesign

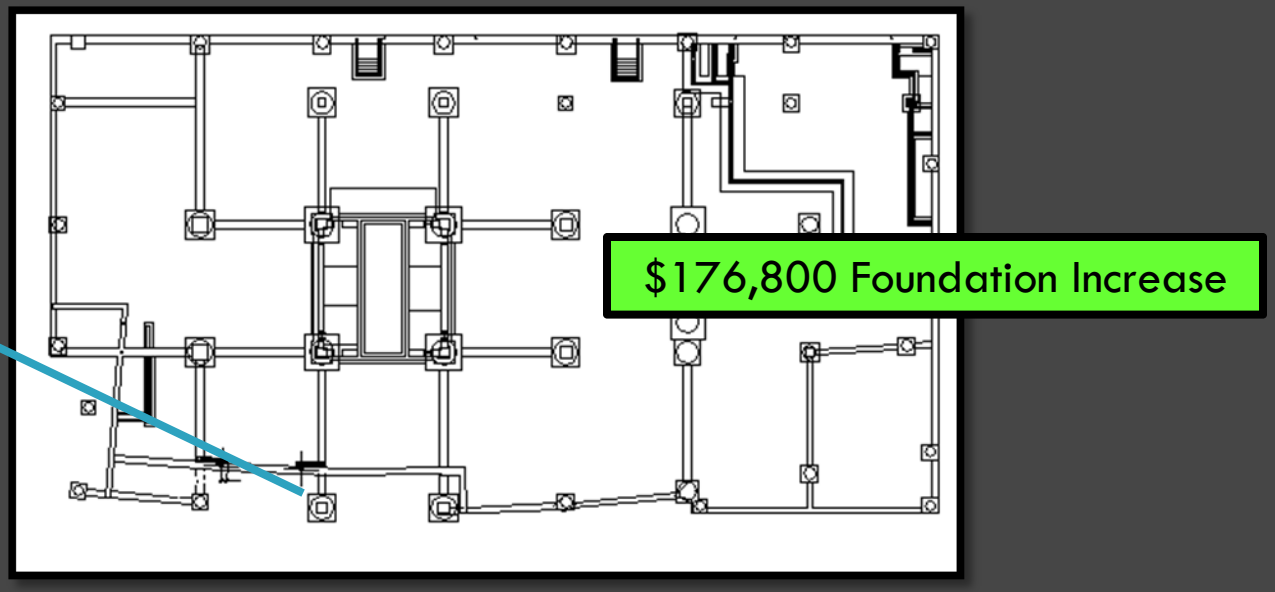
- Coupling Beam



Structural Redesign

- Caisson Adjustment
  - Caisson Uplift → Zero
  - Diameter Increase





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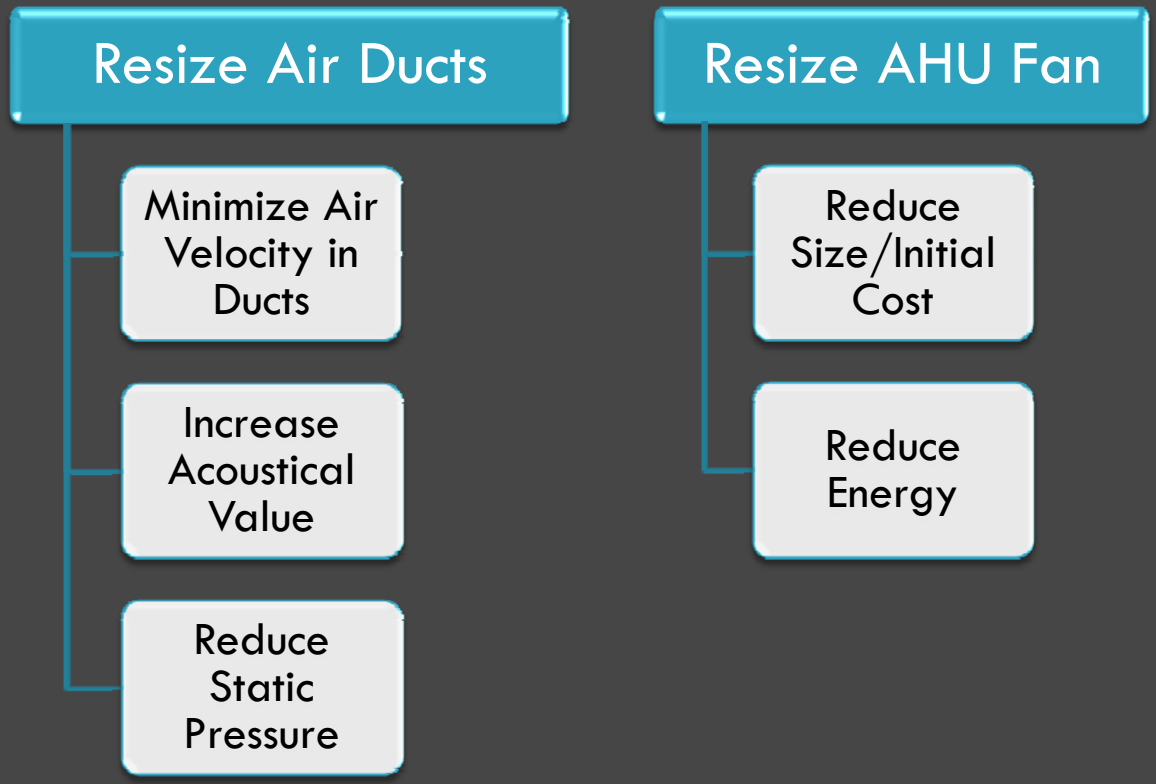
Mechanical Retrofit

- **Existing Air Distribution System:**
- AHU located at each typical floor
  - Distributes 17000cfm
- Powered Induction Units

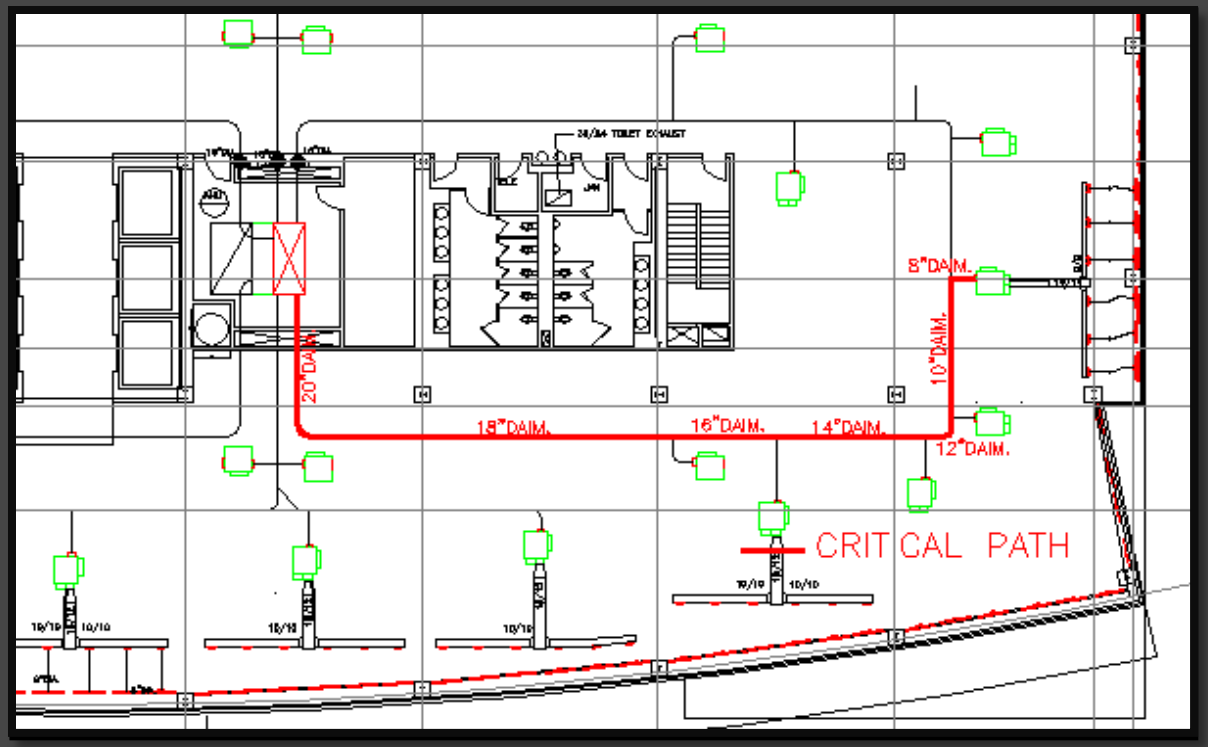
Mechanical Retrofit

Objectives:



Mechanical Retrofit

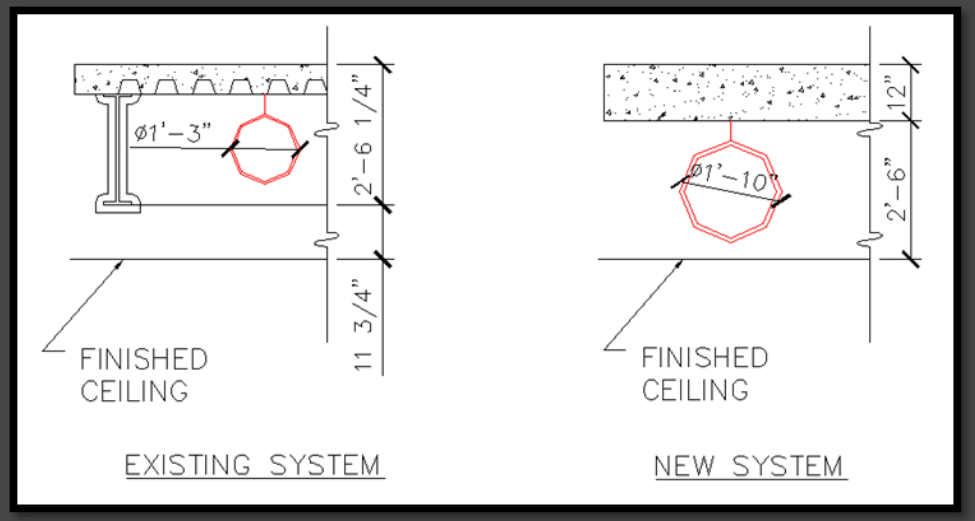
- Resized Air Ducts According to TRANE Calculator



Greatest Change in Diameter = 5”

Mechanical Retrofit

- Section Difference
  +14” Utilized



- Change in Air Velocity: $2275^{ft}/_{min}$ → $1698^{ft}/_{min}$

Mechanical Retrofit

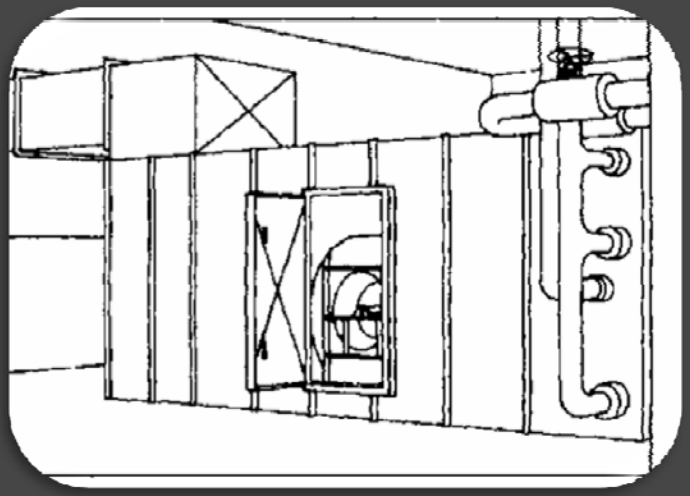
Existing Fan

- 40", TRANE manufactured
- 20 Horsepower, 480V/3 Phase
- Force Flow Centrifugal Variable Frequency Drive, blow-thru
- Δ3.6" static water pressure required

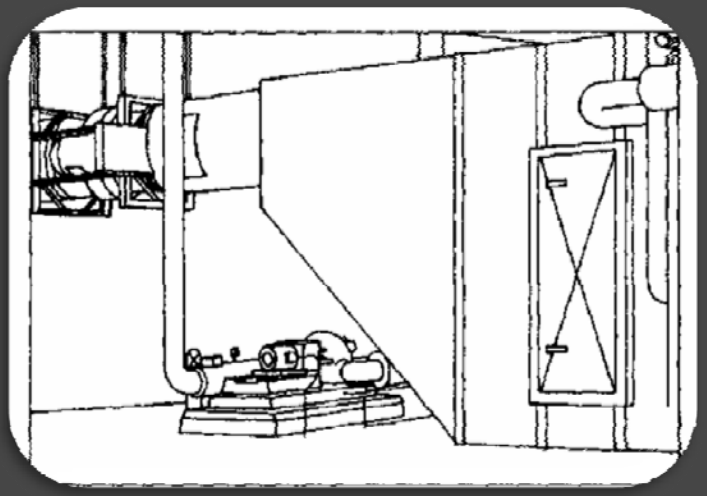
Proposed Fan

- 40" TRANE manufactured
- 11.2Horsepower, 480V/3Phase
- Type Q
- Δ2.83" static water pressure required (0.2" losses provided by the fan)

Mechanical Retrofit



Centrifugal Blow-Thru Fan
www.trane.com



Type Q Fan
www.trane.com

Costs

- Added Cost of Air Ducts

Benefits

- Increased Acoustical Value
- Less Energy Required
- Additional MEP Room Space

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Cost & Schedule Analysis

Cost Consideration:

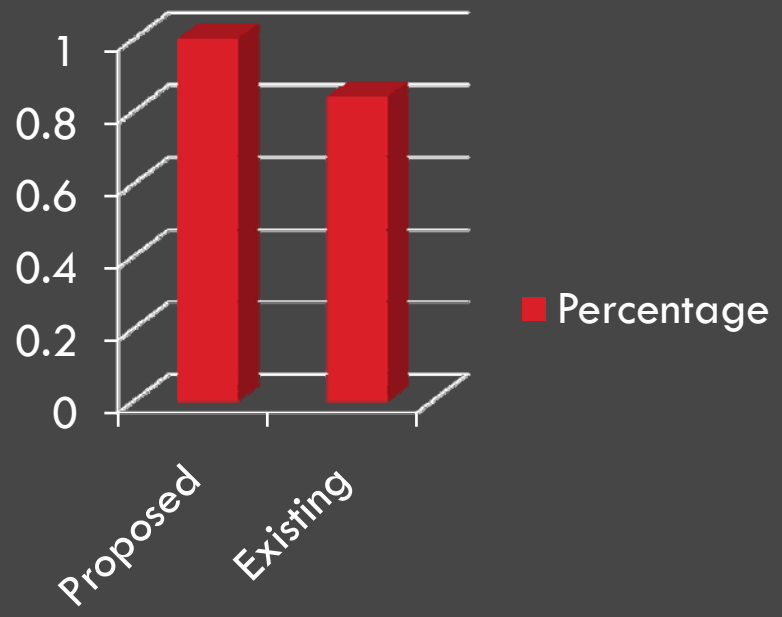
Existing

- Structural Steel
- Super-Structure Concrete
- Spray- on Fireproofing
- Punched Hole Detailing

Proposed

- Super-Structure Concrete
- Additional Foundation Concrete
- Regular & Post-Tensioned Reinforcement

Cost Comparison:



16% Savings!

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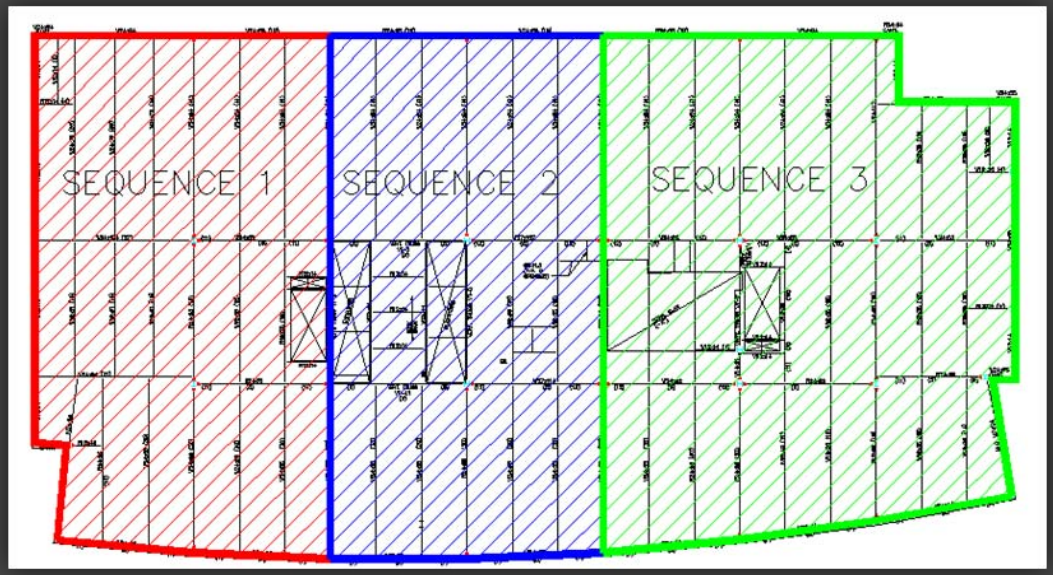
Cost & Schedule Analysis

- Existing Schedule

  Construction: June 2003- September 2004

  3 Sequences constructed – 3 Levels/ Sequence



Total Structure Construction = 35 weeks

Cost & Schedule Analysis

- Proposed Schedule

  1Sequence= 1 Level

  Total Structure Construction= 40 weeks

- Comparison

	Existing	Proposed
Start Date	06/02/03	06/02/03
Finish Date	3/21/04	4/29/04
Total Time	35 Weeks	40 Weeks

5 Additional Weeks!

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- Decrease Structural Floor Depth with Concrete System
- Larger Air Duct and Smaller Fan Size Requiring Less Energy
- Reasonable Cost & Schedule Differences

Acknowledgements

My Family & Friends

Dr. Linda Hanagan
The Pennsylvania State University, Faculty Advisor

Architectural Engineering Faculty
The Pennsylvania State University

Carol Hayek, PhD
SD Post-Tensioning

Hope Furrer
Hope Furrer Associates, Inc.

B&A Consulting Engineers

Milton Steel, Inc.

Jason Witterman
Penn State AE Mechanical Option

Todd Povell
Penn State AE Construction Option

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