Courtesy of Holbert Apple Associates

8621 Georgia Avenue
Silver Spring, MD

Nick Dastalfo | Structural Option
Advisor: Dr. Thomas Boothby
April 13, 2015

Courtesy of Holbert Apple Associates

8621 Georgia Avenue

- **Building Introduction**
  - **Statistics**
  - Gravity System
  - Lateral System
- Problem Statement & Solution
- Composite Steel System
- Lateral System
- Foundation System
- Ventilation System
- Cost and Schedule Analysis
- Conclusion

Building Introduction

Owner: FP Wilco, LLC
Structural Engineering: Holbert Apple Associates

Size: 347,000 GSF
Stories: 17
Height: 162 ft.
Cost: $52 Million
January 2015– February 2017

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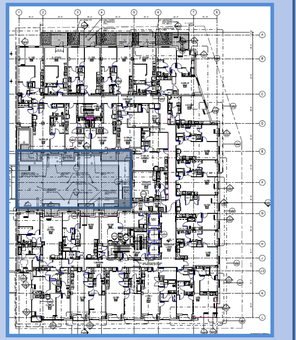
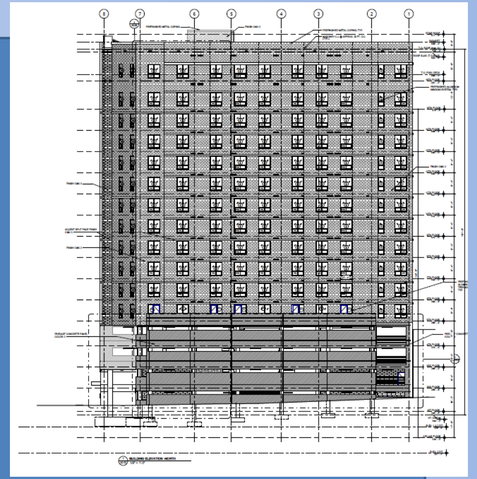
Building Introduction

Occupancy: 13 floors of apartments
4 floors of parking & retail, etc.

Features:
- Geometry change at level 5
- Green Roof
- Rooftop pool





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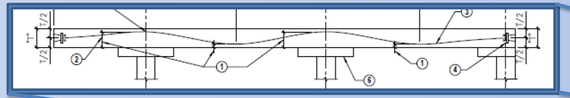
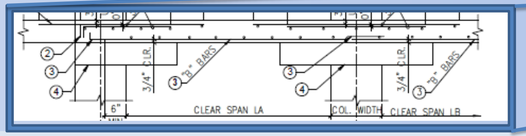
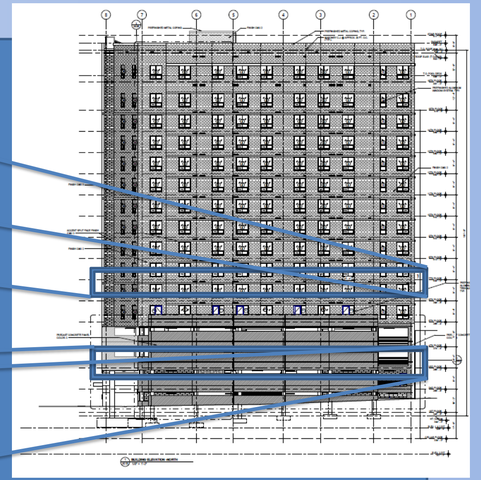
Gravity System



- 7.25″ post-tensioned flat plate

- 8″ slab w/ 4″ drop panels





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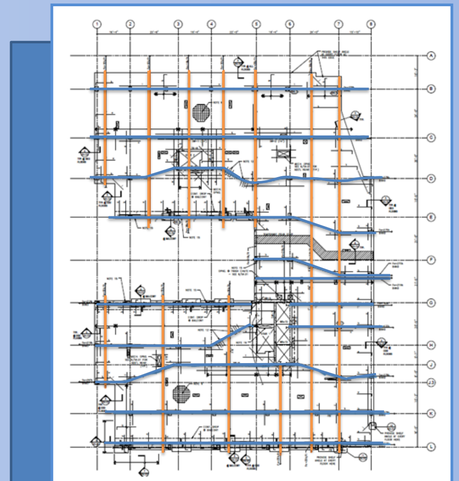
Gravity System

Two way PT system

-Banded Tendons

-Uniformly Distributed Tendons



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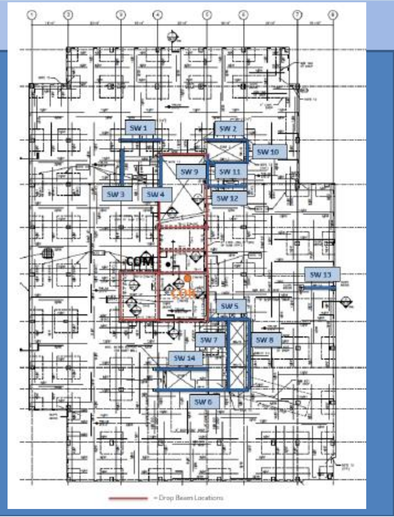
Lateral System

- Ordinary Reinforced Concrete Shear Walls
  - 12″ or 14″ thick
  - located near stair and elevator cores

- Additional beams added in parking garage



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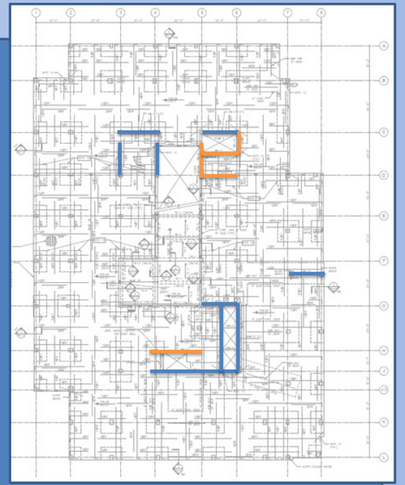
  - located near stair and elevator cores
- Additional beams added in parking garage

- Shear Walls vary in height



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Problem Statement

- Building is acceptable as designed
- Scenario: redesign the apartment levels in steel
- Consider impact on:
  - Architecture
  - Foundations
  - Vibrations
  - Cost

Proposed Solution

- Create a modular bay size and column locations
- Design apartment levels using composite beams and girders
- Move a level of parking garage below grade
- Investigate effects on foundations and lateral system
- Compare overall project cost

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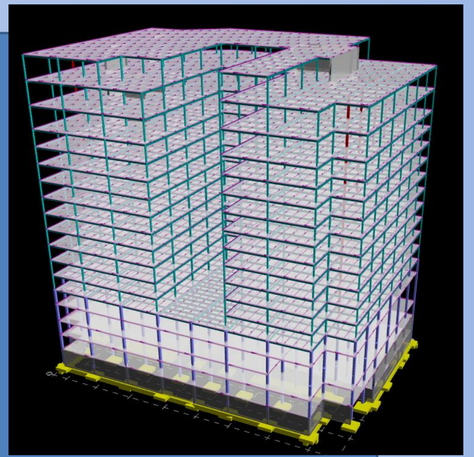
Gravity Redesign



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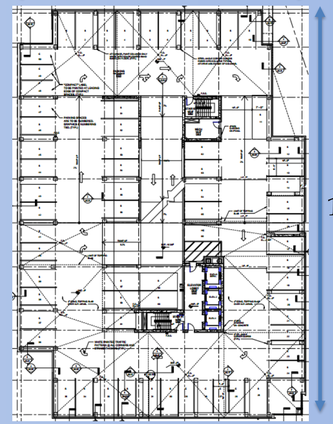
Typical Bay/Columns

- Square ⟶ Rectangular Bays
- Move Columns onto grid
- Mirror building proportions in bay proportions



$$\frac{192}{133.5} = 1.44$$

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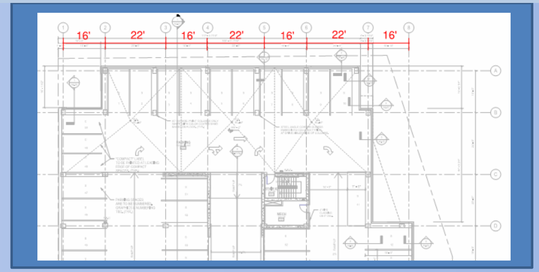
- Re-Orient Parking Spaces from 90° to 60°



Parking Space Orientation	Minimum Throughway Width
90° spaces	24 feet
60° spaces	18 feet

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  - Beam Layout
  - Beam/Column Design
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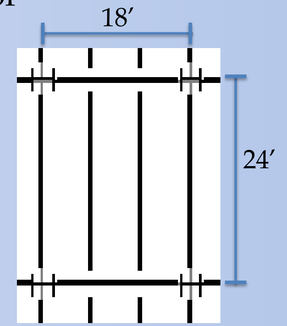
Vibrations Analysis

- Vibrations due to human walking activity
- Minimize accelerations in the floor

- Design Inputs:
  - Deck: 1.5VLR20
  - 4.5″ LW Topping
  - 6′ beam spacing



Deck Properties	
Concrete Strength	4000 psi
Steel Grade	50
Deck Type	1.5VLR20
Topping (in)	4.5
Concrete Weight	LW
Total Slab Thickness (in)	6
Force from Excitation	$P_o = 65\ lbs.$
Damping Ratio	0.05
Acceleration Limit	$\frac{a_o}{g}\ x\ 100\% = 0.5\%$

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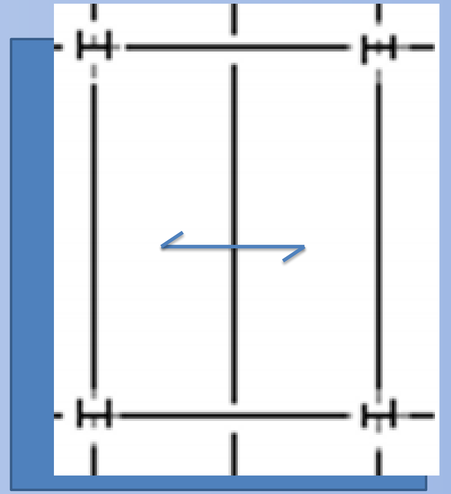
Vibrations Analysis

- Increasing beam sizes reduced steel utilization
- Increase Deck Gauge and Space beams further
  - 1.5VLR16
  - 9′ foot beam spacing
- Increase Interaction to 0.75
- Limited by deflections

- Re-Check Vibrations $\frac{a_o}{g} = 0.48 < 0.5$



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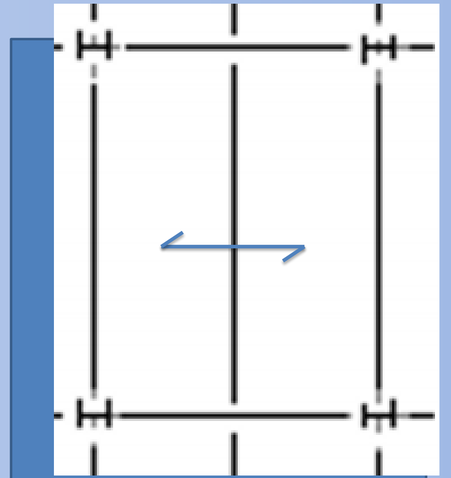
Beam Layout

- **Long Direction**
- Short Direction



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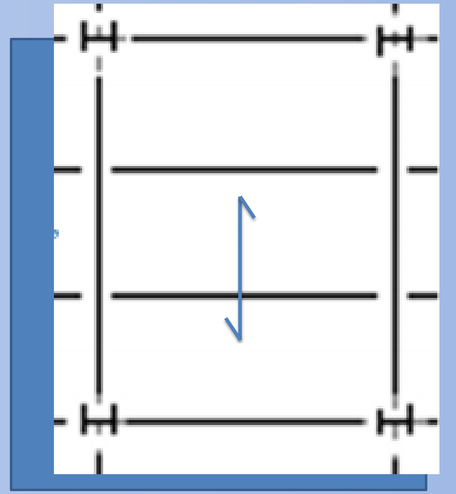
Beam Layout

- Long Direction

- **Short Direction**
  - Deck can not support single mid-span infill beam



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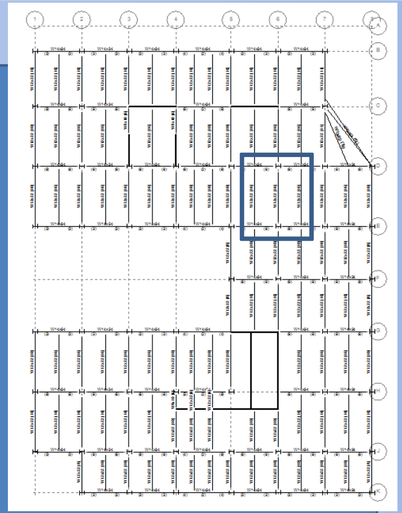
Beam Layout

- Long Direction selected

Beam Orientation			
	Steel Weight (tons)	# of Members	# of studs
Long	590.9	2,220	25,093
Short	627.3	2,577	28,387



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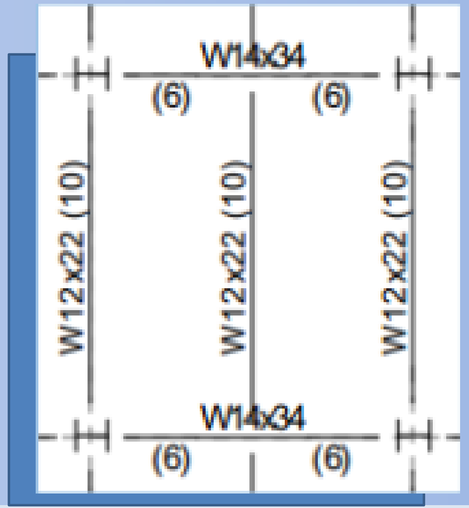

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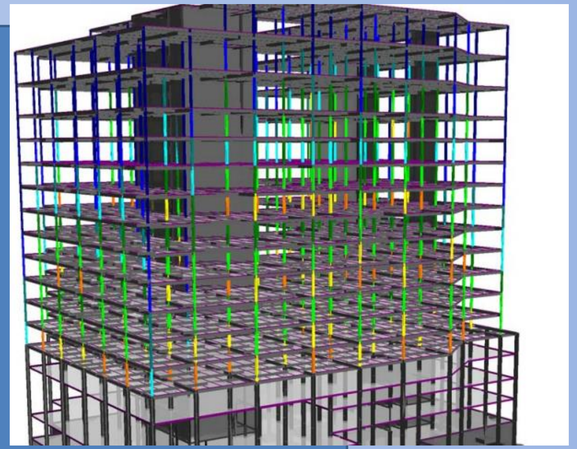
Column Design

- W10 or W12 columns
  - Column depth constant through building height
  - Sizes vary along height for efficiency

- Spliced every two floors



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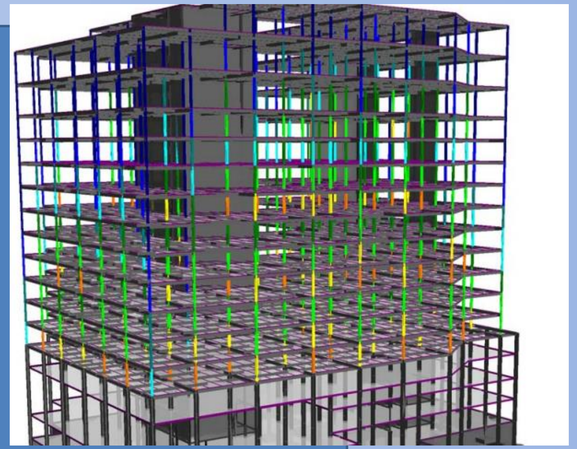
Column Design

Exterior Column – H8			Interior Column – D6		
Floor	Size	Interaction	Floor	Size	Interaction
10-16	W10x33	0.20 – 0.93	13-16	W12x40	0.35 – 0.94
7-9	W10x45	0.76 – 0.95	10-12	W12x58	0.72 – 0.98
4-6	W10x54	0.81 – 0.94	7-9	W12x79	0.78 - 0.97
			4-6	W12x106	0.79 - 0.91



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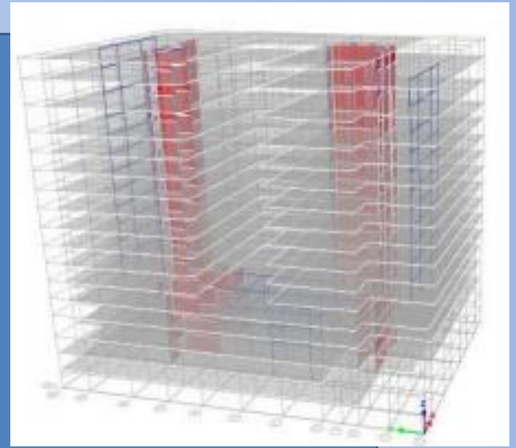

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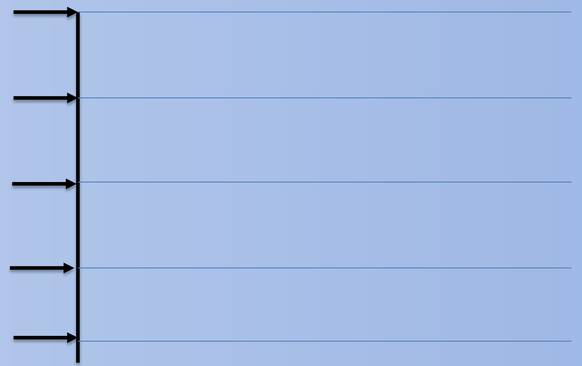
Lateral Layout

-Reduced Building Weight
  -Seismic forces decrease

-Wind Controls

-Building height unchanged with less floors
  -Story forces increase



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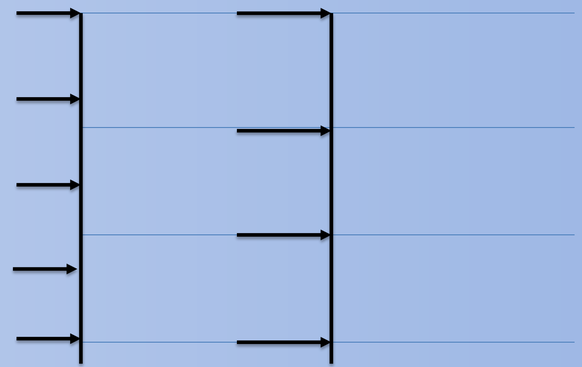

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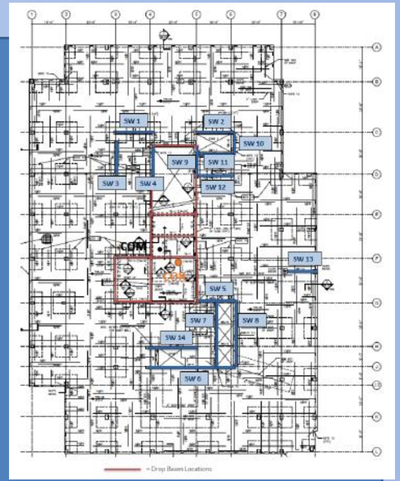

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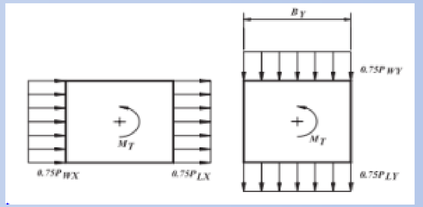
Lateral Layout

- Remove isolated shear wall
  - -architectural conflicts
  - -ineffective in resisting torsion

- Check without SW#13



Drift due to Wind Case 2 in the X Direction			
Load Case	Max Drift (in)	Allowable Drift (in)	Pass / Fail
X Direction (+M)	2.840	4.83	PASS
X Direction (-M)	4.822	4.83	RE-EVALUATE

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-Remove isolated shear wall
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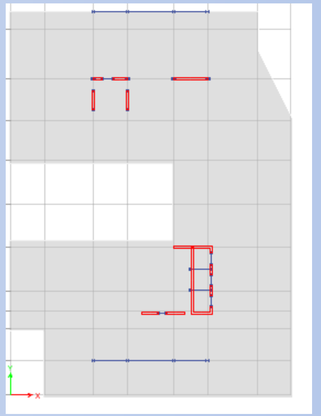
  -ineffective

-Add Moment Frames
  -reduce displacement
  -reduce torsion



Drift due to Wind Case 2 in the X Direction

Load Case	Max Drift (in)	Allowable Drift (in)	Pass / Fail
X Direction (+M)	2.80	4.83	PASS
X Direction (-M)	4.76	4.83	PASS

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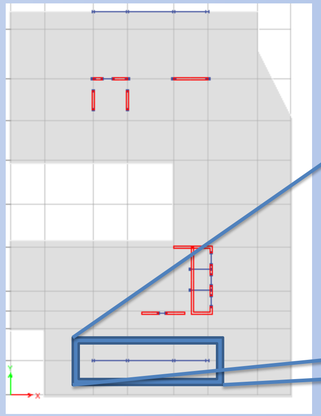

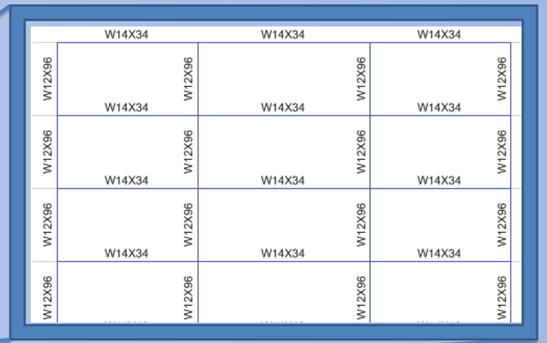

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Foundation System

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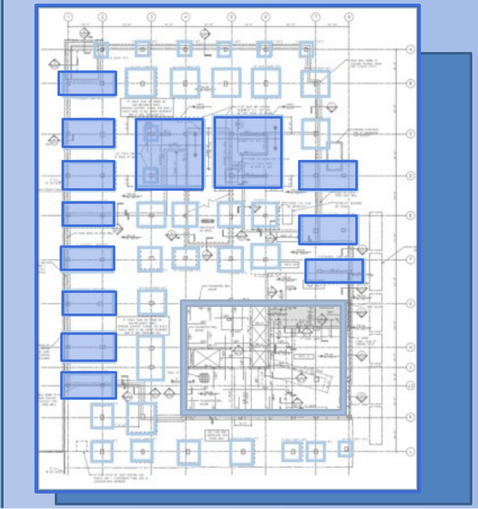
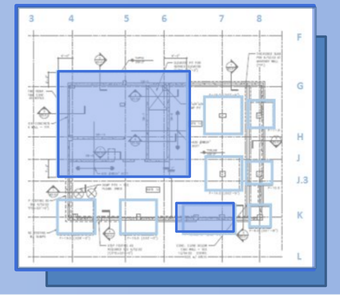
Foundation System

- Reduced Building Weight ⟶ Reduce Footing Size

- Shared Column Footings → Two individual footings





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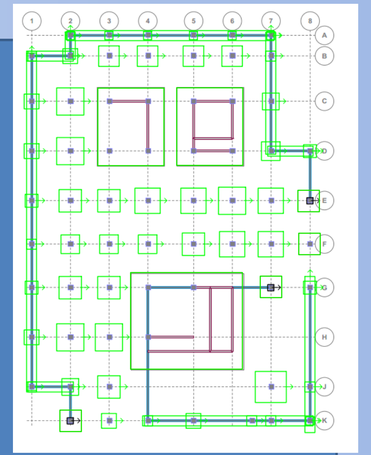

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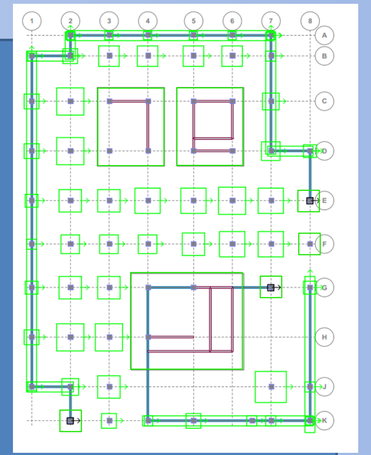
Foundation System

Foundation System Comparison			
	Concrete (CY)	Formwork (SFCA)	Steel (tons)
Existing	1762.4	10599.5	69.48
Re-Designed	1105.0	7094.7	56.14
% Decrease	37.3%	33.1%	19.2%



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Ventilation System Design

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Ventilation System

- Underground parking ⟶ Need to exhaust air

- 4 Exhaust fans

- Rely on air pressure to move clean air

- Air exhausted safely away from pedestrian area.

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Cost Comparison

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Cost Comparison

- Based on Cost Information from RS Means

- Cost Savings from Foundation Reduction

Steel System Cost Analysis		
Redesigned System	Cost	Net Difference
Steel Framing	$9,452,439	- $3,400,736
Foundation	$1,028,110	+ $721,356
Ventilation	$52,274	- $52,274
Additional Excavation	$149,804	- $149,804
Parking Spaces	$79,380	- $79,380
Totals	$10,762,007	-$2,960,837

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Cost Comparison

6% Project Cost Increase

23% Structural Increase

Total System Cost	
Steel	Concrete
$10,762,007	$7,801,170

Per Square Foot Cost	
Steel	Concrete
$43.11	$31.25

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Conclusion

- Created a modular bay size with minimal architectural impact
- Designed a steel gravity system with vibration controlling characteristics
- Re-design foundation system
- Provide underground parking

- Determine the feasibility of a steel system
  - Project cost increase

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- Composite Steel System
- Lateral System
- Foundation System
- Ventilation System
- Cost and Schedule Analysis
- **Conclusion**

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Questions and Comments?

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