

800 NORTH GLEBE
ARLINGTON, VA



RYAN JOHNSON - STRUCTURAL OPTION
AE SENIOR THESIS - 2010

- PROJECT INFO

- EXISTING STRUCTURE

- PROJECT GOALS

- STRUCTURAL DEPTH

- ARCHITECTURAL BREADTH

- CONSTRUCTION BREADTH

- COMPARISON AND CONCLUSION

- QUESTIONS AND COMMENTS

OUTLINE

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General Building Data

• Location: Arlington, VA

• Occupancy Type: Mixed-Use Office

• Distinctive Architectural Features

• Building Setbacks At Levels 4,6 And 8

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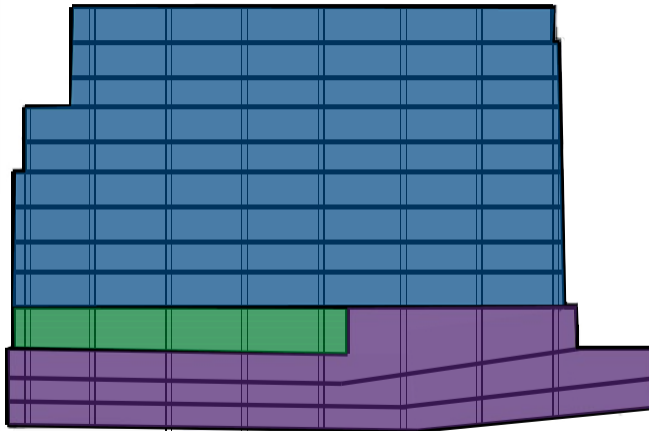
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General Building Data

• **Size: 316,000 SF**

3 Below Grade Parking Levels

• **Completion Date: 2011**
On Ground Level

9 Levels Of Offices

• **Estimated Project Cost: \$62 Million**

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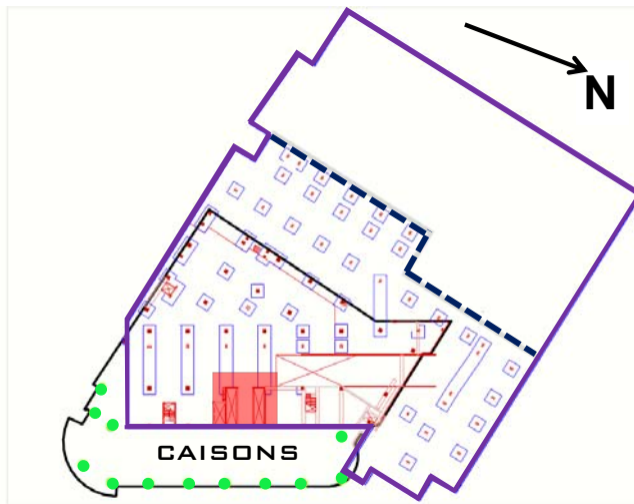
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Existing Structure

- Column Foundations Range In Size From 4'-0" Up To 14'-0"
- Caissons Supporting On-grade Columns
- 6'-0" Thick Mat Foundation Supporting Shearwalls
- 12" Foundation Wall Around Parking Substructure

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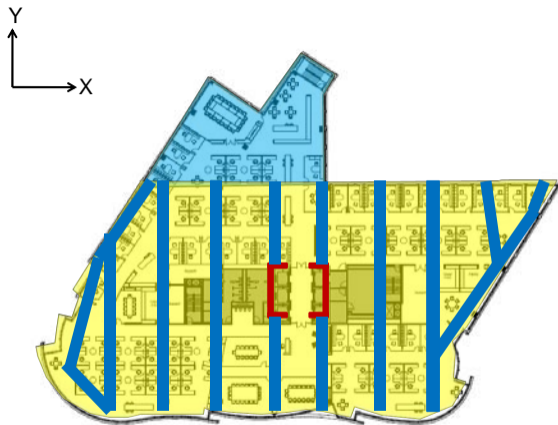
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Existing Structure

- Post-tensioned Girders With 9" Thick One-Way Slab
- 10.5" Two-way Slabs Used For Building Stepouts
- Two 12" Thick "C" Shaped Shear Walls At The Building's Core

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Project Goals

- Uniform Slab Type And Thickness
- Uniform Column Sizes
- Reduce Lateral loads Carried By The Shearwalls
- Determine Affects On Floor Plans
- Compare Sequencing And Cost

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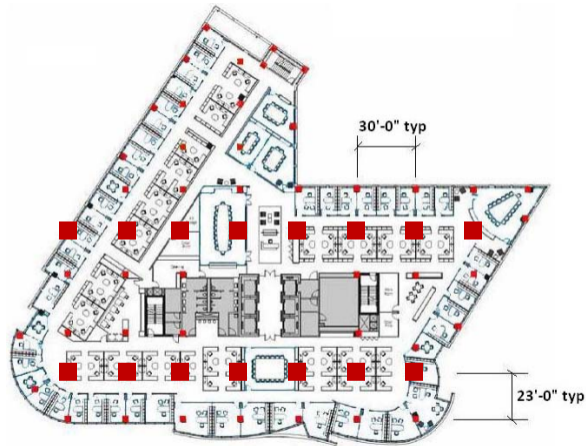
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Structural Depth

Design Process

1. Initial Plan Layout
2. Slab Design
3. Lateral System Design

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	Continuous Spans		Simple Spans	
	Roof	Floor	Roof	Floor
One-way solid slabs	50	45	45	40
Two-way solid slabs (supported on columns only)	45-48	40-45	-	-
Two-way slabs with full depth beams	-	-	-	-
two-way waffle	-	-	-	30
beams (b=3h wide beams)	35	30	30	25
beams (b=h/3 deep beams)	24	22	22	20
one-way joists	42	38	38	35

Slab Design

• Slab Type And Thickness

• Direction Of Banded Tendons $d = 30' \times 12''$
45

• Tendon Stresses Altered To Account For Opening And Nonuniform Slab Edges

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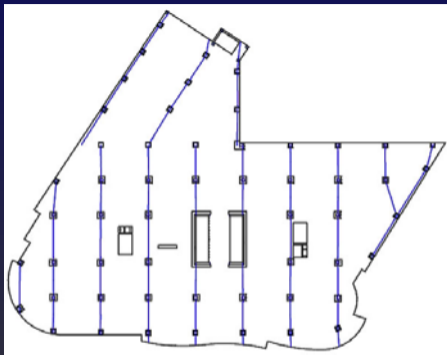
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X - Direction

- Distributed Tendons
- 4 7-wire Strands Per Tendon
- Uniformly Spaced To Allow For 250 psi Minimum Precompression Stress

Y - Direction

- Tendons Banded Along Column Strip
- 25 7-wire Strands Per Tendon Grouping
- 650 Kips Average Tendon Forces

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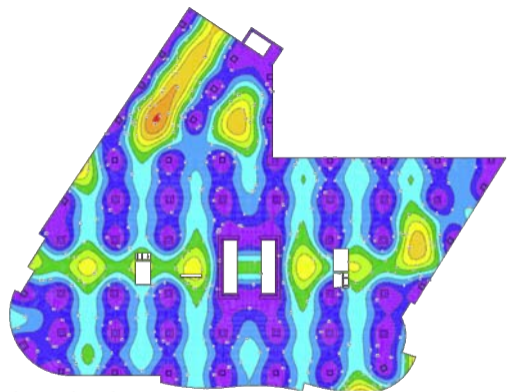
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Vertical Deflection Plot



Min Value = -0.01748 Inches @ (110.4,7.714) Max Value = 0.4564 Inches @ (108,154.3)

Immediate Load Deflection =
Service LC – (Dead +Balanced)

Time Dependent Deflection =
Long Term LC–(Dead + Balanced)

Deflection					
	Code Maximum	Hand Calculation		RAM Concept	
Live Load	0.74"	0.362"	MEETS CODE	0.31"	MEETS CODE
Time Related	1.1"	NA	NA	1.06"	MEETS CODE

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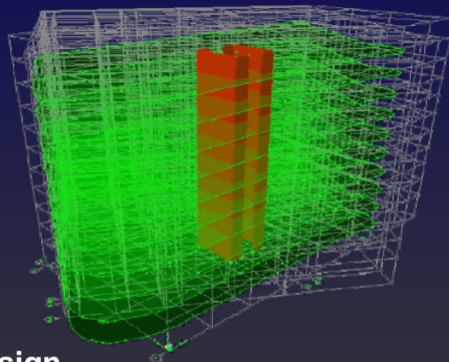
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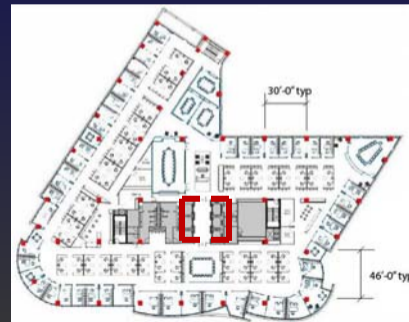
Lateral System Design



Initial Design
• Shear wall core

Initial Design

- Uniform R-value For Both Directions ($R=6$)



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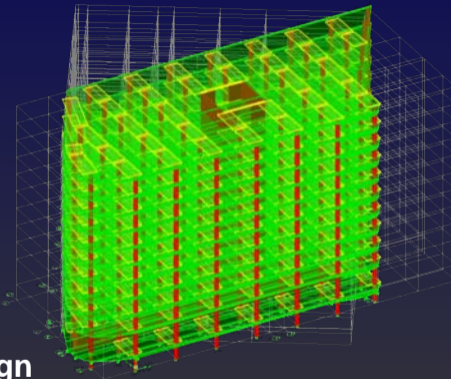
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Lateral System Design



Redesign

- Shear Wall Core
- Concrete Moment Frame Included In Y - Direction

Redesign

- Different R-value Per Direction ($R_x = 5, R_y = 5.5$)
 - Ordinary Reinforced Shearwall & Dual System
- PT Flat Plate Slabs Used In LFRS Not In Code



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Lateral System Design

System Comparison

Loading Condition:

- Wind Load Case 1 Controlled Both Designs

Displacement

- Max X: 53% Reduction
- Max Y: 27% Reduction

Story Drift

- Max X: 45% Reduction
- Max Y: 20% Reduction

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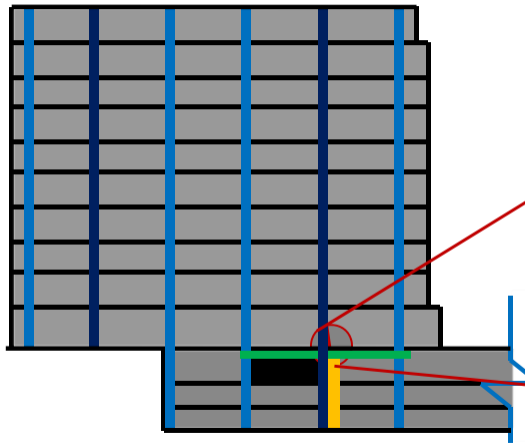
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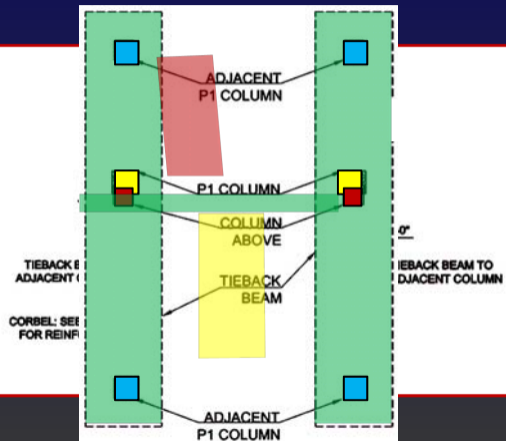
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Column Design



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DEPTH CONCLUSION

- Uniform Slab Type And Thickness
 - Reduced Need for PT Girders
- Lateral System Successfully Altered
 - Building Rotation Reduced
 - Shear Wall Loads Reduced
 - Drift And Displacement Reduced

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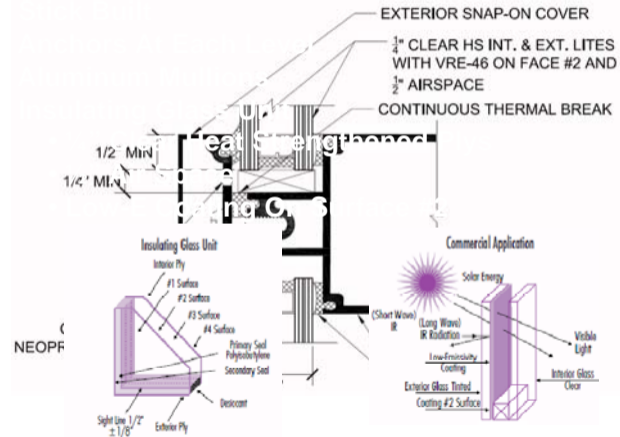
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BUILDING ENVELOPE STUDY



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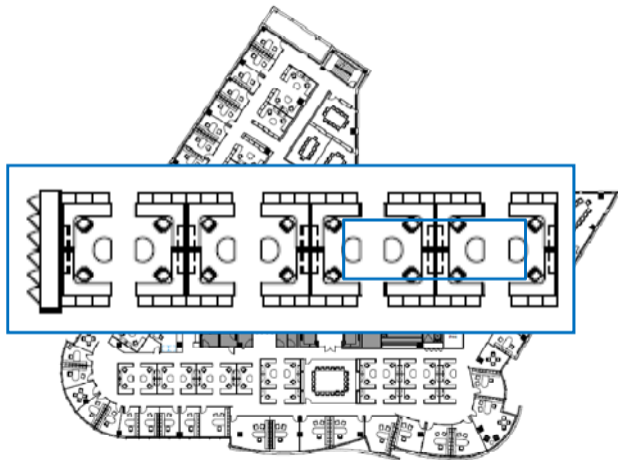
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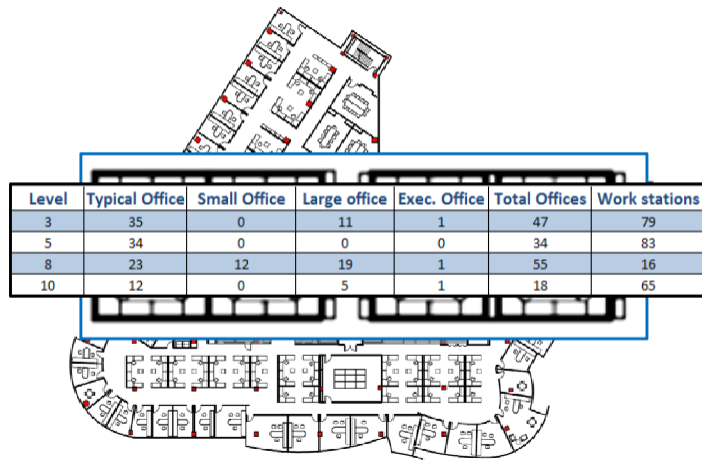
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ORIGINAL FLOOR PLAN



REDESIGNED FLOOR PLAN



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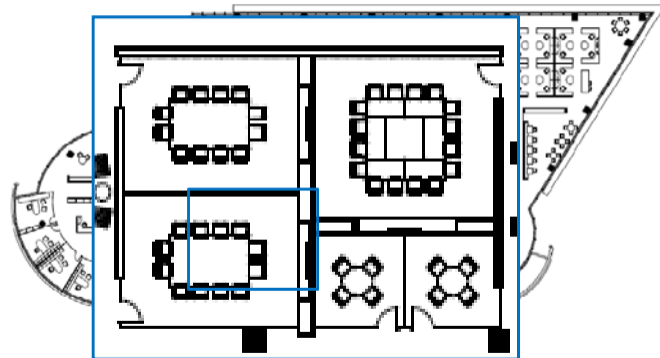
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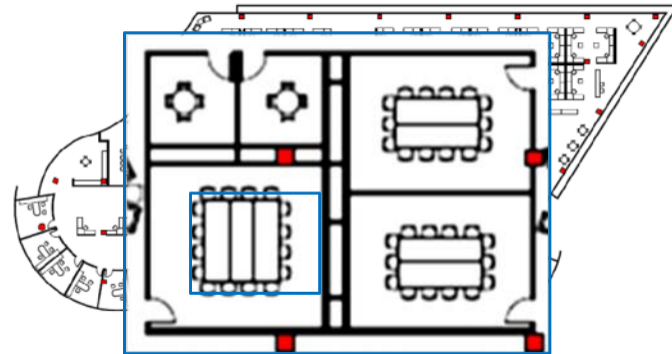
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Current Building



• 43 Days Of Construction

Thesis Building Redesign



• 94 Days Of Construction

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Original Design

	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Total
Concrete	\$ 1,535,010.49	\$ -	\$ -	\$ 1,535,010.49	\$ 1,686,292.28	\$ -	\$ -	\$ 1,686,292.28	\$ 3,221,302.77
Placing	\$ -	\$ 159,626.46	\$ 73,546.10	\$ 233,172.56	\$ -	\$ 246,264.96	\$ 81,030.00	\$ 327,295.22	\$ 560,467.78
Finishing	\$ -	\$ 106,267.00	\$ -	\$ 106,267.00	\$ -	\$ 154,846.20	\$ -	\$ 154,846.20	\$ 261,113.20
Forms	\$ 611,789.60	\$ 1,508,804.20	\$ -	\$ 2,120,593.80	\$ 674,879.10	\$ 2,338,092.70	\$ -	\$ 3,012,971.80	\$ 5,133,565.60
Reinforcement	\$ 351,817.06	\$ 1,185.56	\$ -	\$ 353,002.62	\$ 386,391.24	\$ 1,937.46	\$ -	\$ 388,328.70	\$ 741,331.32
Post-tensioning	\$ 82,260.36	\$ 87,483.24	\$ 2,611.44	\$ 172,355.04	\$ 90,094.68	\$ 142,323.48	\$ 2,611.44	\$ 235,029.60	\$ 407,384.64
	\$ 2,580,877.51	\$ 1,863,366.46	\$ 76,157.54	\$ 4,520,401.51	\$ 2,837,657.30	\$ 2,883,464.80	\$ 83,641.70	\$ 5,804,763.80	\$ 10,325,165.31

	Existing Structural System	Thesis Structural System	Difference
Cost	\$10.3 Million	\$11.0 Million	6.6% Increase
Time	43 Day	94 Days	51 Day Increase

Thesis Building Redesign

	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Total
Concrete	\$ 2,057,650.71	\$ -	\$ -	\$ 2,057,650.71	\$ 2,265,231.69	\$ -	\$ -	\$ 2,265,231.69	\$ 4,322,882.40
Placing	\$ -	\$ 140,595.26	\$ 64,728.48	\$ 205,323.74	\$ -	\$ 216,727.77	\$ 71,320.00	\$ 288,048.55	\$ 493,372.29
Finishing	\$ -	\$ 106,267.00	\$ -	\$ 106,267.00	\$ -	\$ 154,846.20	\$ -	\$ 154,846.20	\$ 261,113.20
Forms	\$ 528,996.27	\$ 1,299,878.79	\$ -	\$ 1,828,875.06	\$ 583,930.53	\$ 2,012,747.52	\$ -	\$ 2,596,678.05	\$ 4,425,553.11
Reinforcement	\$ 221,492.70	\$ 1,185.56	\$ -	\$ 222,678.26	\$ 243,260.44	\$ 1,937.46	\$ -	\$ 245,197.90	\$ 467,876.16
Post-tensioning	\$ 209,664.00	\$ 222,976.00	\$ 6,656.00	\$ 439,296.00	\$ 229,632.00	\$ 362,752.00	\$ 6,656.00	\$ 599,040.00	\$ 1,038,336.00
	\$ 3,017,803.68	\$ 1,770,902.61	\$ 71,384.48	\$ 4,860,090.77	\$ 3,322,054.66	\$ 2,749,010.95	\$ 77,976.78	\$ 6,149,042.39	\$ 11,009,133.16



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Conclusion:

- Uniform Slab Type & Thickness and Column Sizes
 - Reduced Floor Weight And Material Use
- Lateral System Modified To Include Moment Frame
 - Shearwall Loads Reduced
- Floor Plans Were Not Overly Modified
- Sequencing and Cost Increase

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QUESTIONS



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