Nathan Eck

Structural

Dr. Memari

Falls Church Tower

Falls Church, VA

Presentation Overview

About Falls Church Tower

Project Team

Owner: Sunburst Hospitality
Equity Residential
Structural Engineer: SK&A Group
Architect: WDG Architecture
General Contractor: Donohoe Construction Company

Building Information

Location: Falls Church, VA
Size: 536,000 SF
Occupancy Type: Residential
Total Cost: $92,000,000

About Falls Church Tower

Architecture

11 Stories + Penthouse
3 ½ Levels of Undeground Parking
Brick façade with concrete and glazing elements
private pool across from the plaza

Thesis Objectives

Project Goals

- Improve Lateral Framing System
- Decrease the weight of the building
- Reduce the cost and schedule of the framing system
- Minimize the impact on the architecture

Structural Depth

- Originally an ordinary concrete moment frame with post tensioned slab
- Irregular column layout

Proposal

- In corporation of a shear wall system
- Reduction in column sizes throughout building

Thesis Objectives

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Architectural Breadth

- Redesign column layout
- Modification of floor plan and façade elements

Cost and Scheduling Breadth

- Compare validity of existing and alternative structural systems

Depth Study

Existing Gravity System

- 7” thick post-tensioned slab
- 2-3 strand tendons
- Tendons spaced 5’ on center
- Irregular array of columns
- Range of sizes
- Typical 25’x25’ bays

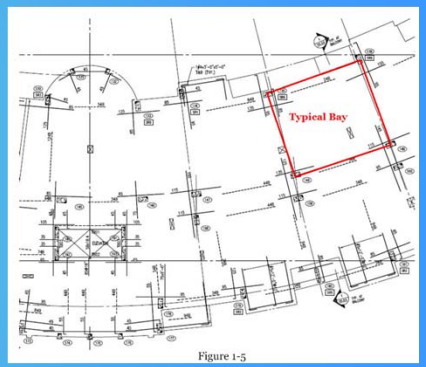


Figure 1-5

Depth Study

Existing Lateral System

- Columns uniquely oriented to reduce lateral displacement in both directions
- Range in column sizes meant to resist lateral loads as much as gravity loads

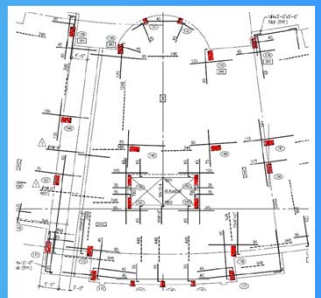
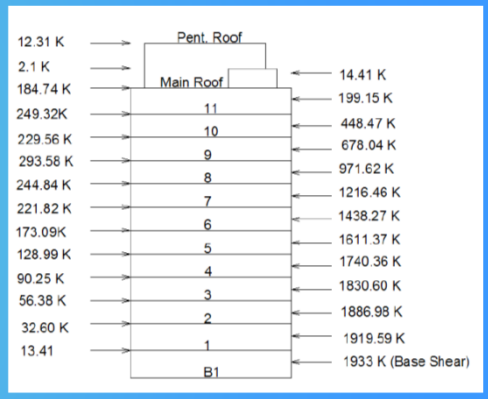


Figure 1-6 : Column Layout

Depth Study

Existing Frame Analysis

- Wind Shear = 957 K
- Seismic Shear = 1933 K
- Seismic Conctrols



Depth Study

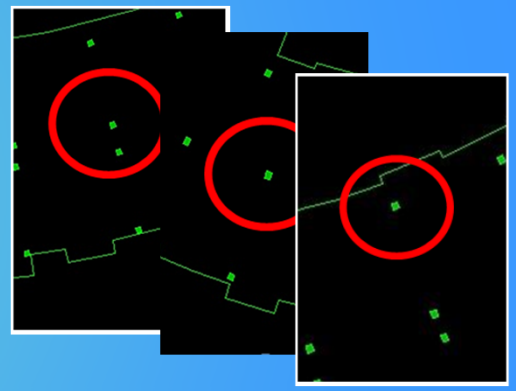
ETABS Model

- Originally modeled in AutoCAD
- Transferred to ETABS
- Diaphragms were assumed to be rigid
- All seismic forces were applied at center of mass
- All column were fixed at both ends

Depth Study

Column Design

- Sized columns based on the new layout
- Tributary areas determined in AutoCAD
- 3 typical column types
  - Interior Column
  - "Large Area" Interior Column
  - Exterior

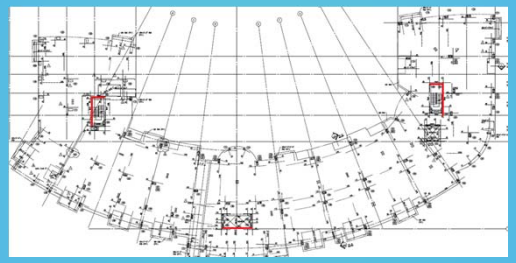


Depth Study

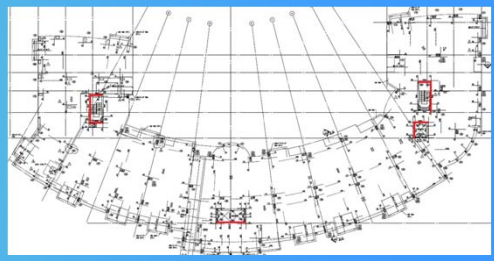
Shear Wall Design Criteria

- Locate walls around elevator shafts and stairwells
- Multiple layouts

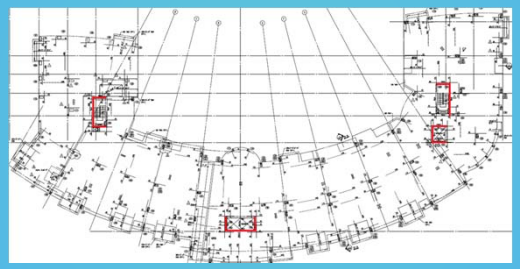
Depth Study



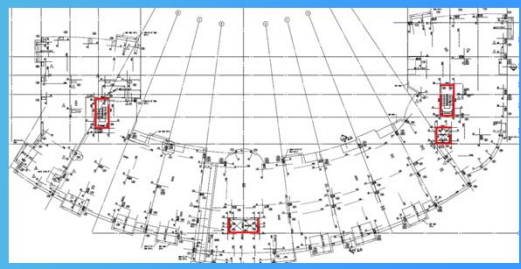
Shear Wall Layouts



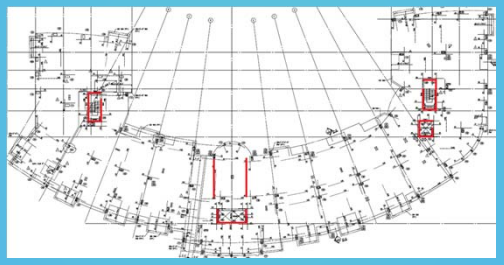
Depth Study



Shear Wall Layouts



Depth Study



Layout 5

- **Capable of reducing drift to values less than the existing frame**

Depth Study

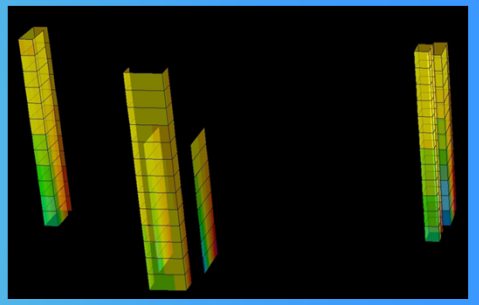
Seismic Story Drift of Existing Structure				
Floor	Y (in)	X (in)	Total Y	Total X
Pent. Roof	0.065	0.014	0.065	0.014
Mech. Roof	0.093	0.014	0.158	0.028
Main Roof	0.098	0.017	0.256	0.045
11	0.099	0.019	0.356	0.064
10	0.098	0.019	0.454	0.083
9	0.096	0.019	0.550	0.102
8	0.092	0.018	0.642	0.120
7	0.086	0.017	0.729	0.137
6	0.078	0.015	0.806	0.153
5	0.066	0.013	0.872	0.166
4	0.052	0.011	0.924	0.177
3	0.036	0.008	0.960	0.184
2	0.013	0.003	**0.973**	**0.187**

Seismic Story Drift of Revised Structure				
Floor	Y (in)	X (in)	Total Y	Total X
Pent. Roof	0.052	0.088	0.052	0.013
Mech. Roof	0.057	0.052	0.108	0.025
Main Roof	0.059	0.094	0.167	0.037
11	0.060	0.099	0.228	0.047
10	0.060	0.099	0.288	0.055
9	0.059	0.097	0.346	0.061
8	0.057	0.095	0.403	0.065
7	0.053	0.089	0.457	0.068
6	0.048	0.081	0.505	0.072
5	0.041	0.070	0.546	0.075
4	0.033	0.055	0.579	0.078
3	0.022	0.037	0.601	0.081
2	0.009	0.015	**0.610**	**0.082**

Depth Study

Shear Wall Design

- Layout 5 was modeled in ETABS
- New seismic load was determined
- Analysis was run to determine the stresses in the shear wall
- Strength checks were performed and the wall strength verified



Architectural Breadth

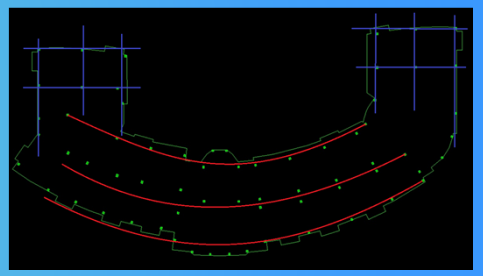
Goals

- Revise the existing column layout to a definable grid
- Reduce the impact in the floor plan and facade

Architectural Breadth

Column Layout

- Adheres to two different grids
  - Radial
  - Rectangular
- Reduces the number of columns per floor



Architectural Breadth

Column Layout

- Only minor changes in floor plan
  - Slight partition shifts
  - Balcony shift

Architectural Breadth

Column Layout

- Effect on Facade
  - Glazed façade on south face of the building
  - Originally had 5 columns across face
  - Reduced to 4 columns

Architectural Breadth

Column Layout

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Cost and Scheduling

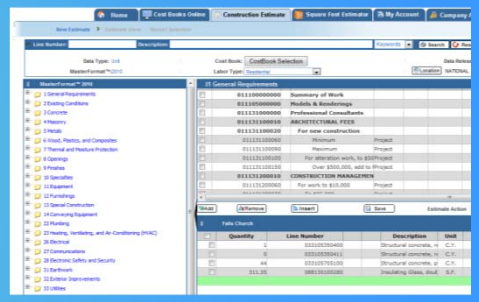
Goals

- Develop estimates for both the existing structure and the revised structure
- Develop scheduling estimates for both the existing structure and the revised structure
- Compare the cost and schedule estimates and verify the feasibility of the revised structure

Cost and Scheduling

Cost and Scheduling Process

- Determine necessary criteria
  - Materials, formwork, steel, etc.
- Find unit prices/hours using RS Means Costworks



Cost and Scheduling

Element	Existing Structure	Redesigned Structure
Columns	$1,071,333.38	$535,663.77
Slabs	$2,334,217.66	$2,334,574.61
Shear Walls	-	$386,345.68
Total Time	**$3,405,551.04**	**$3,256,584.05**
Difference	**-$148,966.99**	

	Time Required (Days)	
Element	Existing Structure	Redesigned Structure
Column Formwork	515	243
Column Concrete	15	11
Slab Formwork	617	617
Total Time	**1,147**	**871**
Difference	**-276**	

Conclusion

Structural
- Reduce Size
- Incorporate shear walls and reduce lateral drift

Architecture
- Reduce the number of columns and assign to grid with minimal impact on the floor plan

Cost and Scheduling
- Use cost estimates to verify the feasibility of the shear wall system

Acknowledgements

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Questions?