

# Lexington II


at Market Square North, Washington D.C.



Alexis Pacella – Structural Option

## Presentation Outline

- 📄 Building Summary
- 📄 Existing Structure
- 📄 Proposal
- 📄 Gravity System
- 📄 Lateral System
- 📄 Other Structural Factors
- 📄 Construction Management
- 📄 Mechanical
- 📄 Conclusion



## Building Summary



12 Story Residential Tower  
Market Square North Complex  
3 below grade levels  
72,000 sq ft  
49 Apartment Units  
Completed in 2002




## Building Summary







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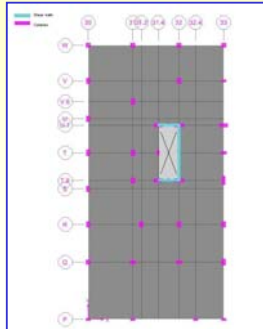
## Existing Structure



**Gravity System:**  
2 Way Flat Plate Slab  
8 inches  
Irregular Column Layout  
Small Bays


**Lateral System:**  
Shear Walls

**Foundation:**  
MAT




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## Proposal




Current design restricted by height limit: 130 feet  
(current height = 125 ft w/ penthouse)

Only structures with a thin floor sandwich, such as flat plate and pre-stressed were considered

When height restriction is not a factor,  
**Can A More Economic System be Found???**

## Proposal




How will a steel structural system effect...


- 📄 Other building systems
- 📄 Time
- 📄 **COST**

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## Gravity System




**Composite:**  
Steel composite deck on steel beams and columns

- 📄 Relatively shallow floor sandwich
- 📄 No large change in stiffness and vibration
- 📄 Steel is usually most cost effective

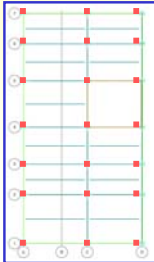
Additional cost and labor for fireproofing and connections

## Gravity System




New column layout required for steel system to be economical

- 📄 **Does not interfere w/architecture**
- 📄 **Windows moved**
- 📄 **One closet obstructed**



### Gravity System




**Composite Decking:**

- Span is too long, bisect each bay with a beam
- Unshored saves on labor and material
- Unshored will use extra concrete

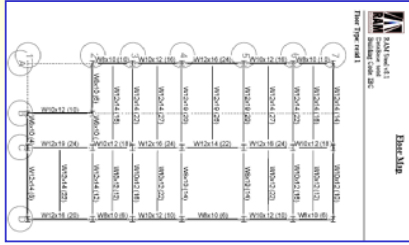
**Residential Levels: 2" LOK floor deck with 4.5" slab**  
**Public Levels: 3" LOK deck with 5.5" slab**

Decking chosen from USD catalog.

### Gravity System



Beams, columns, and shear studs were designed for gravity loads using RAM software.



RAM criteria set to LRFD 3<sup>rd</sup> Edition

### Gravity System




**Final Design:**

- 4.5" deck + slab
- 12" beam
- = **16.5" Total floor sandwich depth**

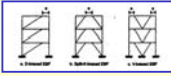
Increase of 8.5" per floor → 8.5' total  
 New Height = 133.5' > Allowable 130'

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### Lateral System

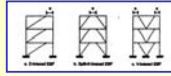


3 possible Lateral Systems:

- Shear Walls
- Moment Frames
- Braced Frames

Local building code allows for soft  
 Architect only allows for building

### Lateral System

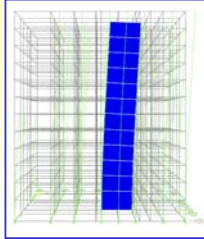


**Shear Walls:**

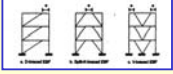
- Check Existing Walls
- ETABS

**Results:**

- Surround Elevator Shaft
- Steel → Lighter Weight → Less Seismic Load
- 8.5' height increase → Slightly Greater Wind Load



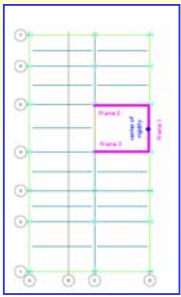
### Lateral System



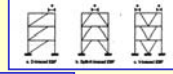
**Braced Frames:**

- Find location in building
- Distribute Loads by Rigidity
- Check ASCE 7 wind cases
- Design, check on STAAD

Design was controlled by allowable stress

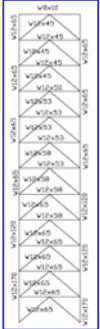


### Lateral System

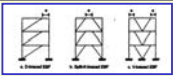


**STAAD Design:**

- Chevron Braces
- Member Stresses Controlled
- Size Range: W12x65 – W12X170
- Total Deflection < 3.6" allowable



### Lateral System



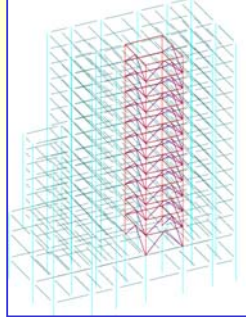
**Final Design:**

Some columns controlled by biaxial bending → increased size

$$\frac{Pu}{2\phi Pn} + \left( \frac{Mux}{\phi Mn_x} + \frac{Muy}{\phi Mn_y} \right) \leq 1$$


Sizes: W12x65 – W14x342

Final Deflection = 2.7" < 3.6" allowable




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### Other Structural Factors



Are there other issues with the structure to be considered?

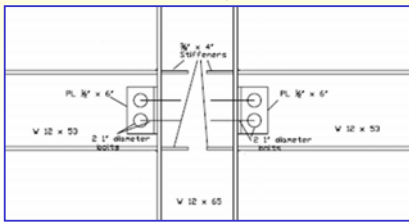
- Connections
- Substructure
- Foundation

### Other Structural Factors



**Beam to Column Connections:**

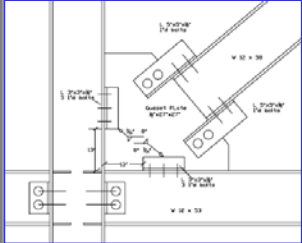
Stiffeners Required



Typical 7<sup>th</sup> floor connection

### Other Structural Factors

**Heavy Bracing Connection:**  
Uniform Force Method



Same beam to column connection  
27"x27"x1/2" gusset plate  
3"x3"x1/2" angles

Typical 7<sup>th</sup> floor connection

### Other Structural Factors

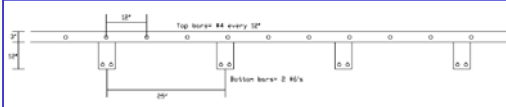
The Substructure:

- Concrete is better in subterranean conditions
- Additional building weight
- Concrete is a more durable parking structure

### Other Structural Factors

Substructure:

One way joist floor ~easy to construct  
~works with new bay sizes

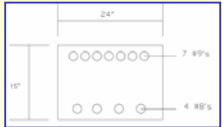


20" pans; 5" ribs; 25" o.c.

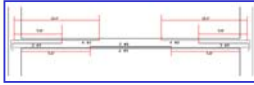
### Other Structural Factors

Substructure:


Girders: 24"x15"  
top steel = 7 #9's  
bottom steel = 4 #8's



Girder Section



Reinforcement Cutoffs

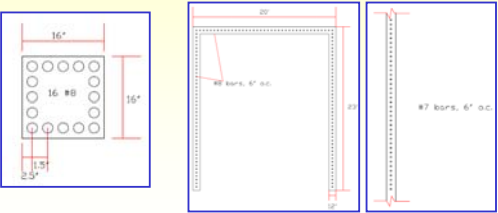


Stirrup Placement

### Other Structural Factors

Substructure:

Columns: Below the Braced Frames:

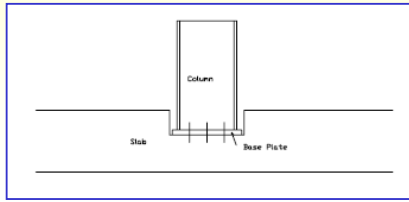


Shear walls were used, shear controlled

### Other Structural Factors

Substructure:


Connections - a base plate sunk into floor slab at each column



### Other Structural Factors

**Foundation:**  
 Existing MAT foundation  
 Punching shear  
 Overturning


**No Problems**



Forces affecting overturning

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### Construction Management

Construction Management Issues:

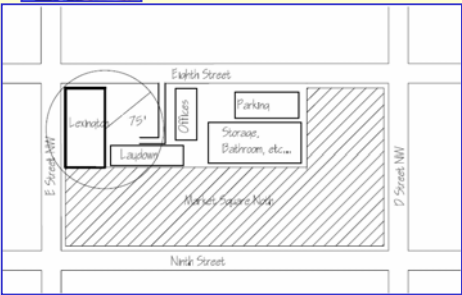
- 📄 Site Layout
- 📄 Cost
- 📄 Scheduling

### Construction Management

Site Layout:  
 Needed spaces: offices, circulation paths, storage, etc...

Steel Design ~ Crane  
 ~ Lay Down Area

### Construction Management



### Construction Management


Cost:

Concrete .....	\$1,526,000
Steel .....	\$1,455,600

**Saves \$70,000**

Building Scale is not large enough to develop full economy associated with a steel structure  
 This does not however account for cost due to extra facade material for steel structure

### Construction Management




Scheduling:  
 Each level is built in the sequence:  
 1 day for columns and beams  
 2 days for deck  
 Next level is started  
 Slabs poured when beam, column, and deck construction is 3 stories ahead.

Total: 18 weeks

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### Mechanical




Mechanical Considerations:

- 📄 HVAC
- 📄 Acoustics


### Mechanical



HVAC:  
 Fresh air requirements are met by windows


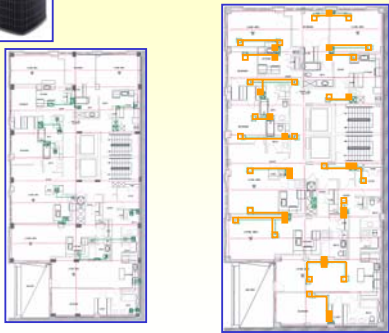


### Mechanical



HVAC:  
 MEP Systems can be moved from soffits into ceiling sandwich.  
 Beams should not be intersected.

### Mechanical

Exhaust                      Supply




## Mechanical

Acoustics:

Original System: Concrete ceilings with sprayed acoustical sealant  
NRF = .75

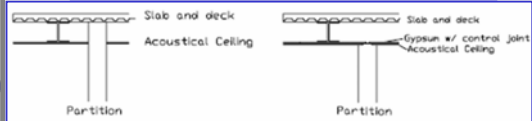
Steel System: Suspended ceiling with acoustical tiles  
NRF = .5 to .95



## Mechanical



Acoustics:

Acoustic Tiles on suspended ceiling  
Assembly Issues



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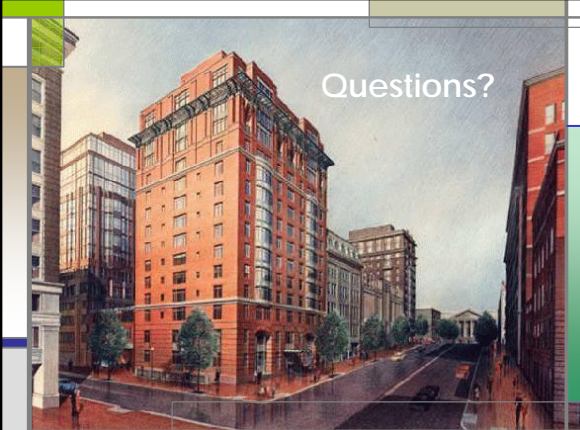
## Conclusions

Structural design was controlled by height restriction

Composite:

- Larger Bays
- Works well with other integrated systems

Full Economy of Steel Savings was not achieved



## Questions?