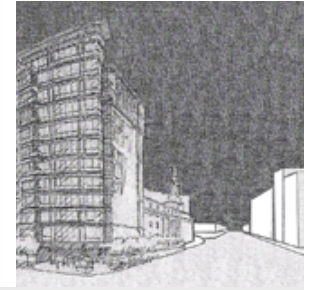


The Executive Tower  
NW Washington DC



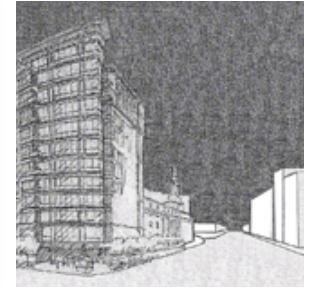
SEAN T HOWARD  
STRUCTURAL EMPHASIS  
ADVISOR: DR. LINDA HANAGAN

æ CLASS OF 2006



(ROOF OF THE FEDERAL BUILDING, CHICAGO 2004)

# The Executive Tower NW Washington DC



## PRESENTATION OUTLINE

Building Information

Existing Building

Problem Statement/Solution

Mechanical Breadth

Architectural Breadth

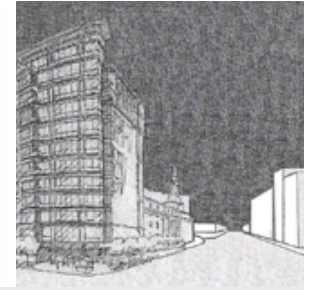
Post Tension Depth Study

Conclusions

Questions



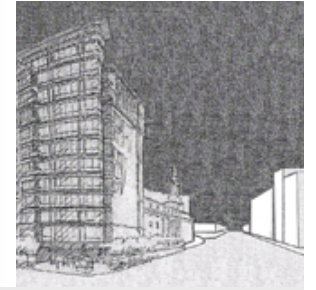
The Executive Tower  
NW Washington DC



## BUILDING INFORMATION

# The Executive Tower

## NW Washington DC

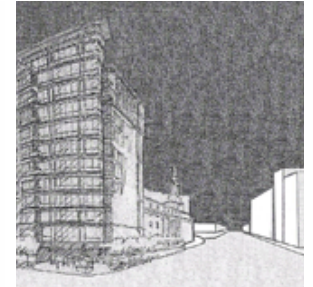


### PROJECT TEAM

|                 |                          |
|-----------------|--------------------------|
| Owner           | 1399 New York Ave Asso.  |
| Managing Group  | Kaempfer Company         |
| Architects      | HOK                      |
| Structural Eng. | Tadger, Cohen, & Edelson |
| MEP Eng.        | GHT, LTD.                |



# The Executive Tower NW Washington DC



-2 blocks from  
white house

-Class A office  
building

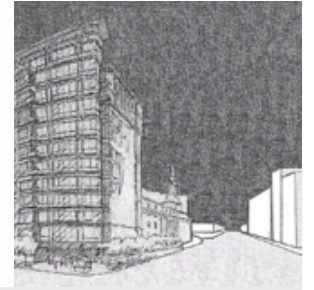
-One of highest  
rents in DC; office,  
**\$47** per sf-month  
& retail **\$38** per  
sf-month

-132,000 sqft

-11 story

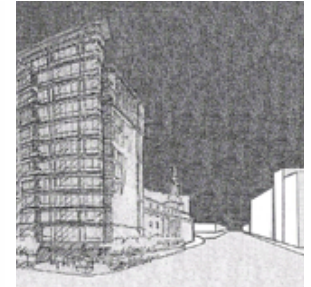


The Executive Tower  
NW Washington DC



EXISTING BUILDING

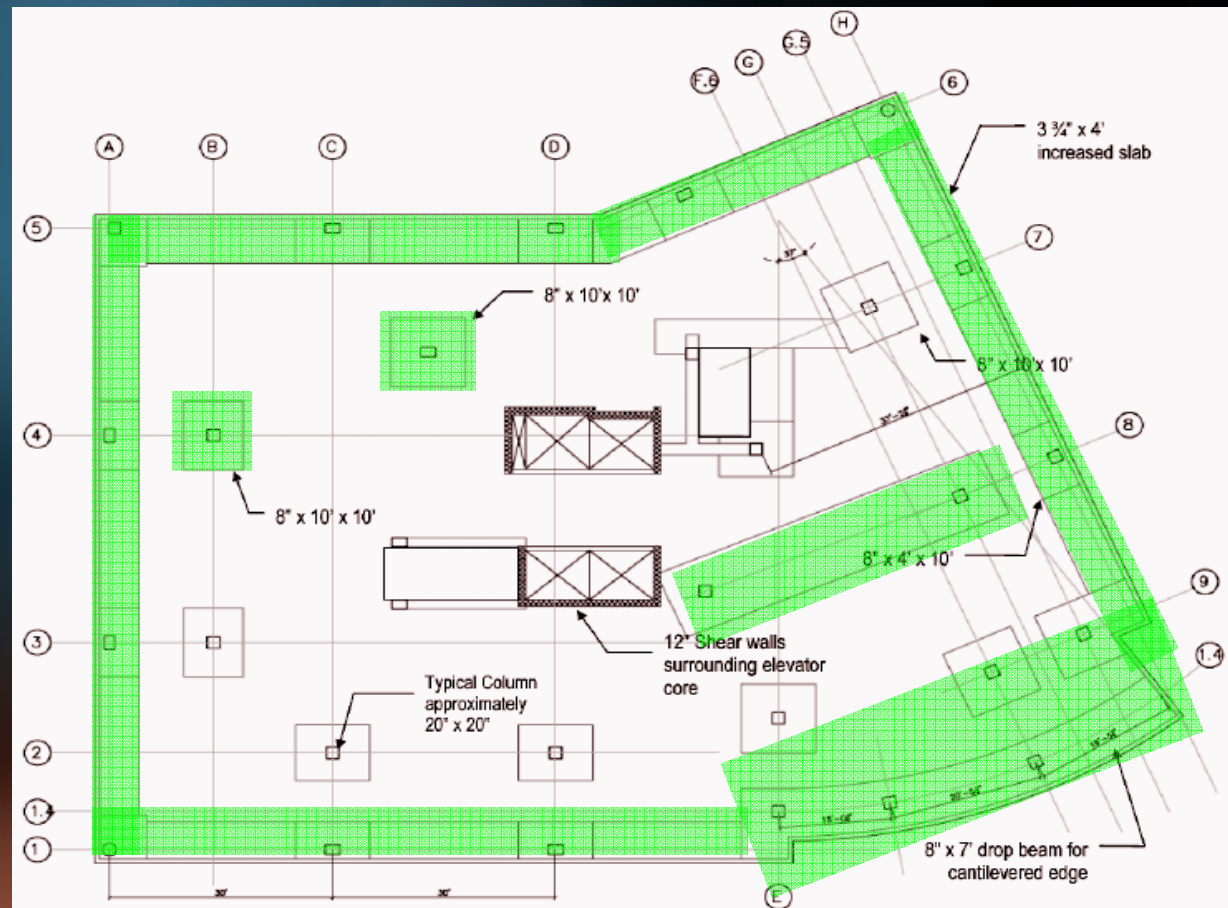
# The Executive Tower NW Washington DC



-8" flat slab with 8" drop panels

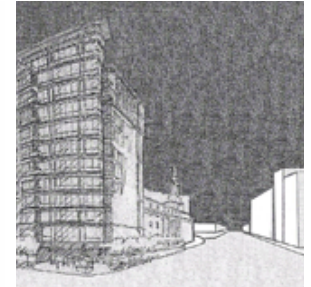
-3  $\frac{3}{4}$ " perimeter beams

-8" drops at column line 8 and at the curved section with a 19' cantilever





# The Executive Tower NW Washington DC



-Concrete flat slab w/ drops,  $F'_c=4000\text{psi}$

-Shear walls extend full height of building

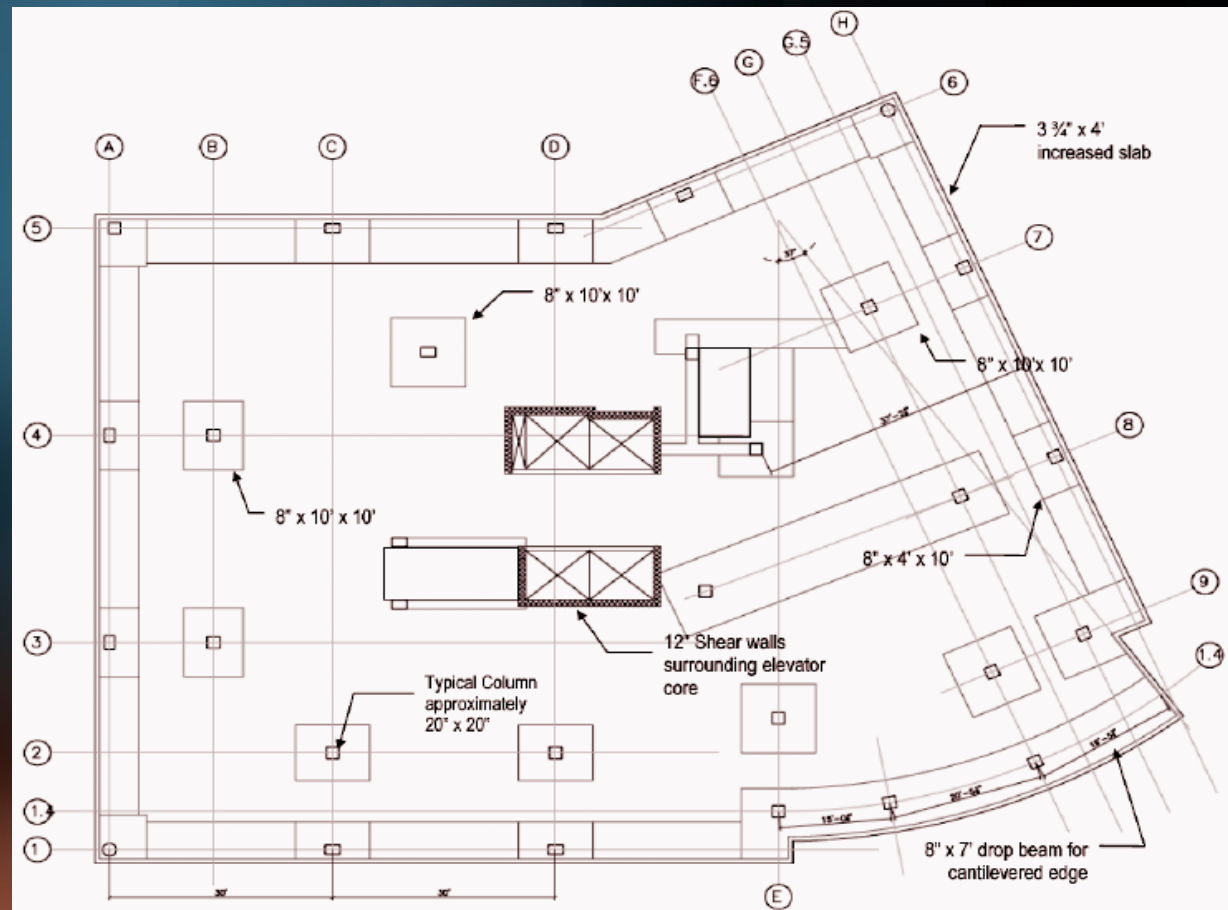
- $F'_c$  for Columns and shear walls:

Levels

1-4 8000 psi

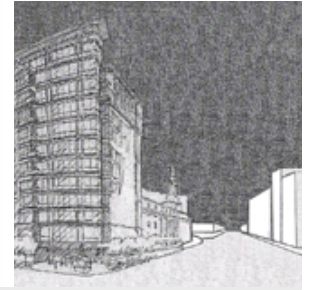
5-7 6000 psi

8-11 4000 psi



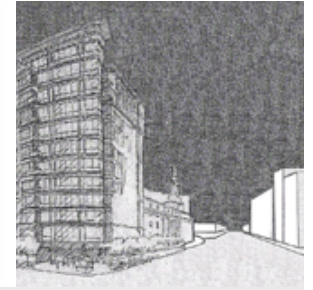


The Executive Tower  
NW Washington DC



# PROBLEM STATEMENT AND SOLUTION

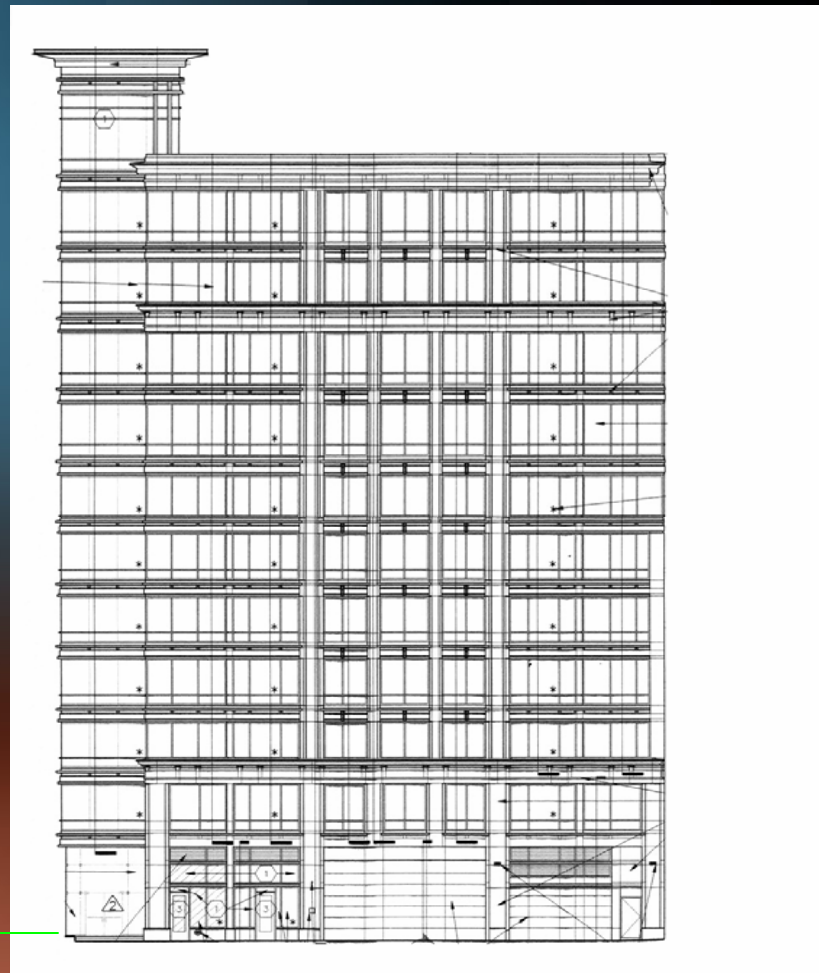
# The Executive Tower NW Washington DC



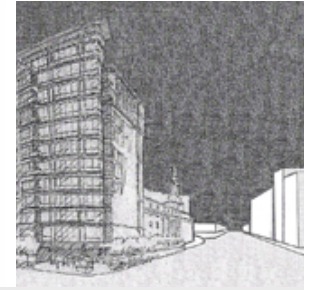
## DC HEIGHT RESTRICTIONS

- Based on width of adjacent road
- New York Ave  $\approx$  100'
- Height is width of road plus 30'
- Max. height = 130'
- Building under restriction by 1' - 4"

128' - 8"



# The Executive Tower NW Washington DC

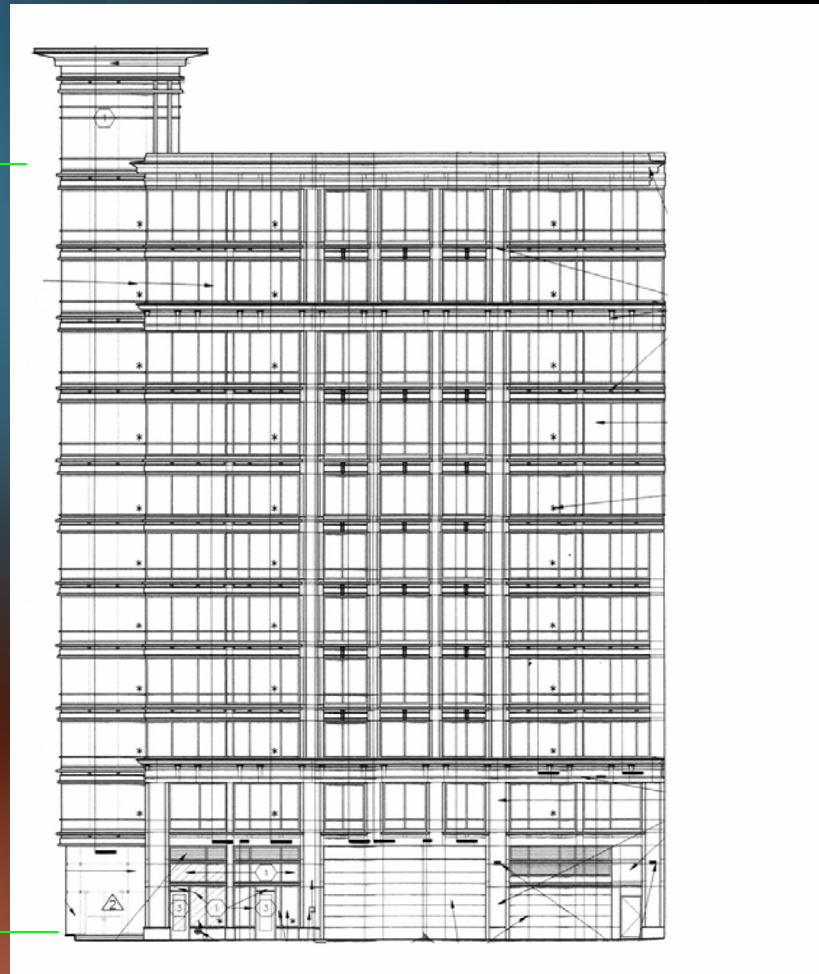


## PROBLEM

Owners request the maximum number of floors obtainable

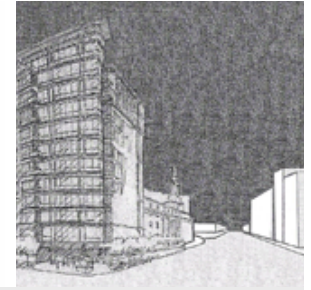
Rent for building:  
Office \$47/sqft  
Retail \$38/sqft

128' - 8"





# The Executive Tower NW Washington DC



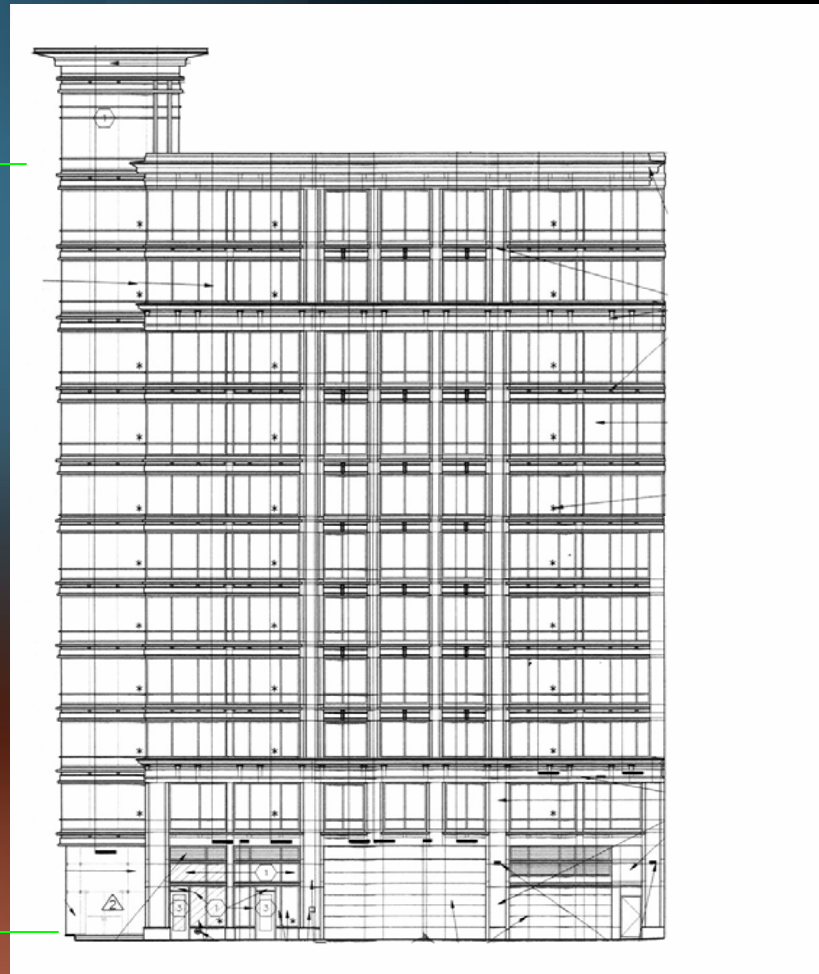
## PROPOSAL

Add a 12<sup>th</sup> floor  
typical to levels 3-9

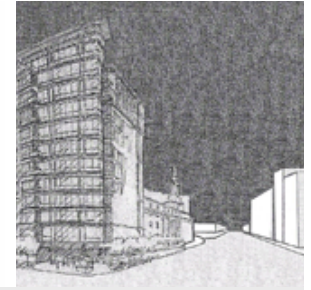
## ADVANTAGE

Added rentable floor  
area to building  
equivalent to  
11750sqft

128' - 8"



# The Executive Tower NW Washington DC



## PROPOSAL

Add a 12<sup>th</sup> floor  
typical to levels 3-9

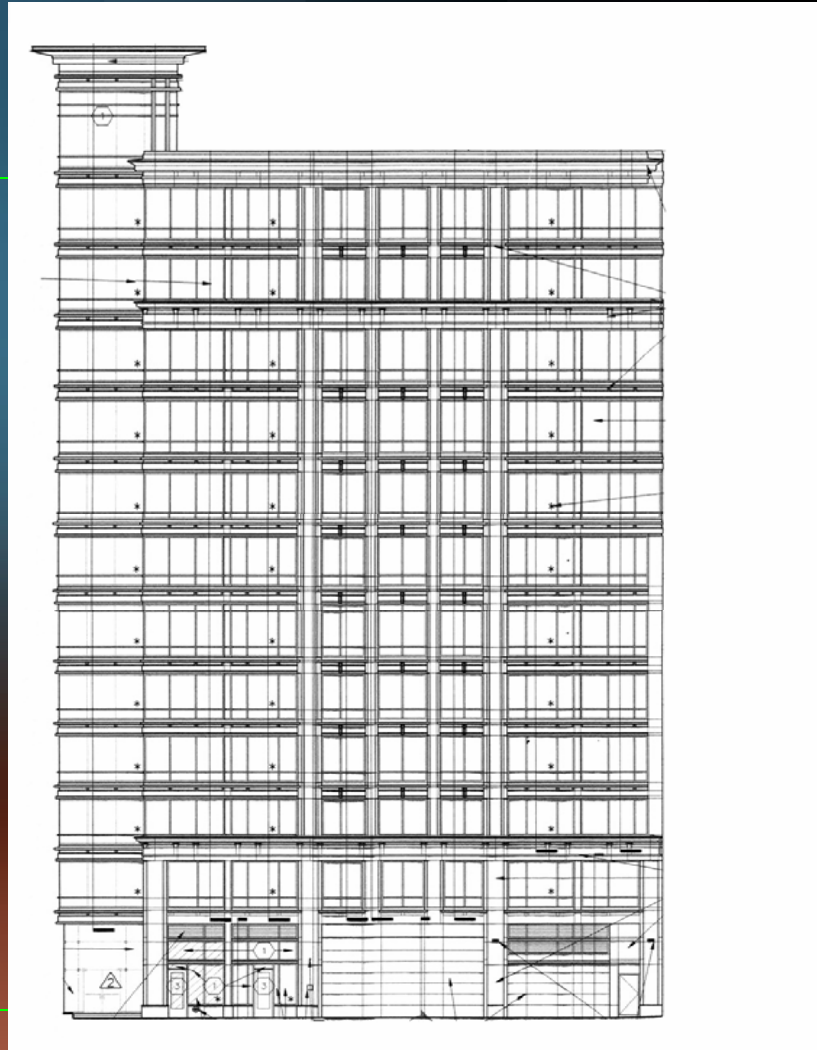
## ADVANTAGE

Added rentable floor  
area to building  
equivalent to  
11750sqft

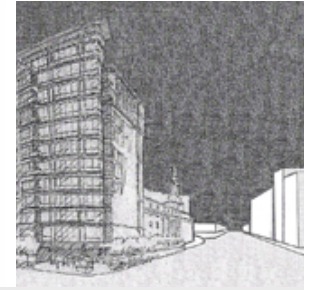
## REQUIREMENTS

A reduction of at  
least 11' - 0"

Under 130'



# The Executive Tower NW Washington DC



## SOLUTION

### Mechanical Breadth

Rerouting of MEP ducts per floor

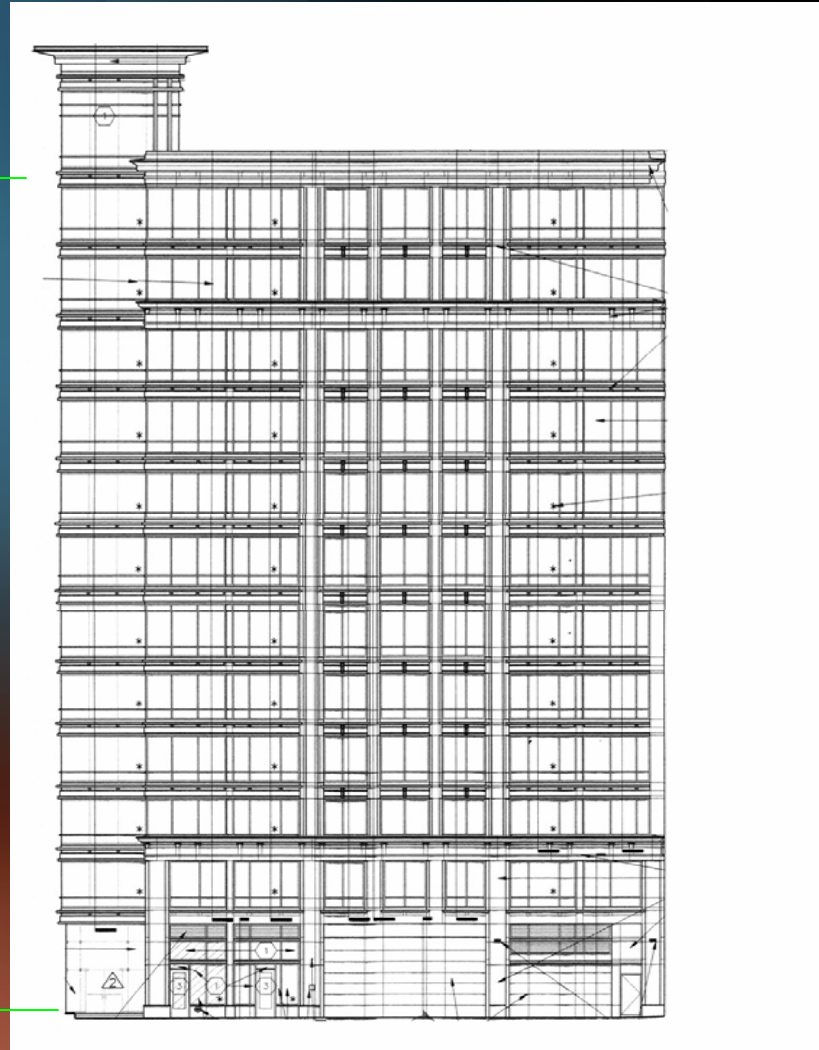
### Architectural Breadth

Design of new entrance into Retail 2

### Structural Depth

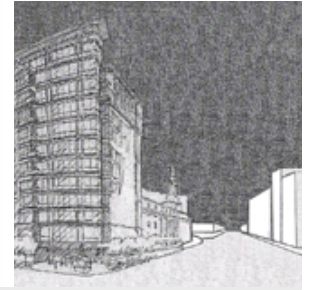
Conversion of flat slab to a post tension system

Under 130'



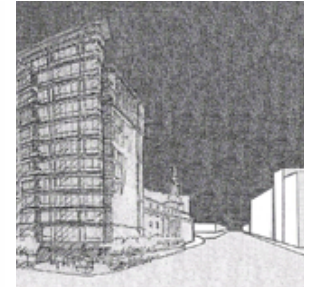


The Executive Tower  
NW Washington DC



# MECHANICAL BREADTH

# The Executive Tower NW Washington DC



## DESIGN GOALS

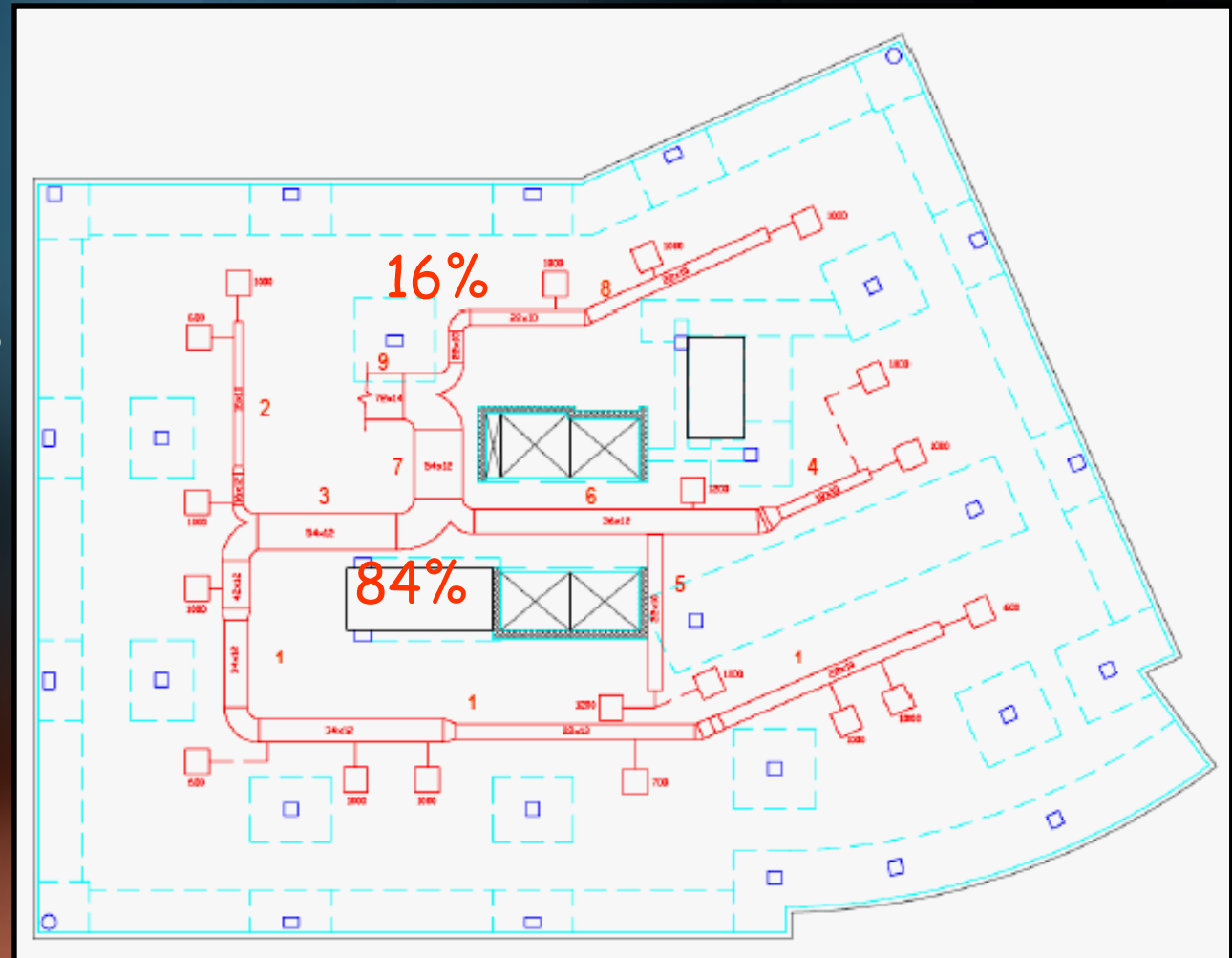
-Reduce ceiling  
depth by 4"

## DESIGN PARAMETERS

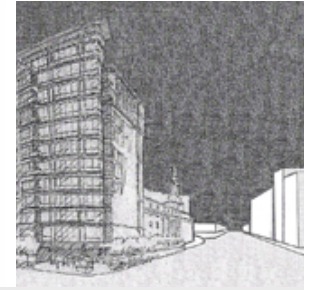
-Not exceed 4:1  
duct ratio

## EXISTING LAYOUT

-Current depths  
for ducts are 12"

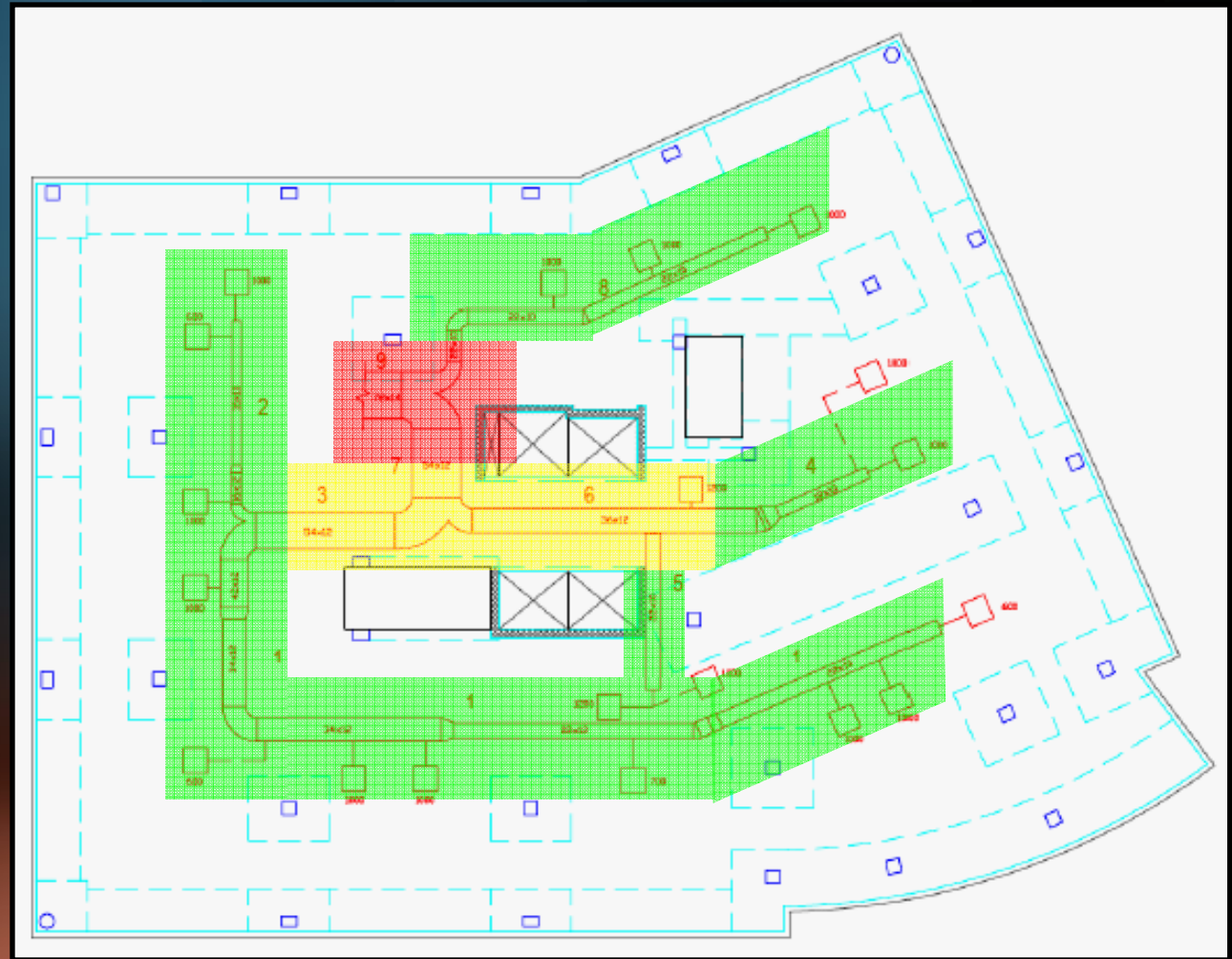


# The Executive Tower NW Washington DC



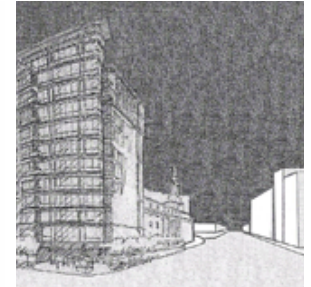
## AREAS DIVIDED BY AIR VELOCITY Controls

- 3100 cfm
- 2700 cfm
- 2300 cfm





# The Executive Tower NW Washington DC

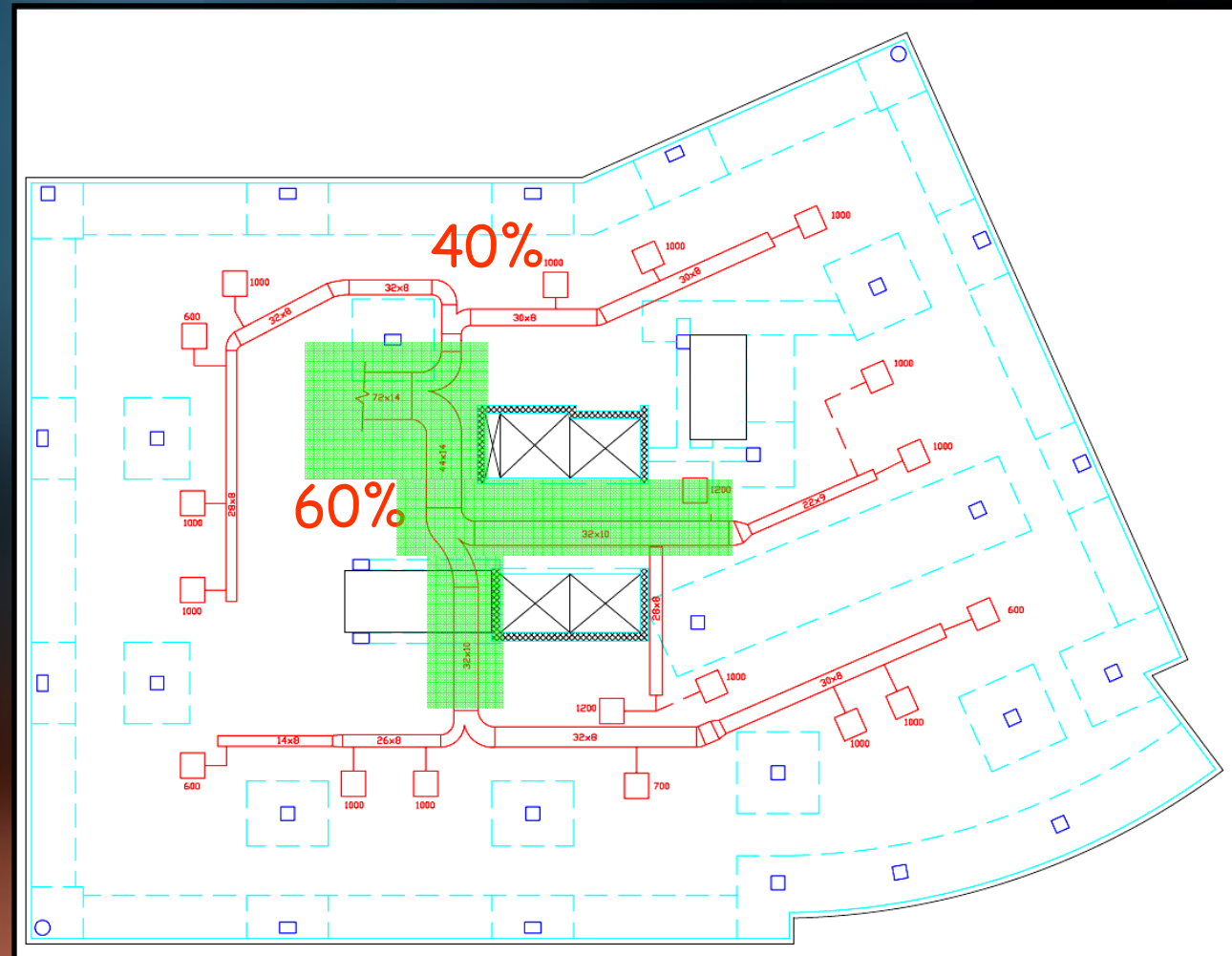


## BULKHEAD DESIGN

-4" bulkhead  
designed for  
restroom

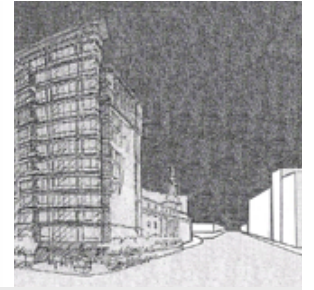
-2" bulkhead  
designed for  
corridor

Allowed  
redistribution of  
air



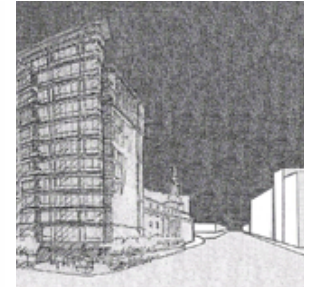


The Executive Tower  
NW Washington DC



ARCHITECTURAL BREADTH

# The Executive Tower NW Washington DC

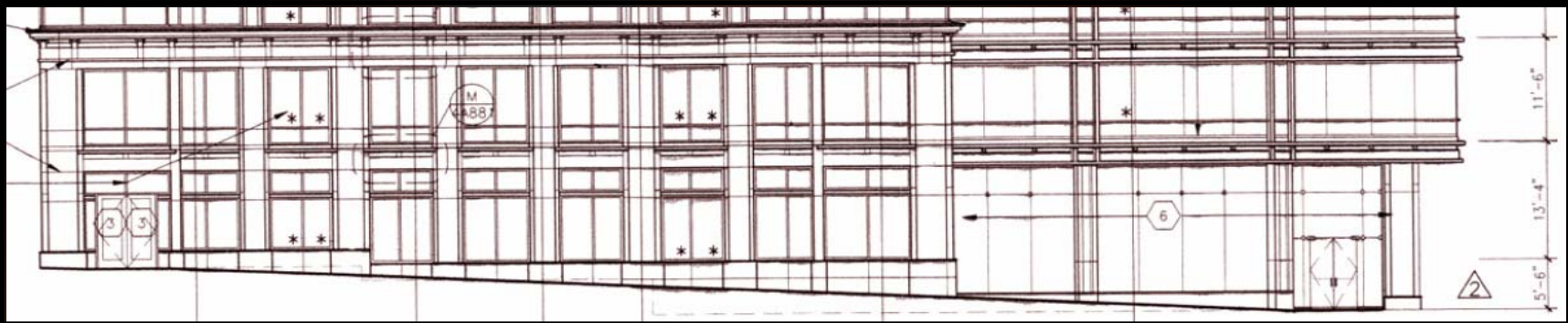
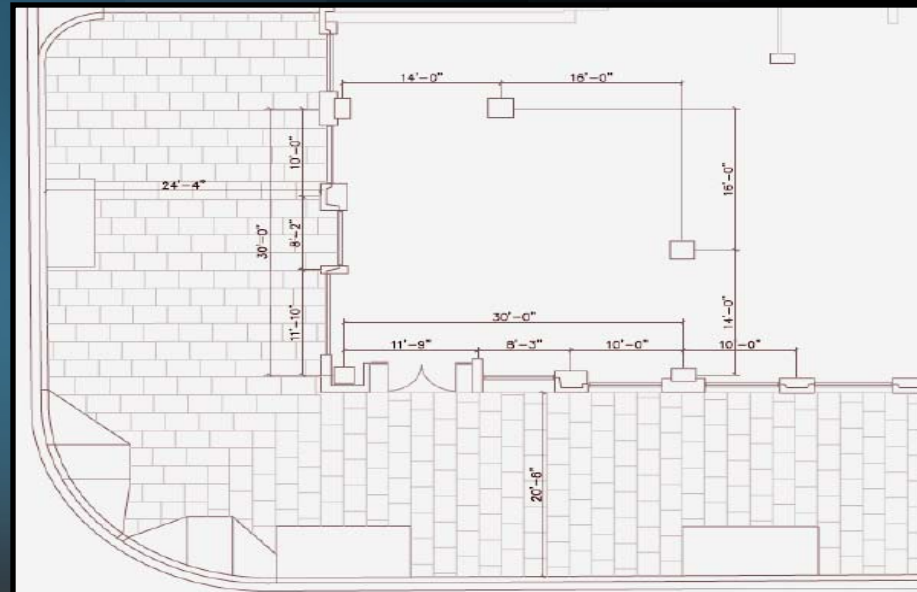


## DESIGN GOALS

- Reduce building height 5' - 6"

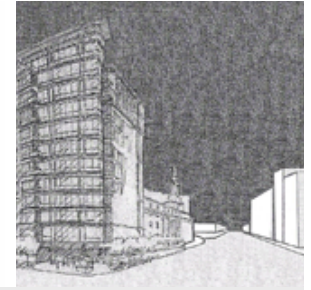
## DESIGN PARAMETERS

- Aim to not distort overall design
- Minimize floor area lost

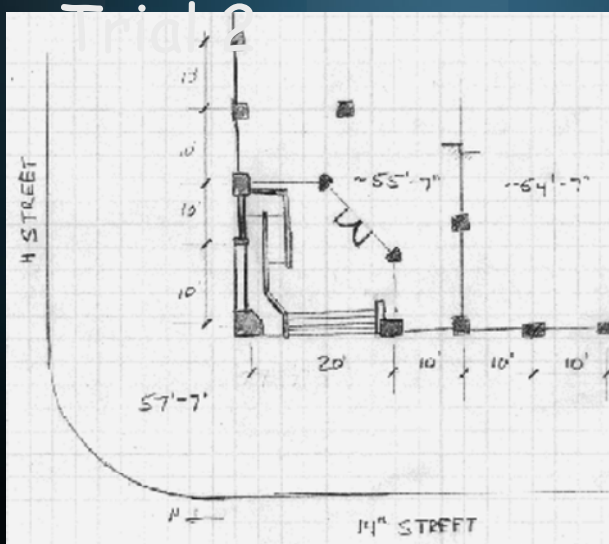




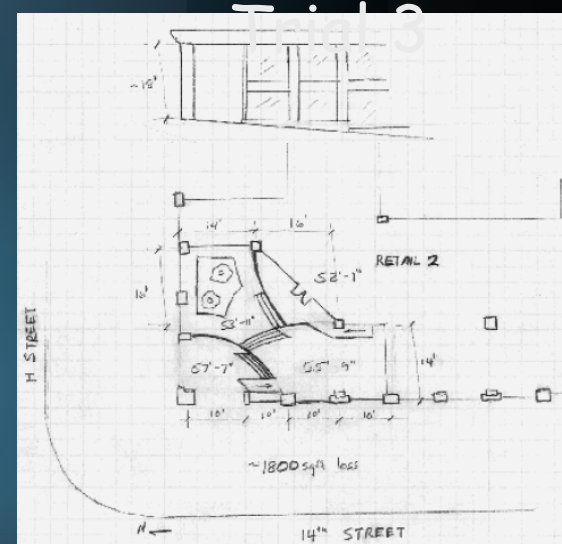
# The Executive Tower NW Washington DC



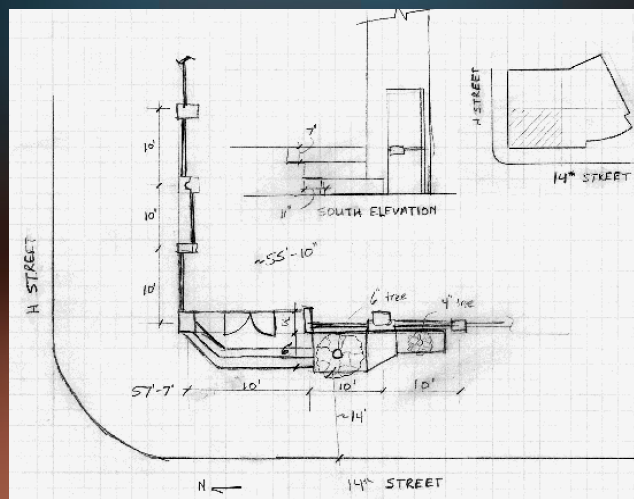
Trial 2



Trial 3

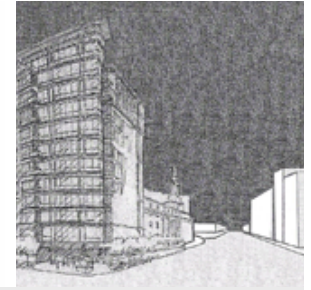


Trial 1

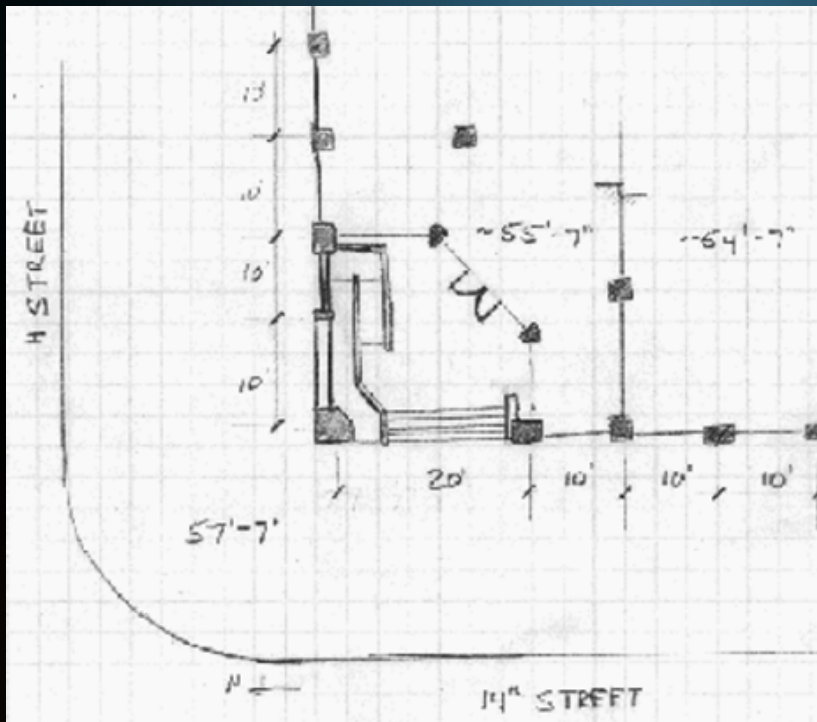


Sketched but did not meet code

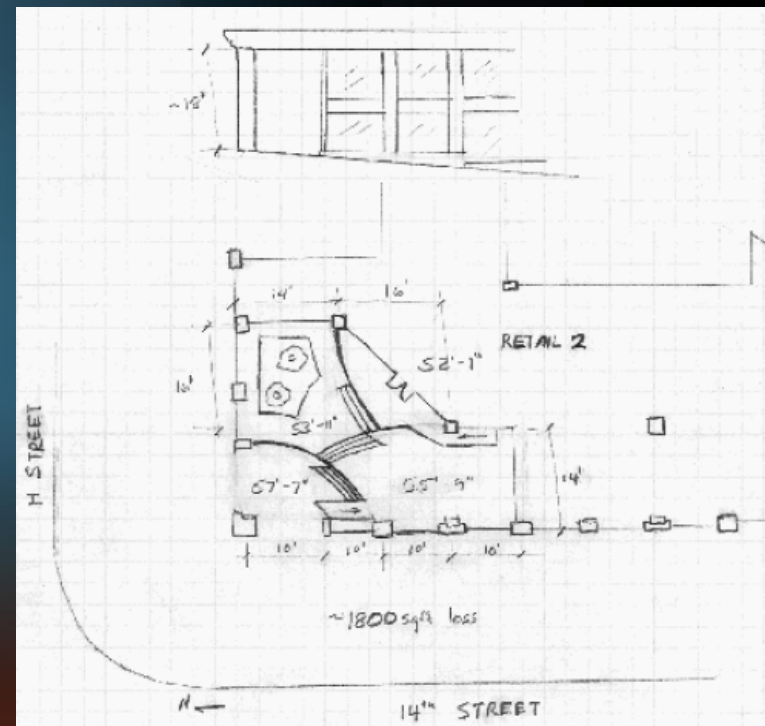
# The Executive Tower NW Washington DC



## Trial 2



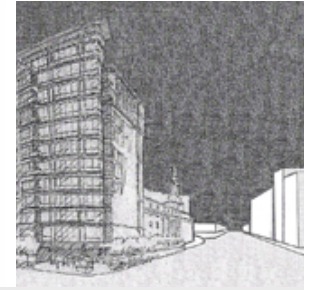
## Trial 3



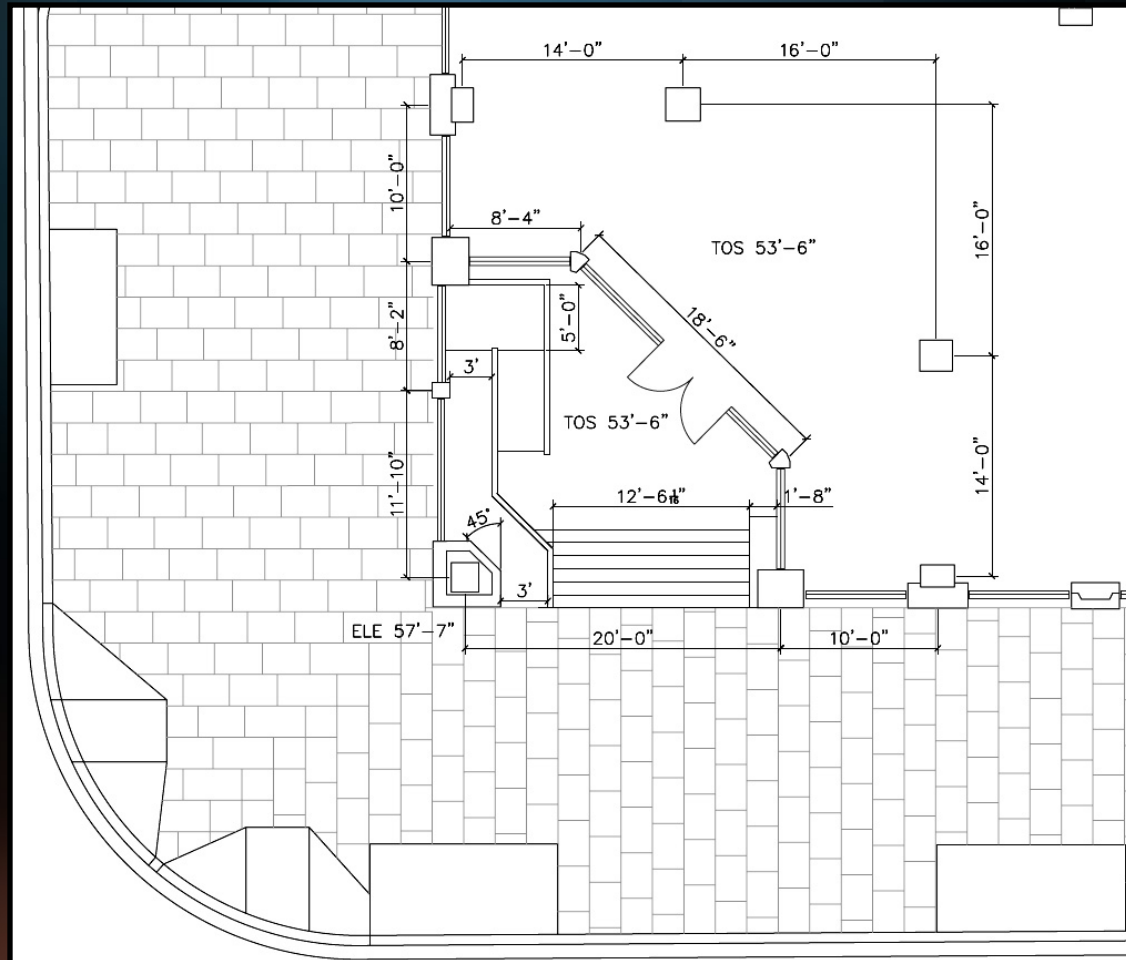
-Requires section of 2<sup>nd</sup>  
floor removed to meet 8'  
headroom by code

-1800 sqft of  
lost rentable  
floor area

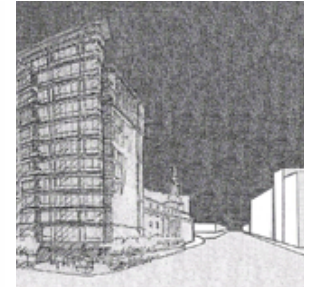
# The Executive Tower NW Washington DC



## TRIAL 2



# The Executive Tower NW Washington DC



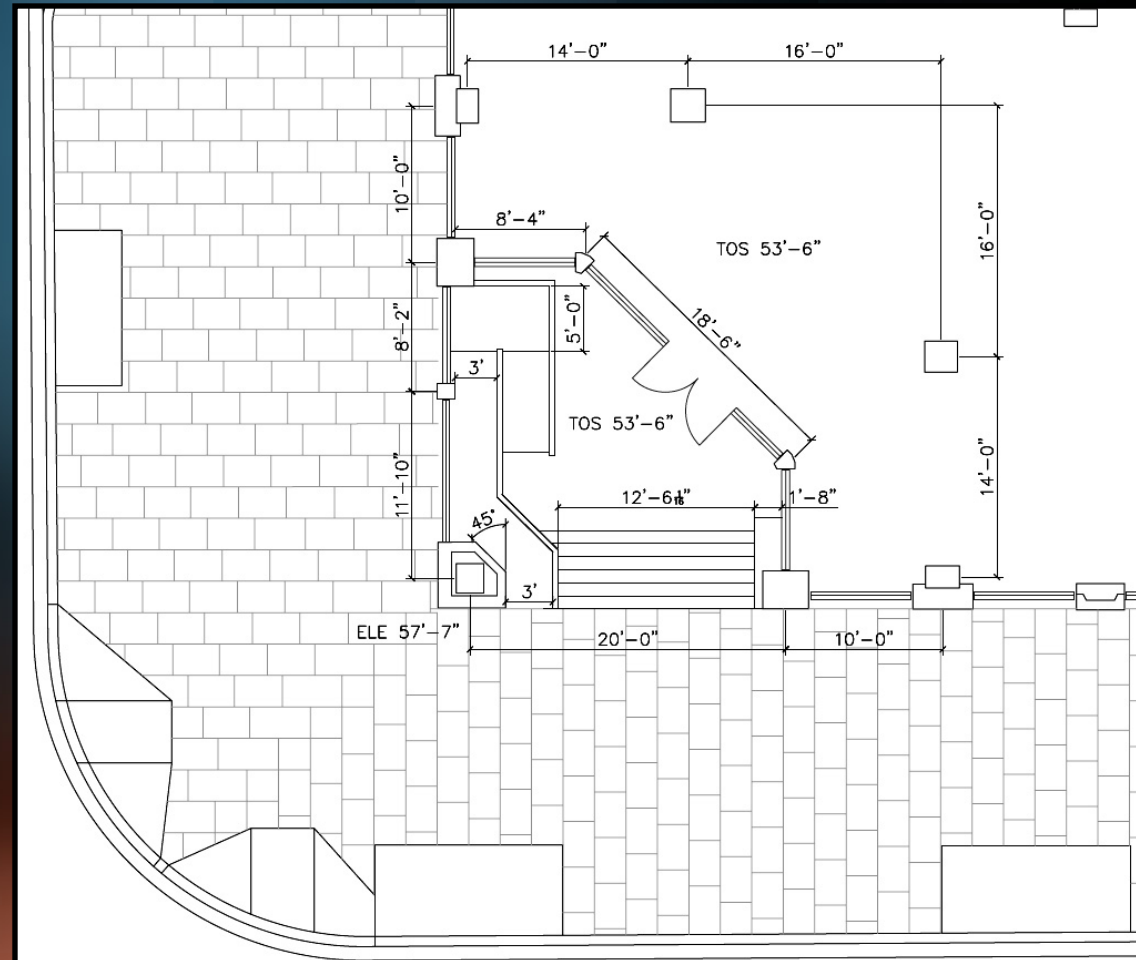
## TRIAL 2

-400 sqft of  
rentable area  
lost to  
construction

-At \$38per sqft

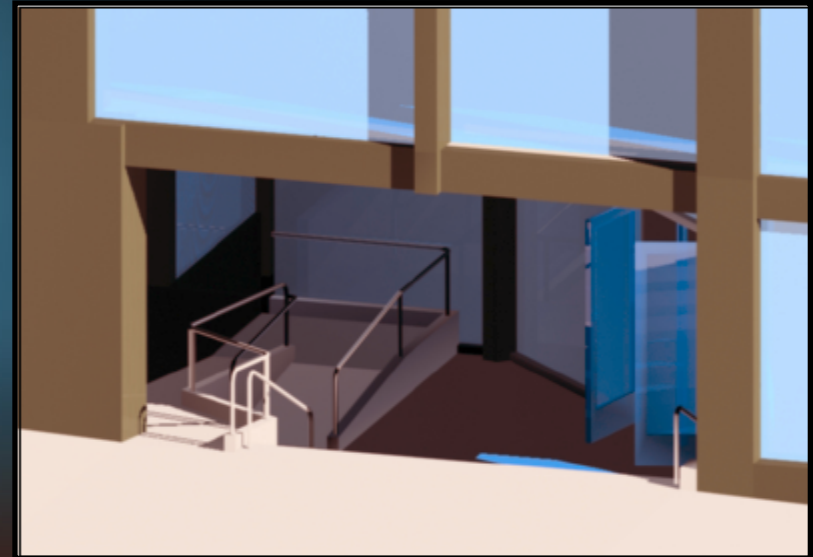
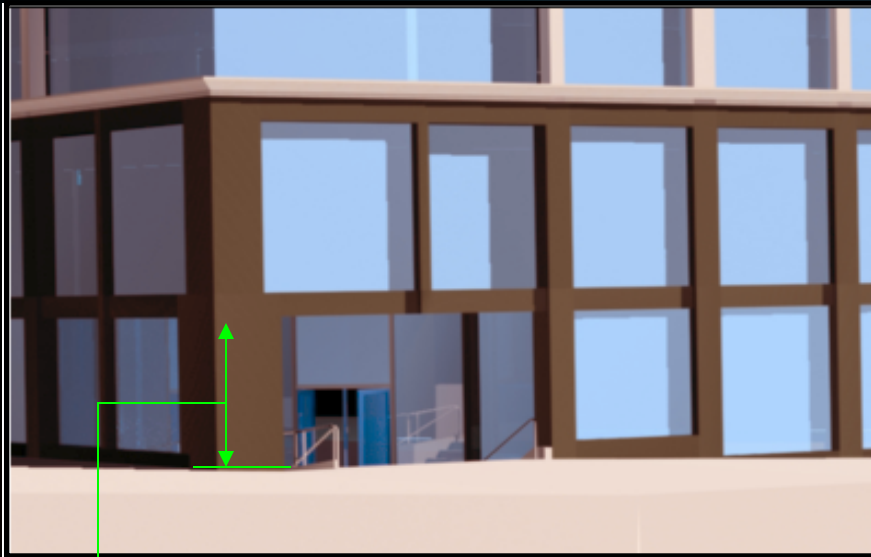
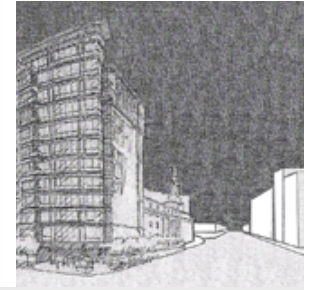
-yields \$16,700

-Building  
reduction, 4' - 1"





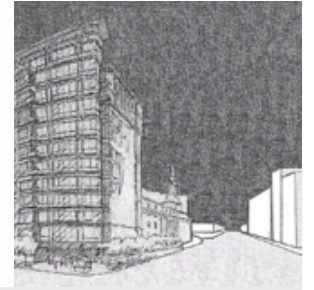
# The Executive Tower NW Washington DC



8' - 9"

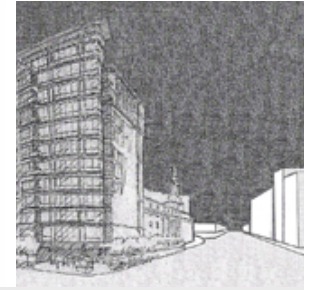
VIZ Rendering of new entrance

The Executive Tower  
NW Washington DC



# POST TENSION DEPTH STUDY

# The Executive Tower NW Washington DC



## DESIGN GOALS

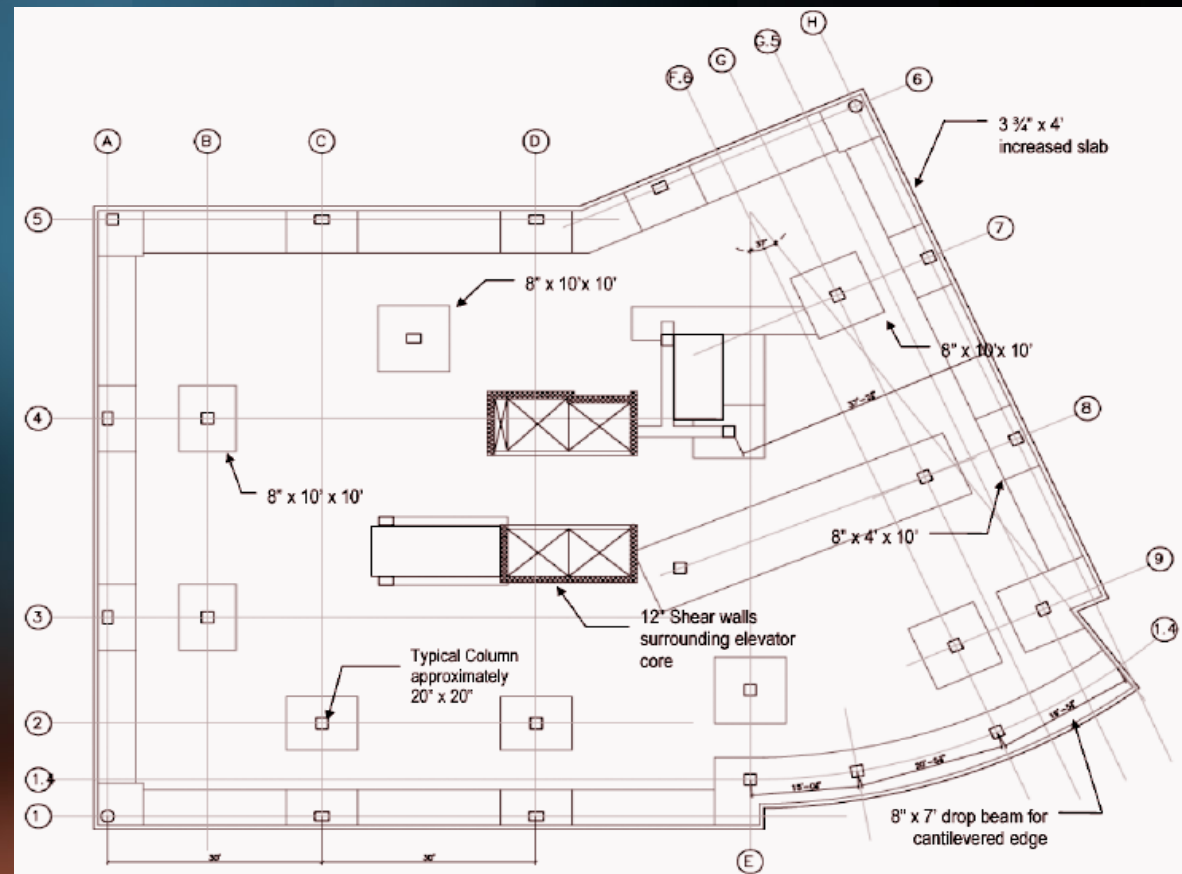
-Reduce slab thickness by 3"

## DESIGN PARAMETERS

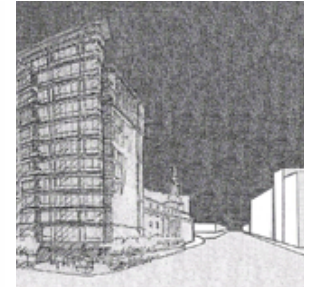
-Deflection Criteria of  $L/360$

## DESIGN METHOD

-Use of RAM Concept to perform a finite analysis on slab



# The Executive Tower NW Washington DC

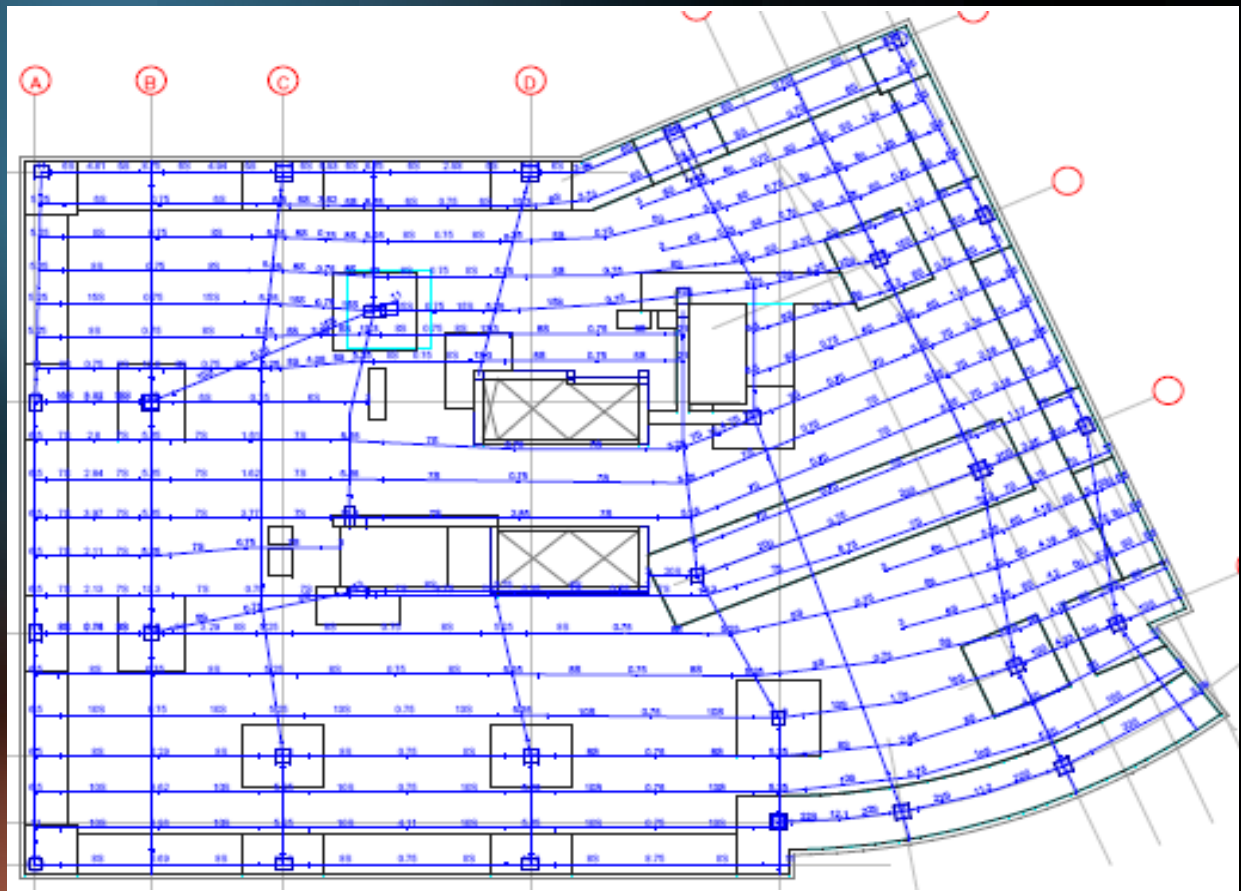


## DESIGN CHALLENGES

- Column layout irregular in building
- Creating column strips to fit column layout

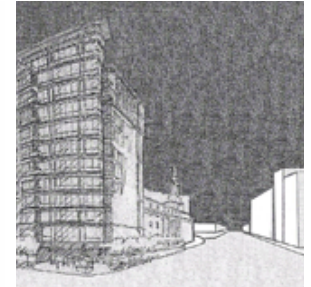
## RESULT

- Trail One tendon layout w/ similar discontinuity





# The Executive Tower NW Washington DC

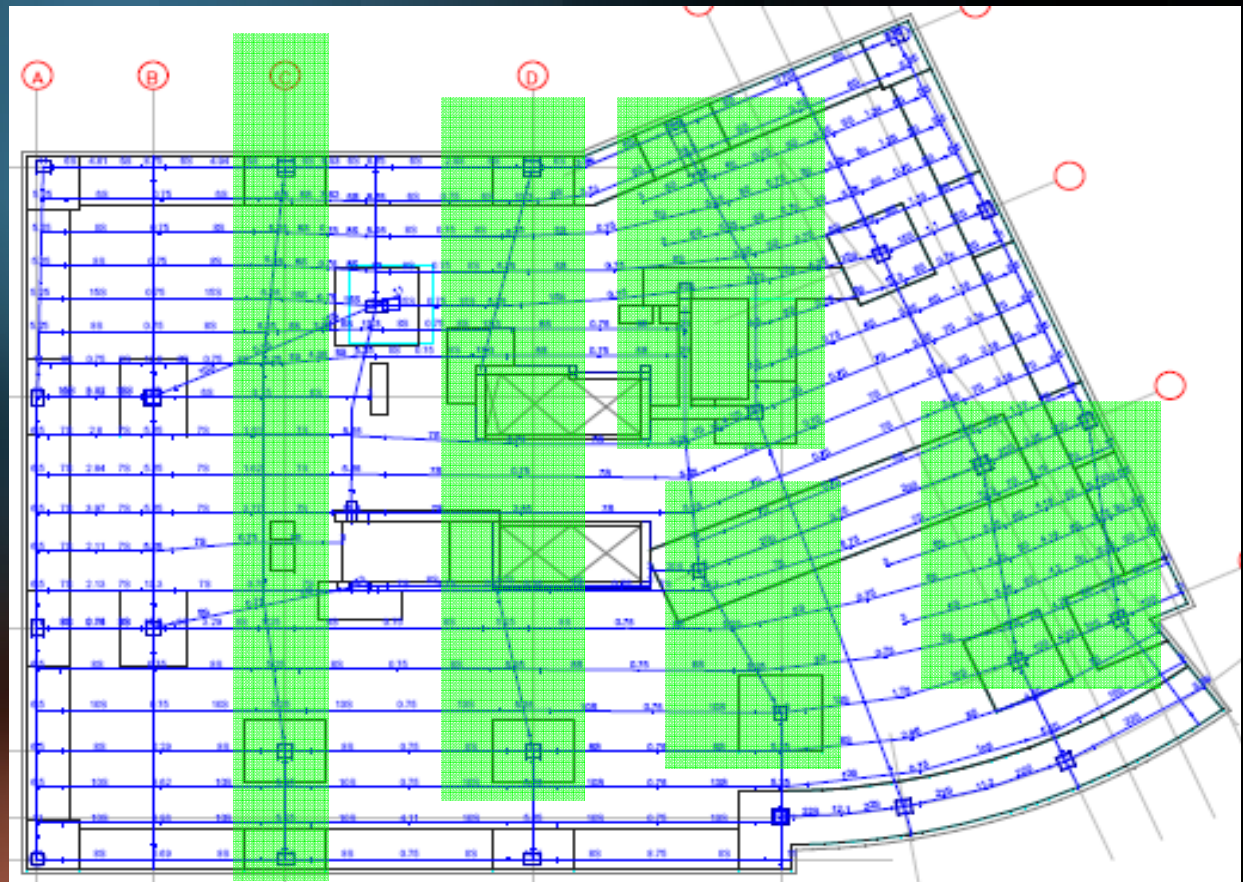


## TRIAL ONE CONCERNS

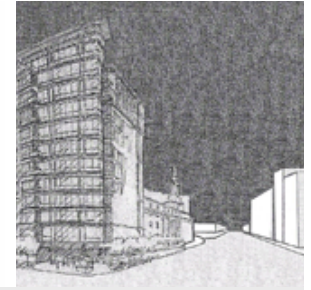
- Column line C
- Column D
- Areas with drastic tendon direction changes

## CONCLUSION

- Attempt to run tendon in opposite direction
- Reduce slab by 2"



# The Executive Tower NW Washington DC



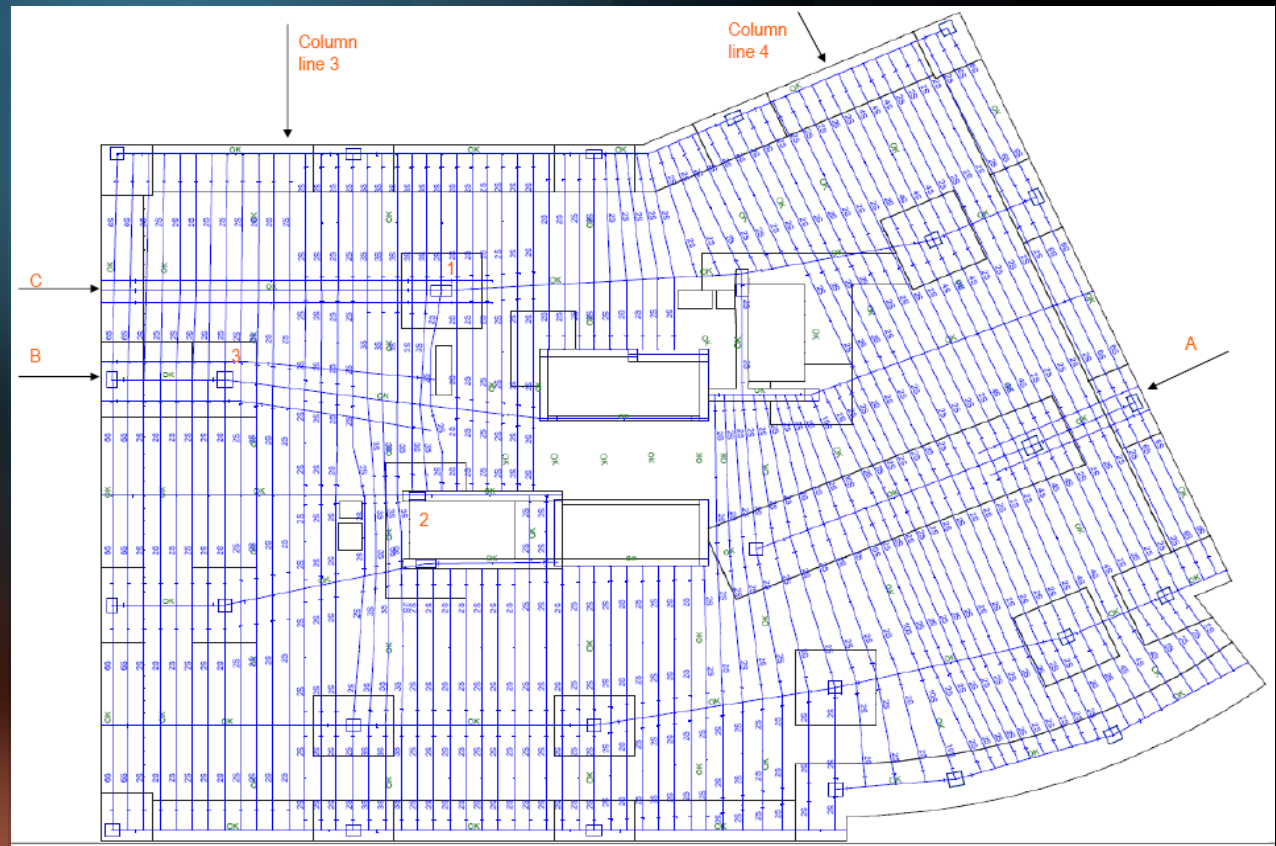
## TRIAL TWO VS. TRIAL ONE

-More successful than Trial One

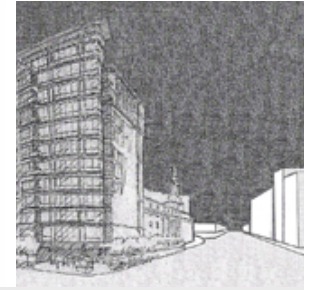
-Easier to bend tendons around openings

-Tendon free corridor

-Smoother transition at 24° skew in building



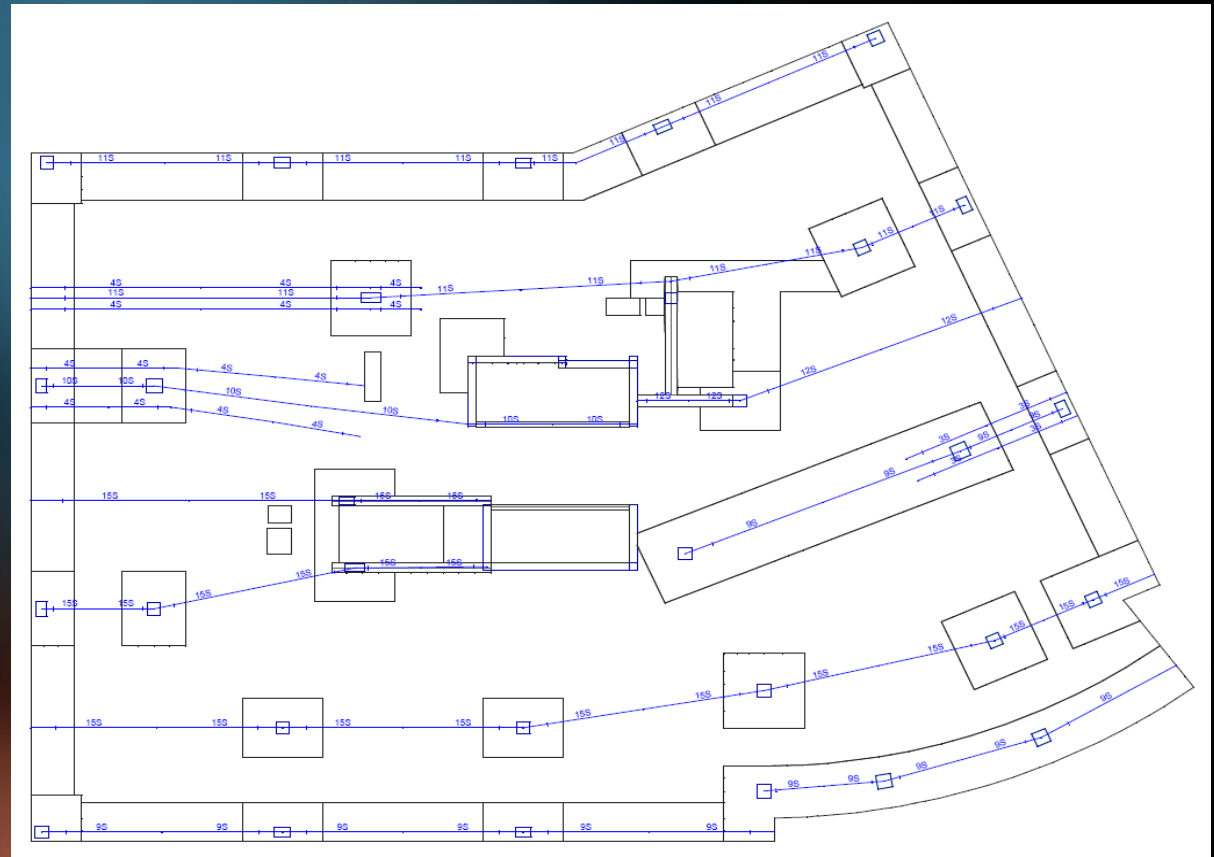
# The Executive Tower NW Washington DC



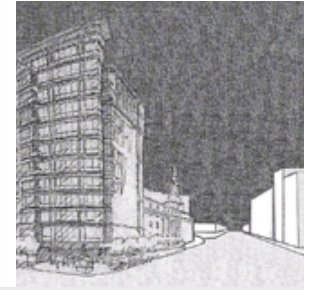
## TRIAL TWO DESIGN

-Maximum bundle was 15 strands; typically 10 strands

-Banded direction is 1 strand per foot in the longitude direction



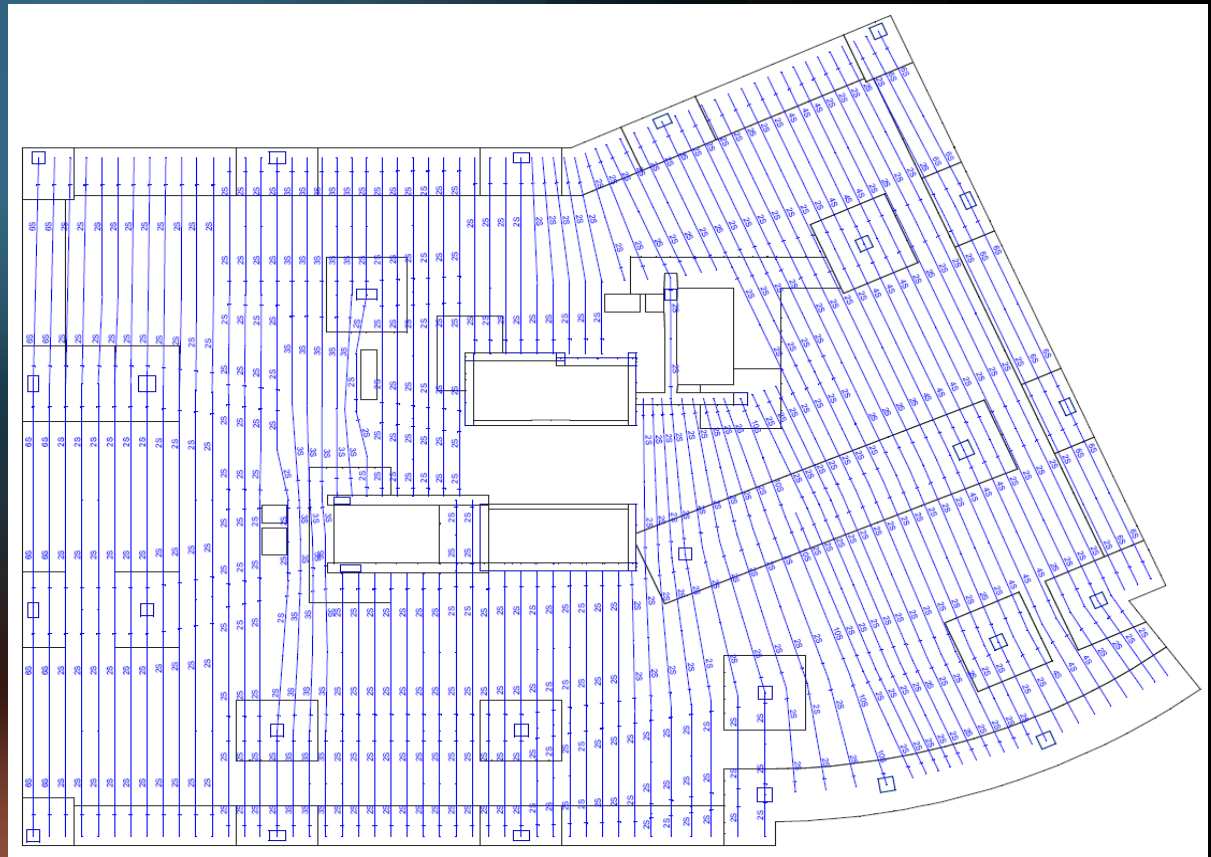
# The Executive Tower NW Washington DC



## TRIAL TWO DESIGN

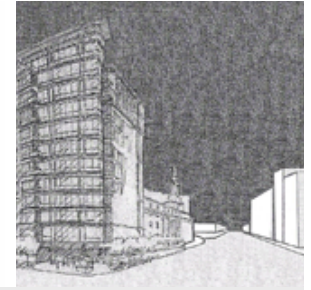
-Maximum bundle was 15 strands; typically 10 strands

-Banded direction is 1 strand per foot in the longitude direction





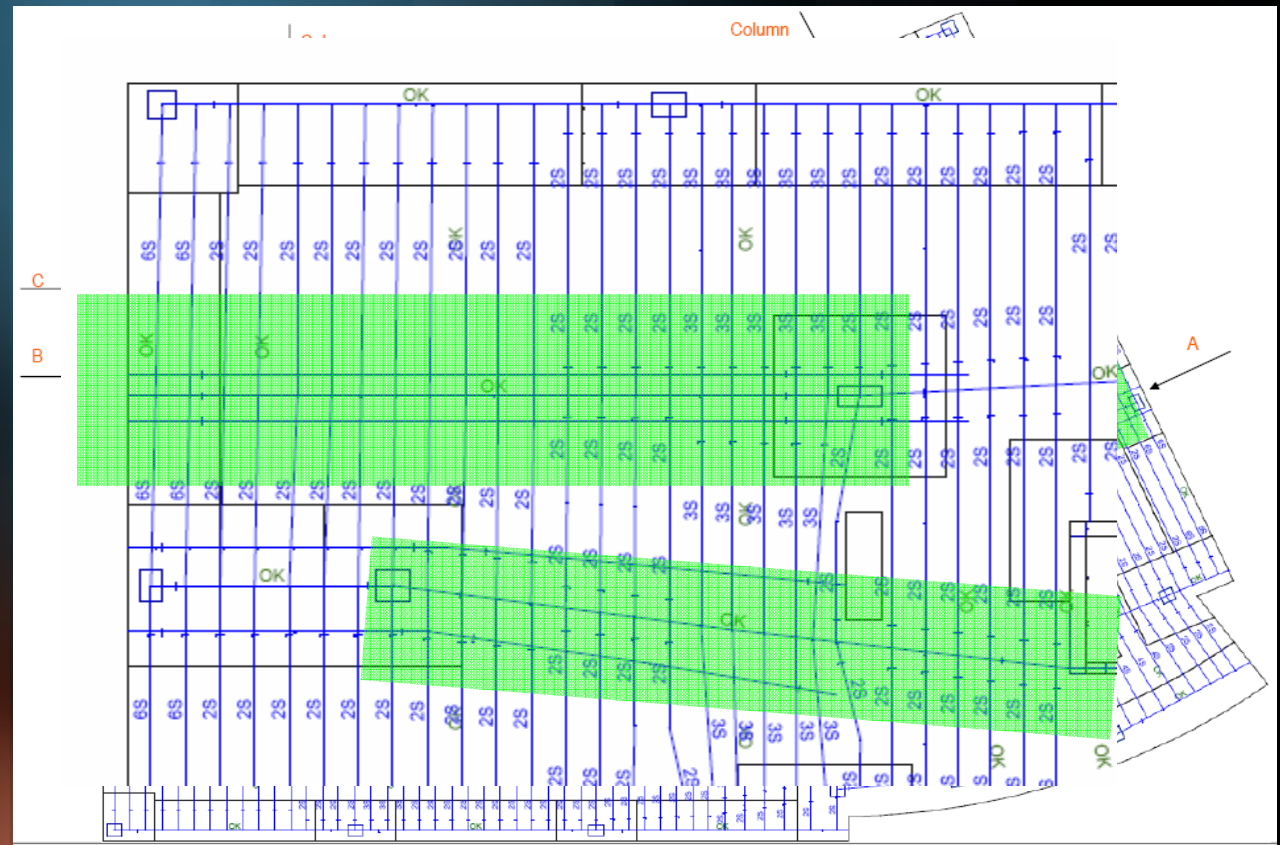
# The Executive Tower NW Washington DC



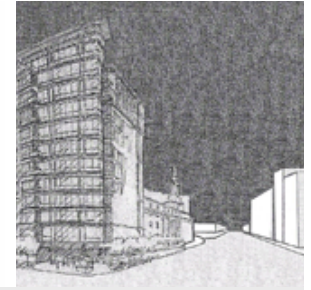
## TRIAL TWO DESIGN

- Positive balancing loads at sections A&B
- Additional strands at long spans to sections B and C

Long spans failing in deflection, additional strands were added



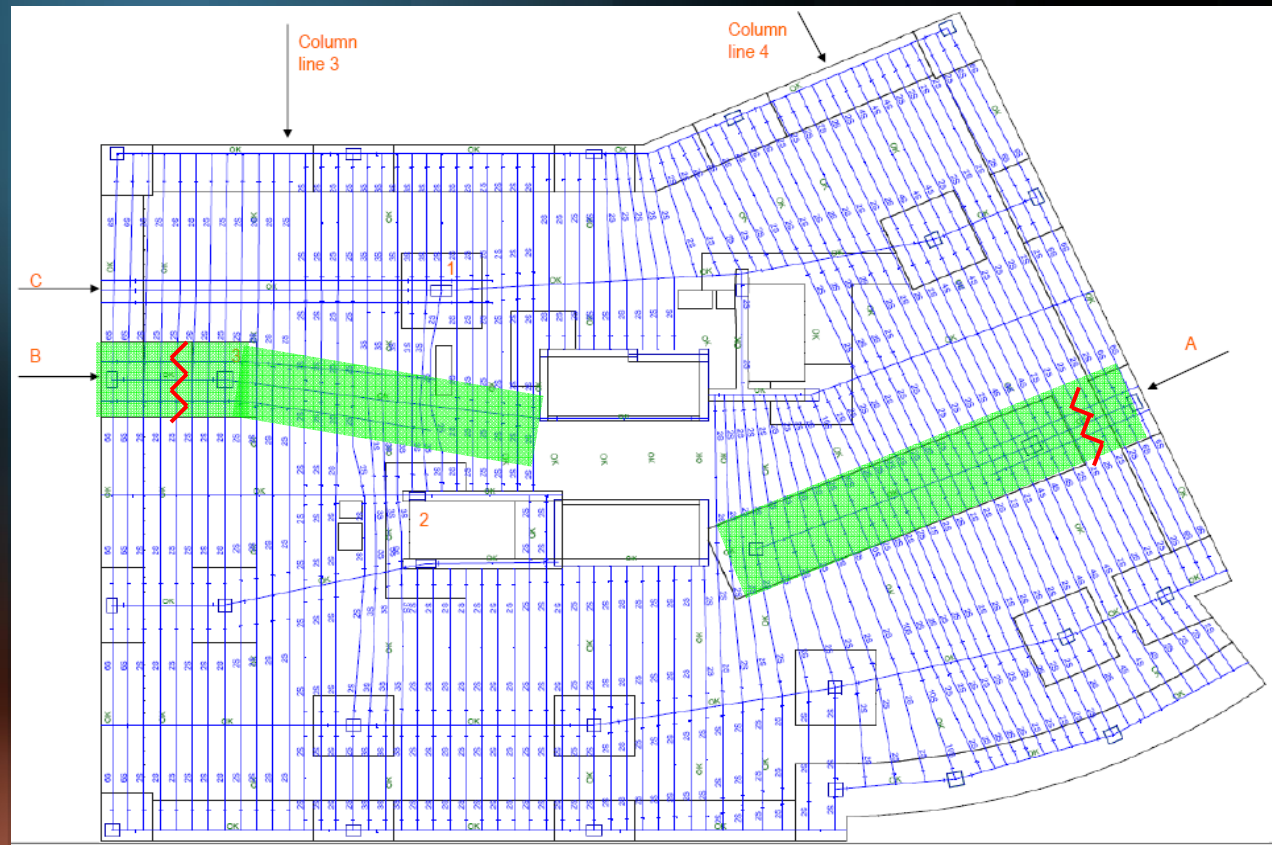
# The Executive Tower NW Washington DC



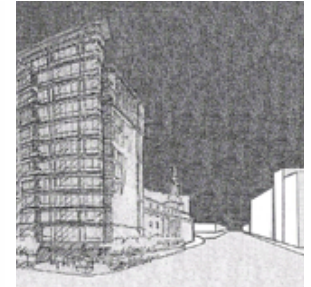
## TRIAL TWO DESIGN

-Positive balancing  
loads at sections  
A&B

Long span causing  
shorter span to  
chamber and fail



# The Executive Tower NW Washington DC



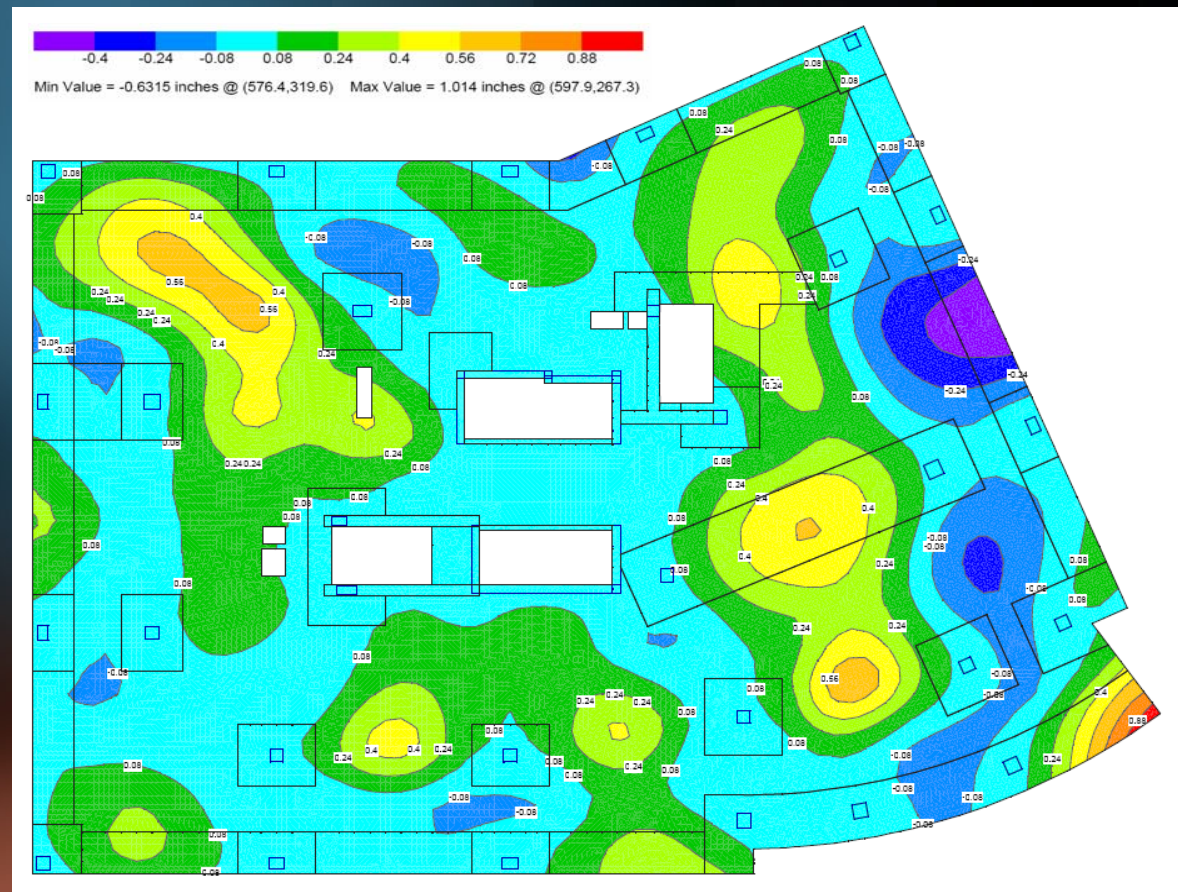
## DEFLECTION PLAN

-Largest Deflection  
is 0.97"

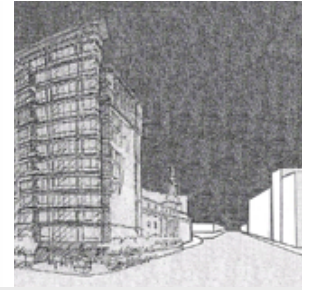
-less than  
deflection criteria  
of L/360

Building drifts  
were 4.30", less  
than 4.5"

Building reduction  
of 2" per floor



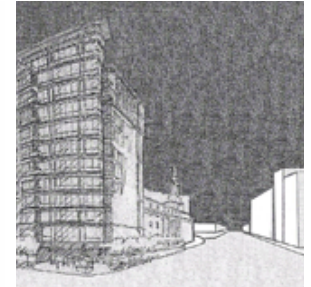
The Executive Tower  
NW Washington DC



CONCLUSIONS



# The Executive Tower NW Washington DC



## COST ESTIMATIONS

| Flat Slab                | Units | Materials | Labor | Equip | Total w/ O&P | Amount | Schedule | Cost         |
|--------------------------|-------|-----------|-------|-------|--------------|--------|----------|--------------|
| Concrete cost with forms | CY    | 190       | 90.5  | 16.5  | 380          | 354.8  |          | 134824       |
| Post tension             | LB    | 0.46      | 0.7   | 0.03  | 1.85         | 0      |          | 0            |
| Steel reinforcement      | tons  | 850       | 305   | 0     | 1475         | 23.17  |          | 34175.75     |
| General condition        | days  |           |       |       |              |        | +0       | 0            |
|                          |       |           |       |       |              |        |          | \$168,999.75 |

| Flat Slab w/ Post Tension | Units | Materials | Labor | Equip | Total w/ O&P | Amount | Schedule      | Cost         |
|---------------------------|-------|-----------|-------|-------|--------------|--------|---------------|--------------|
| Concrete cost with forms  | CY    | 190       | 90.5  | 16.5  | 380          | 308.4  |               | 117192       |
| Post tension              | LB    | 0.46      | 0.7   | 0.03  | 1.85         | 12510  |               | 23143.5      |
| Steel reinforcement       | tons  | 850       | 305   | 0     | 1475         | 12.56  |               | 18526        |
| General condition         | days  |           |       |       |              |        | +30           | 100.000      |
|                           |       |           |       |       |              |        |               | \$258,861.50 |
|                           |       |           |       |       |              |        | Difference of | \$89,861.75  |

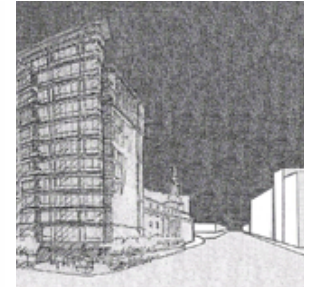
## LOSSES

Structure cost  
Arch. Breadth

$\$90,000 \times 12 \text{ floors} = \$1,080,000$   
 $\$38/\text{sf} \times 400\text{sf} = \$16,700/\text{month}$

# The Executive Tower

## NW Washington DC



### COST ESTIMATIONS

| Flat Slab                | Units | Materials | Labor | Equip | Total w/ O&P | Amount | Schedule | Cost         |
|--------------------------|-------|-----------|-------|-------|--------------|--------|----------|--------------|
| Concrete cost with forms | CY    | 190       | 90.5  | 16.5  | 380          | 354.8  |          | 134824       |
| Post tension             | LB    | 0.46      | 0.7   | 0.03  | 1.85         | 0      |          | 0            |
| Steel reinforcement      | tons  | 850       | 305   | 0     | 1475         | 23.17  |          | 34175.75     |
| General condition        | days  |           |       |       |              |        | +0       | 0            |
|                          |       |           |       |       |              |        |          | \$168,999.75 |

| Flat Slab w/ Post Tension | Units | Materials | Labor | Equip | Total w/ O&P | Amount | Schedule      | Cost         |
|---------------------------|-------|-----------|-------|-------|--------------|--------|---------------|--------------|
| Concrete cost with forms  | CY    | 190       | 90.5  | 16.5  | 380          | 308.4  |               | 117192       |
| Post tension              | LB    | 0.46      | 0.7   | 0.03  | 1.85         | 12510  |               | 23143.5      |
| Steel reinforcement       | tons  | 850       | 305   | 0     | 1475         | 12.56  |               | 18526        |
| General condition         | days  |           |       |       |              |        | +30           | 100.000      |
|                           |       |           |       |       |              |        |               | \$258,861.50 |
|                           |       |           |       |       |              |        | Difference of | \$89,861.75  |

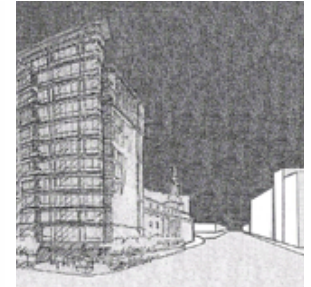
### GAINS

12<sup>th</sup> Floor

$$\$47/\text{sf} \times 11750\text{sf} = \$552,250/\text{month}$$

# The Executive Tower

## NW Washington DC



### COST ESTIMATIONS

| Flat Slab                | Units | Materials | Labor | Equip | Total w/ O&P | Amount | Schedule | Cost         |
|--------------------------|-------|-----------|-------|-------|--------------|--------|----------|--------------|
| Concrete cost with forms | CY    | 190       | 90.5  | 16.5  | 380          | 354.8  |          | 134824       |
| Post tension             | LB    | 0.46      | 0.7   | 0.03  | 1.85         | 0      |          | 0            |
| Steel reinforcement      | tons  | 850       | 305   | 0     | 1475         | 23.17  |          | 34175.75     |
| General condition        | days  |           |       |       |              |        | +0       | 0            |
|                          |       |           |       |       |              |        |          | \$168,999.75 |

| Flat Slab w/ Post Tension | Units | Materials | Labor | Equip | Total w/ O&P | Amount | Schedule      | Cost         |
|---------------------------|-------|-----------|-------|-------|--------------|--------|---------------|--------------|
| Concrete cost with forms  | CY    | 190       | 90.5  | 16.5  | 380          | 308.4  |               | 117192       |
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| Steel reinforcement       | tons  | 850       | 305   | 0     | 1475         | 12.56  |               | 18526        |
| General condition         | days  |           |       |       |              |        | +30           | 100.000      |
|                           |       |           |       |       |              |        |               | \$258,861.50 |
|                           |       |           |       |       |              |        | Difference of | \$89,861.75  |

### NET GAINS

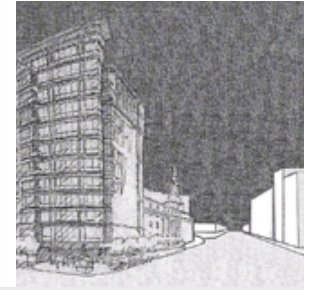
$$\begin{aligned}
 &\$552,250 - 16,700 = \\
 &\quad \$535,550/\text{month}
 \end{aligned}$$

### TIME TO BREAK EVEN

$$\begin{aligned}
 &\frac{\$1,080,000}{\$535,550/\text{month}} = 2.02 \text{ months}
 \end{aligned}$$

# The Executive Tower

## NW Washington DC



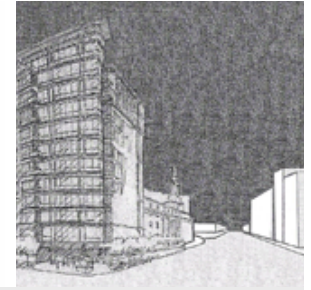
### BUILDING HEIGHT SUMMARY

|    | Original Height | Arch. Breadth | Mech. Breadth | Post Tension | New Floor Heights |
|----|-----------------|---------------|---------------|--------------|-------------------|
| 12 | -               | -             | - 4"          | - 2"         | 11' - 0"          |
| 11 | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 10 | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 9  | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 8  | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 7  | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 6  | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 5  | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 4  | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 3  | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 2  | 11' - 6"        | -             | - 4"          | - 2"         | 11' - 0"          |
| 1  | 13' - 4"        | - 4' - 1"     | - 4"          | - 2"         | 8' - 9"           |
|    | 128' - 4"       |               |               |              |                   |





# The Executive Tower NW Washington DC



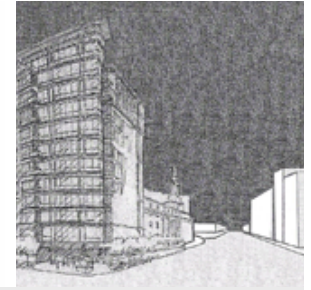
## BUILDING HEIGHT SUMMARY

Building is under 130'  
maximum height limit

129' - 11"



# The Executive Tower NW Washington DC

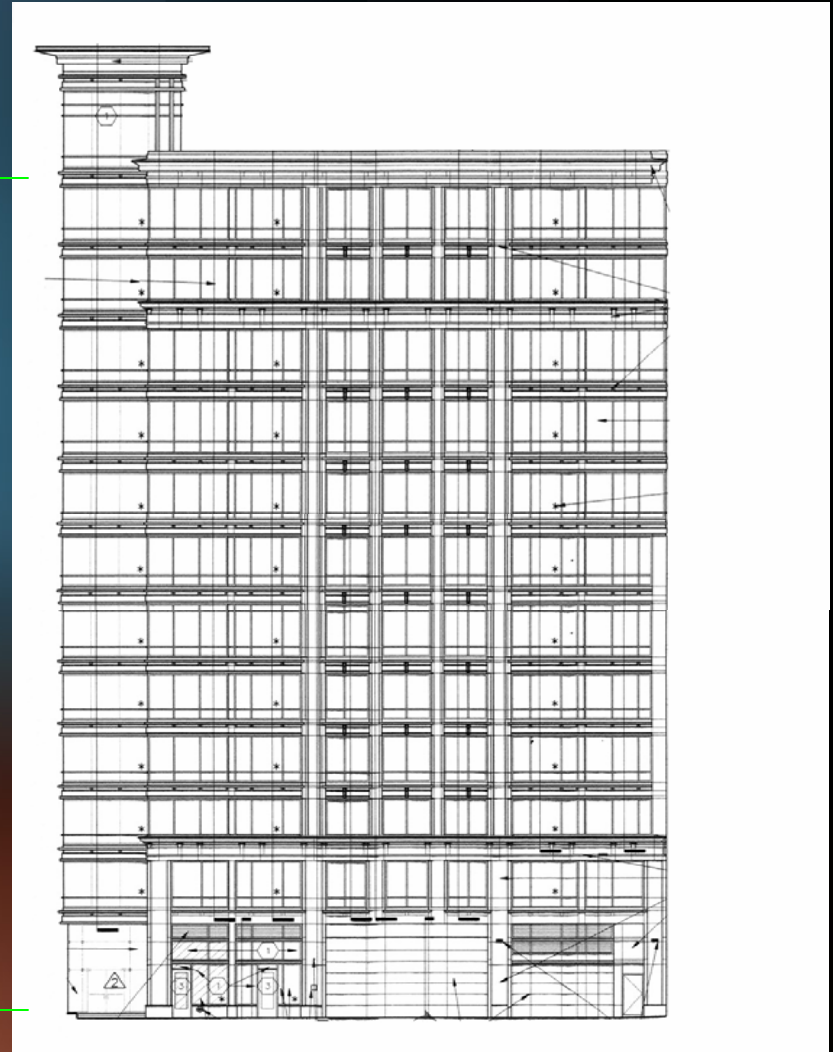


## FINAL REMARKS

- Proposal was successful
- The result of this would be an additional \$500,000 per month for the owners

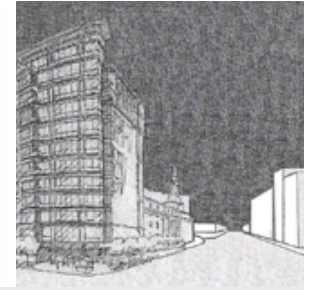


129' - 11"



# The Executive Tower

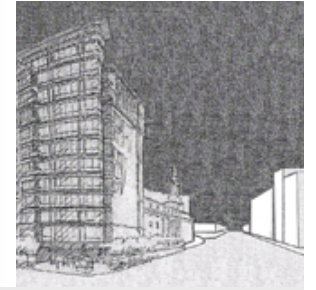
## NW Washington DC



## ACKNOWLEDGEMENTS

- Renee Gibbs and Jason Lee
- The staff of Mesen Associates
- The AE Faculty
- My Family
- Becky
- And finally, all the people that pulled me out of thesis when I needed, but didn't want to admit

The Executive Tower  
NW Washington DC



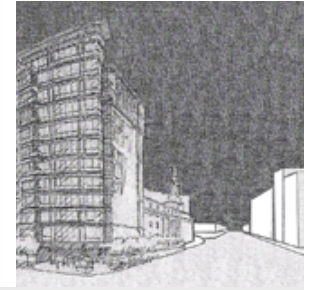
QUESTION & ANSWER



(ROOF OF THE FEDERAL BUILDING, CHICAGO 2004)



# The Executive Tower NW Washington DC



## LIGHTER STRUCTURE

$$11 \times 2'' = 22''$$

$$22'' - 6'' = 16''$$

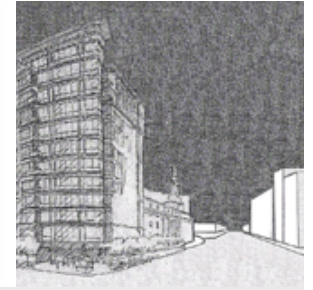
$$150\text{pcf} \times 16''/12'' = 200 \text{ psf}$$

$$1.2 \times 200 - 1.6 \times 100 = 80 \text{ psf}$$

$$80\text{psf} \times 11800\text{sf} = 944\text{kips}$$

$$944\text{kips} / 36 \text{ cols} = \text{avg of } 26.2 \text{ k/col}$$

# The Executive Tower NW Washington DC



## PUNCHING SHEAR CONTROLLED

Reduction of 2" in slab

Used prestress punching shear equation

|   |           |
|---|-----------|
| $V_c = (\beta_p(f_c)^{1/2} + 0.3f_{pc})b_o d + V_p$ | 11.12.2.2 |
| $2(f_c)^{1/2}b_o d$                                 | 11.12.3.1 |

$V_c$  was acceptable for most column except for 1, 8, and 24

#4's @ 6" were required