

# Rockville Metro Plaza II

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**Rockville Pike**

**Rockville, Maryland**



[www.klnbretail.propertycapsule.com](http://www.klnbretail.propertycapsule.com)

**John Vais | Structural Option**

**PSU AE Senior Thesis 2014**

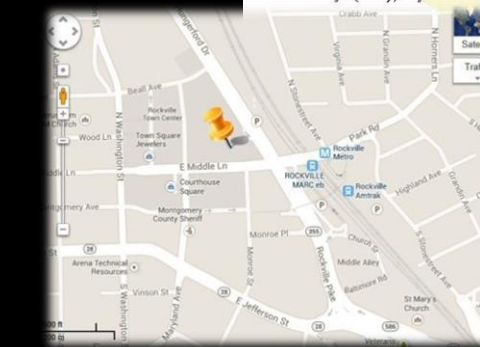
**Faculty Advisor – Dr. Hanagan**

# Rockville Metro Plaza II

## Introduction

- Building Introduction
- Existing Structural System
- Problem Statement
- Proposed Solution
- Gravity Redesign
- Lateral Redesign
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- Questions/Comments

- Developer – Foulger-Pratt
- Architect – WDG Architecture
- Structural Engineer– Cagley and Associates
- 323,000 GSF
- Completed – Fall 2013
- 10 Stories Above Grade (Office)
  - 3 Below Grade (Parking)
- Retail Space on Plaza Level
- Prominent Location
- LEED Platinum

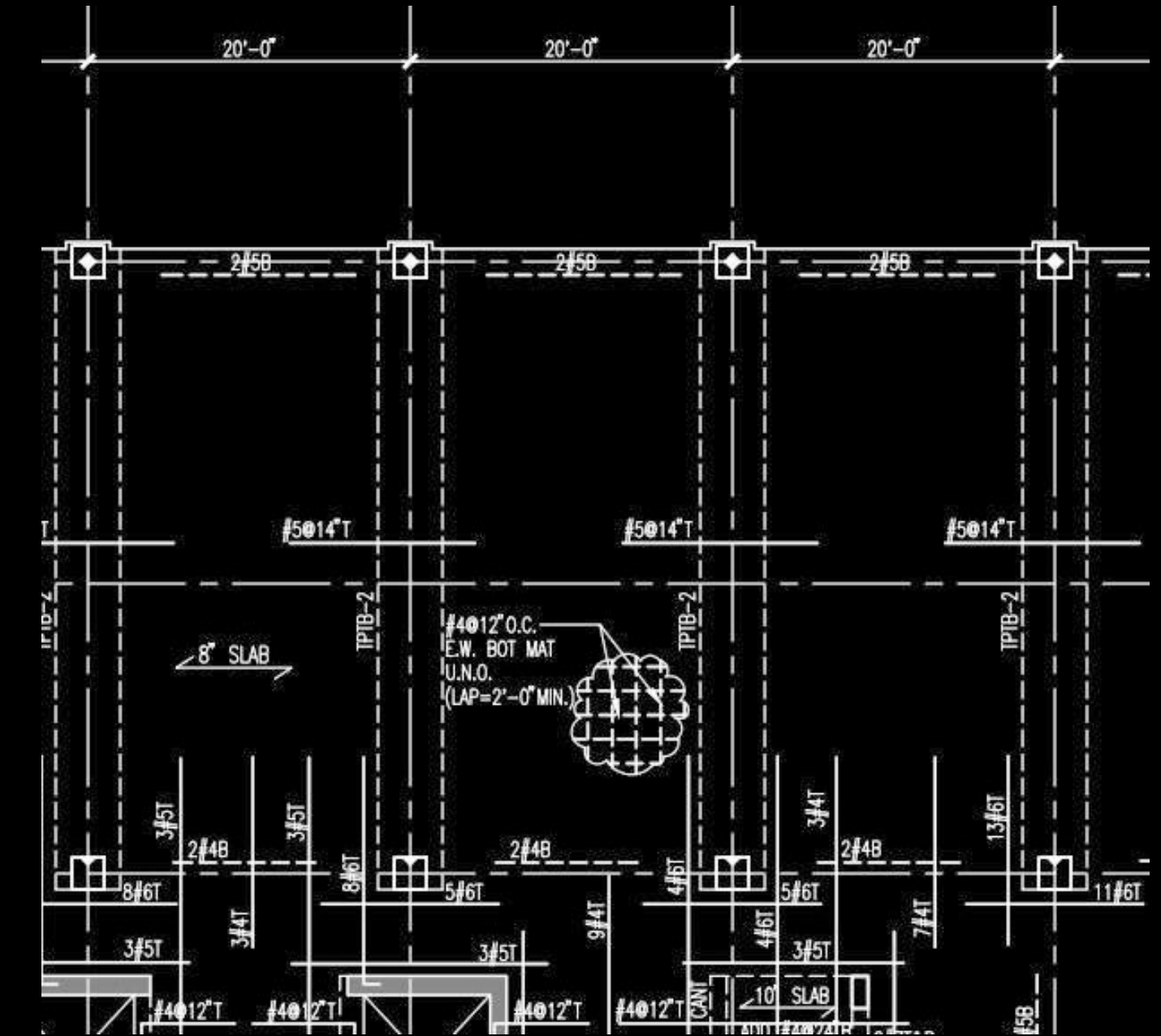


# Rockville Metro Plaza II

## Existing Gravity System

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- ❑ One-way concrete slabs
  - ❑ Bay – 20' x 40' (typically)
- ❑ Post tensioned beams – 20" x 48"
- ❑ Cast in place columns – 2' x 2'
- ❑ Open/versatile floor plan

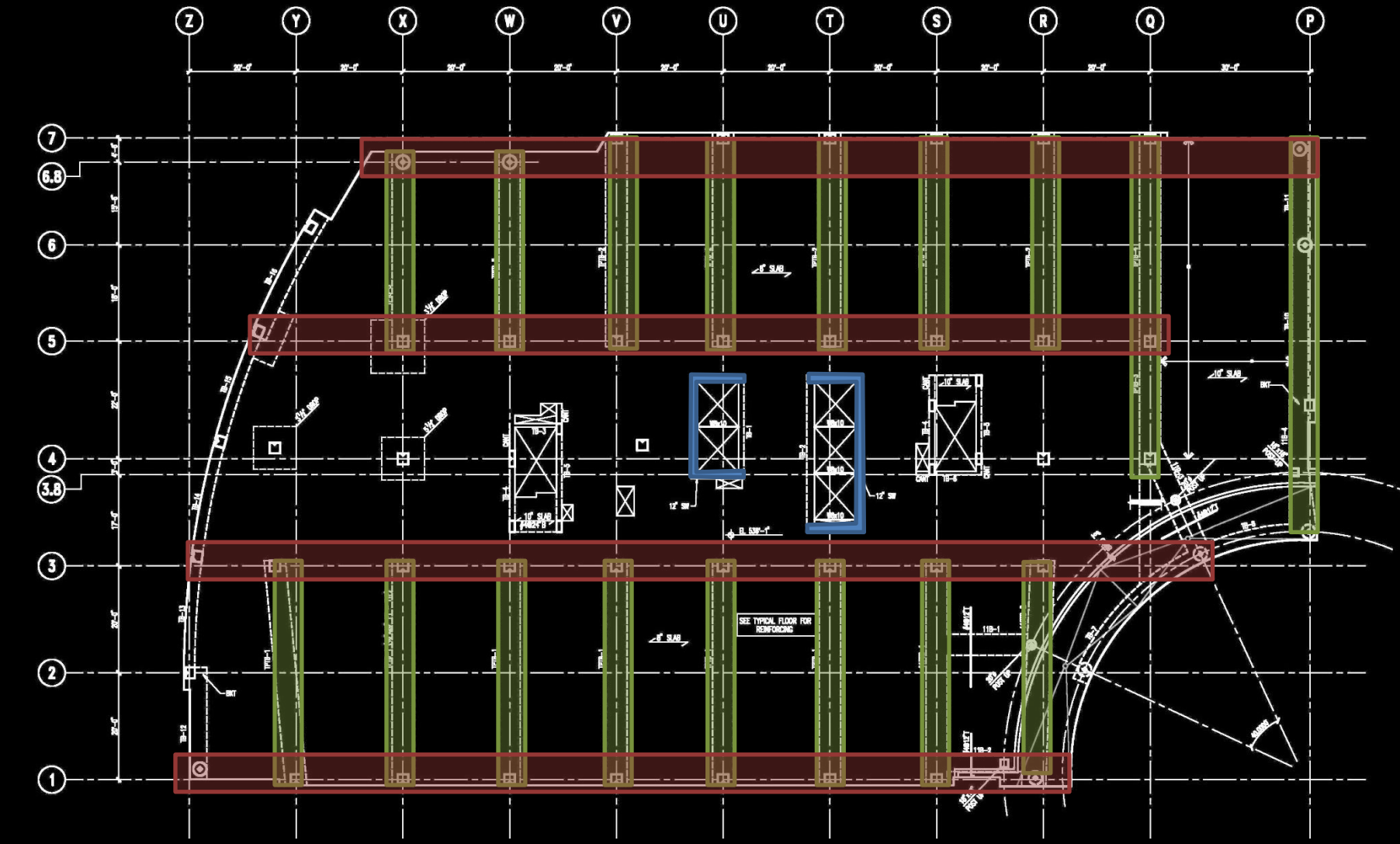


# Rockville Metro Plaza II

## Existing Lateral System

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- Concrete shear walls at elevator core
  - 12 inch thick
- Concrete moment frames
- Low impact on architecture

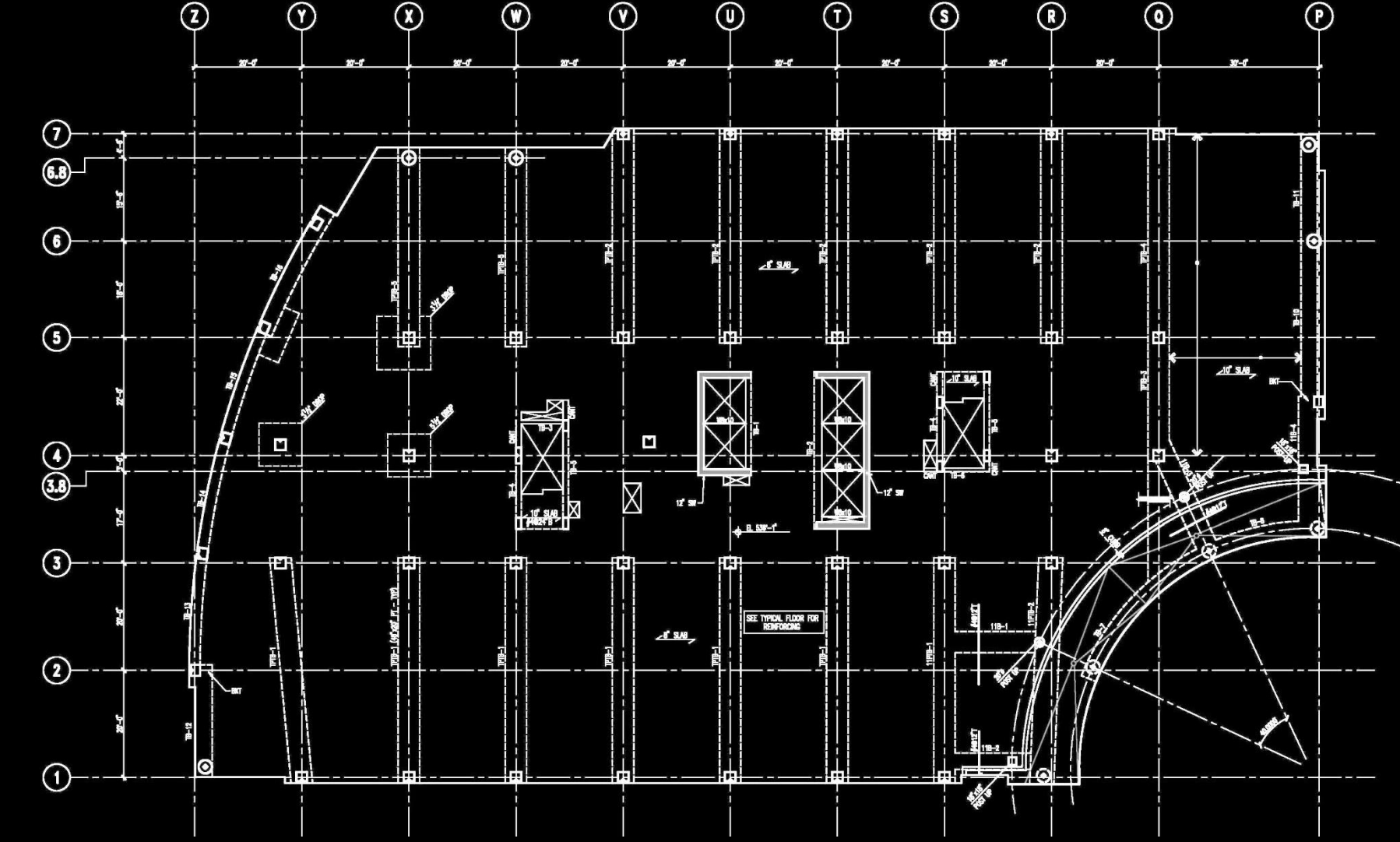


# Rockville Metro Plaza II

## Problem Statement

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- Concrete structure results in a large building self weight
- Lengthy schedule duration due to concrete construction
- Concrete labor intensive



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## Proposed Solution

## Goals

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- Employ steel structure
  - Investigate self weight reduction
  - Investigate use of composite beams and LW concrete
- Maintain architectural design intentions
  - Open floor plan
  - Ceiling height/ceiling cavity
- Decrease cost and construction duration

- Reduce building weight
- Maintain architectural intentions
- Reduce overall cost
- Reduce schedule duration

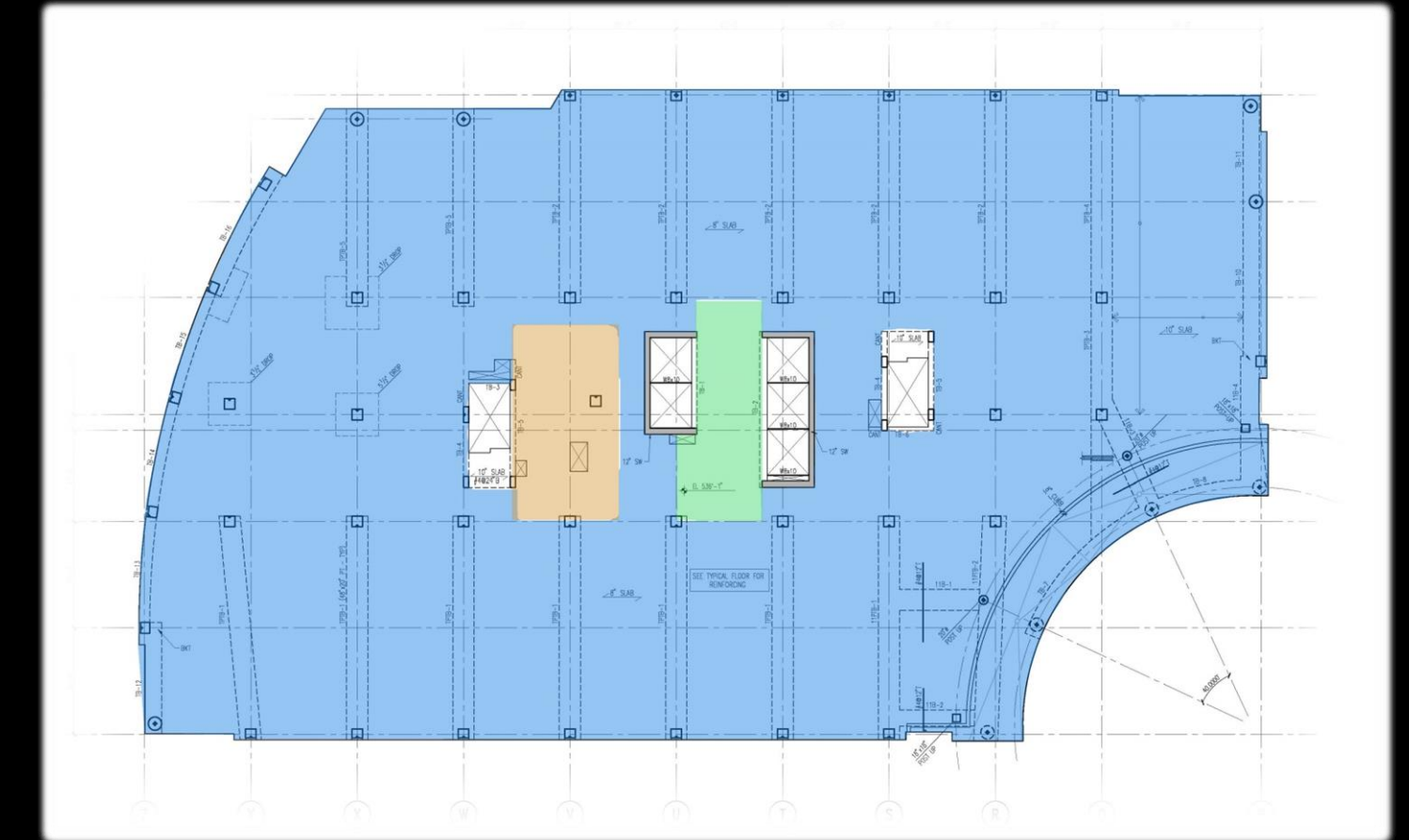
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## Gravity Design

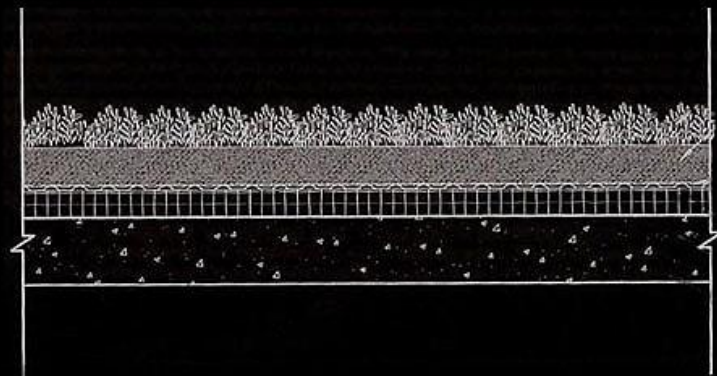
### Gravity Loads

- ❑ **Floor Loads**
  - ❑ Live Load – 80 psf
  - ❑ Partitions – 20 psf
  - ❑ Superimposed DL – 5 psf
- ❑ **Mechanical Rooms**
  - ❑ Live Load – 150 psf\*
- ❑ **Corridors (above first)**
  - ❑ Live Load – 100 psf



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## Gravity Design Gravity Loads

- Roof Loads
  - Live Load – 20 psf
  - Snow – 17.5 psf
  - Green Roof – 40 psf
  - Superimposed DL – 10 psf

### Floor Live Loads

Area	As Designed (psf)	ASCE 7-05 (psf)
Corridors (first level)	100	100
Corridors (above first)	100	80
Lobbies	100	100
Marquees/Canopies	75	75
Mechanical Room	150 (U)	125
Offices	80 + 20 (partitions)	50 + 20 (partitions)
Parking Garage	50	40
Retail – First Floor	100	100
Stairs/Exit Ways	100 (U)	100
Storage (Light)	125 (U)	125



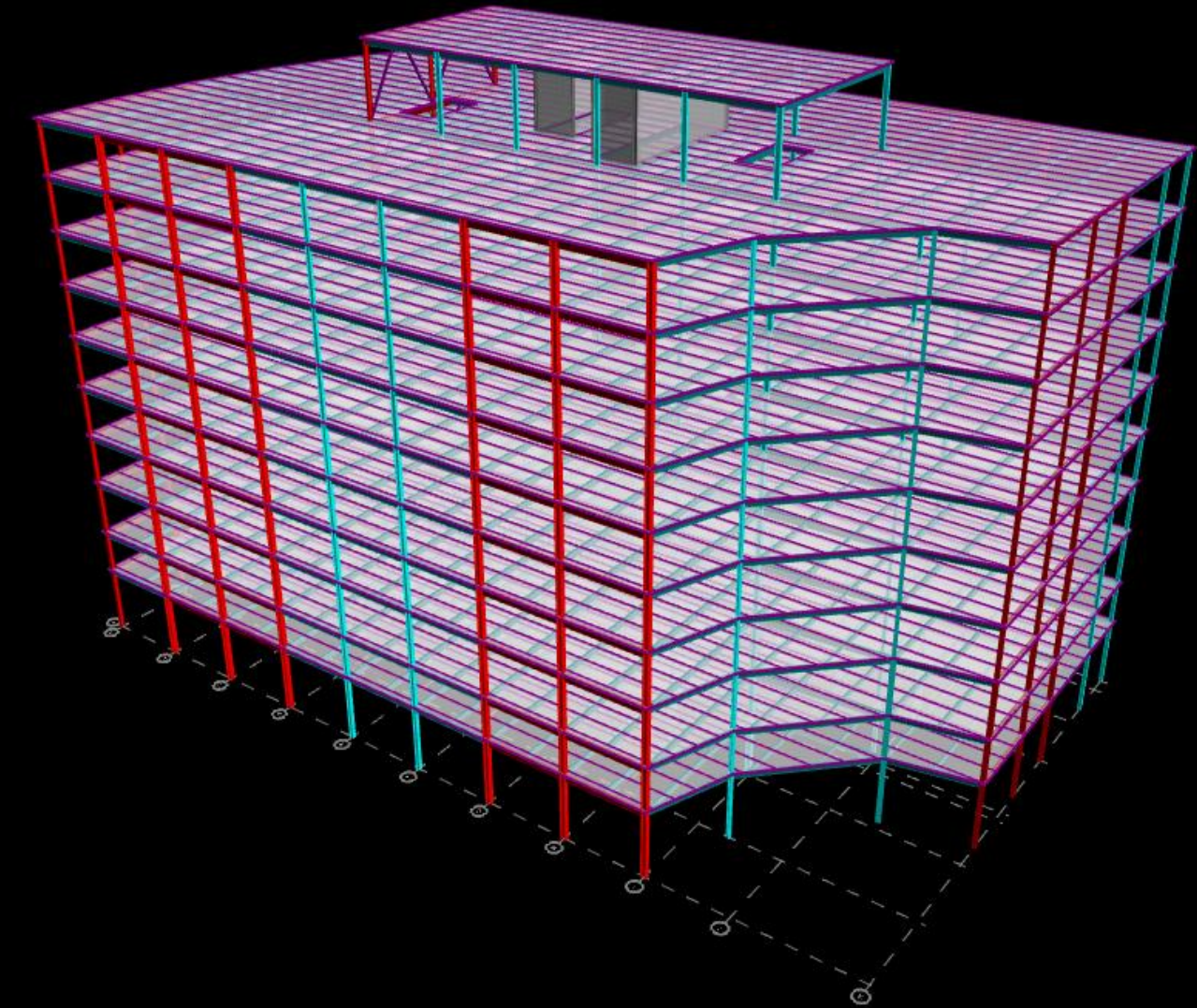
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## Gravity Design

- 3.25" Lightweight Concrete slab
  - 2", 20 gage metal decking
- Beam spacing – 10' max
  - Unshored
  - Long span direction
- Columns spliced every two levels

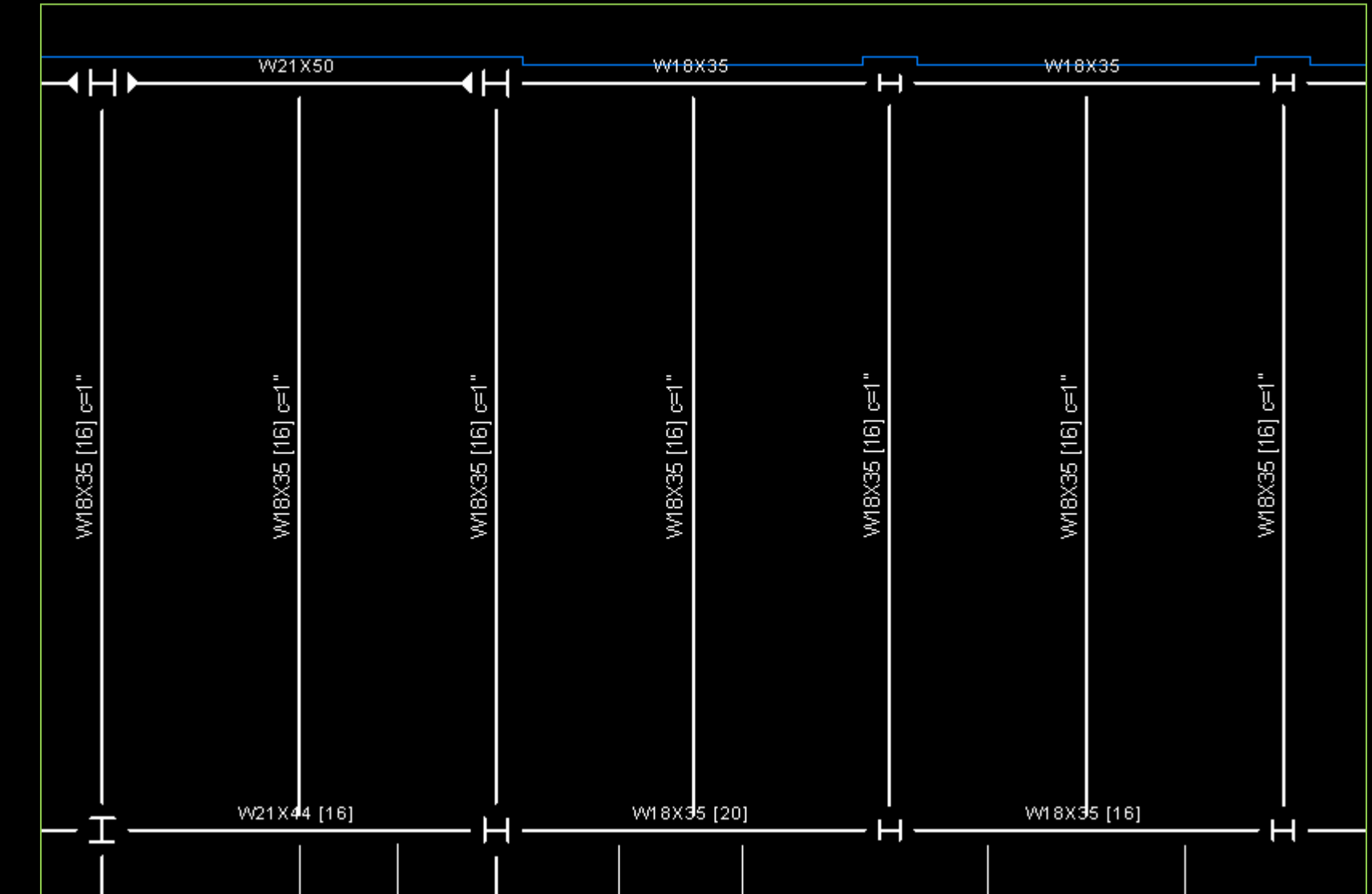


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- Typical Sizes – W18x--
- Floor depth
  - Increased Overall
- Retain original column location
  - Coordinating varying levels



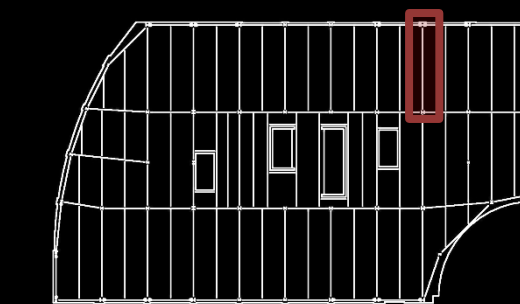
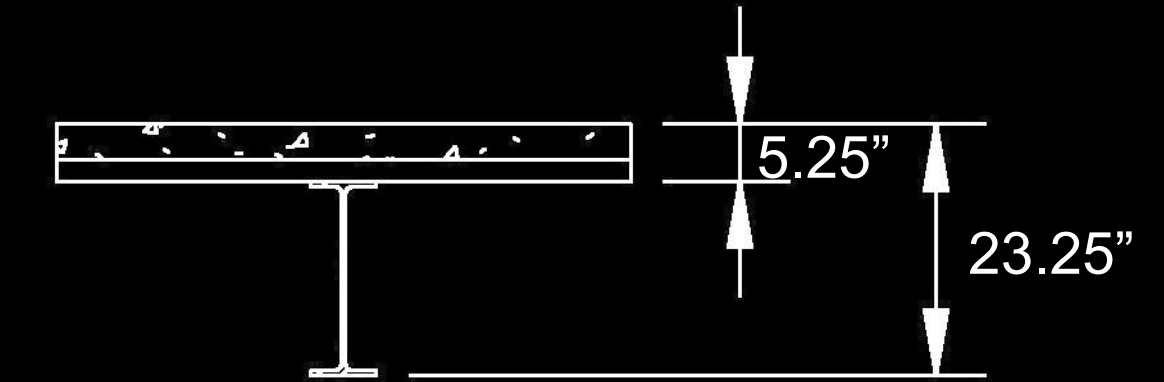
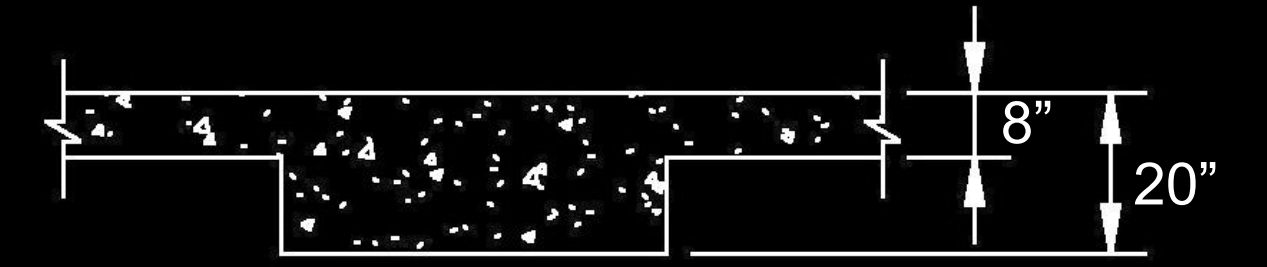
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## Gravity Design

### Floor Depth

- Retain ceiling heights
- MEP space considerations



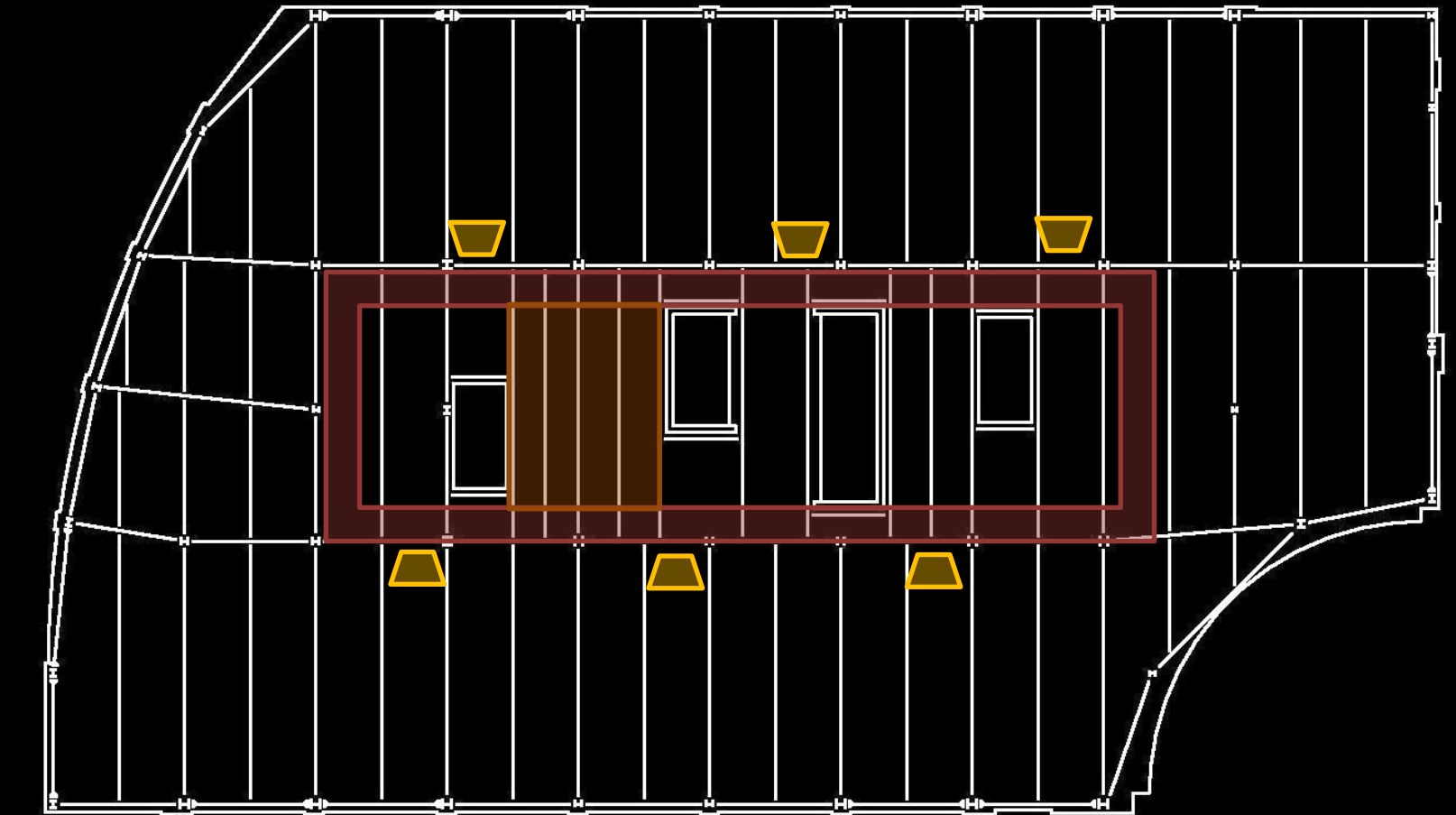
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## Gravity Design

### Floor Depth

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- Retain ceiling heights
- MEP space considerations
- Increase floor depth on each level
  - Approximately 8' added to building height
  - Exceeds zoning



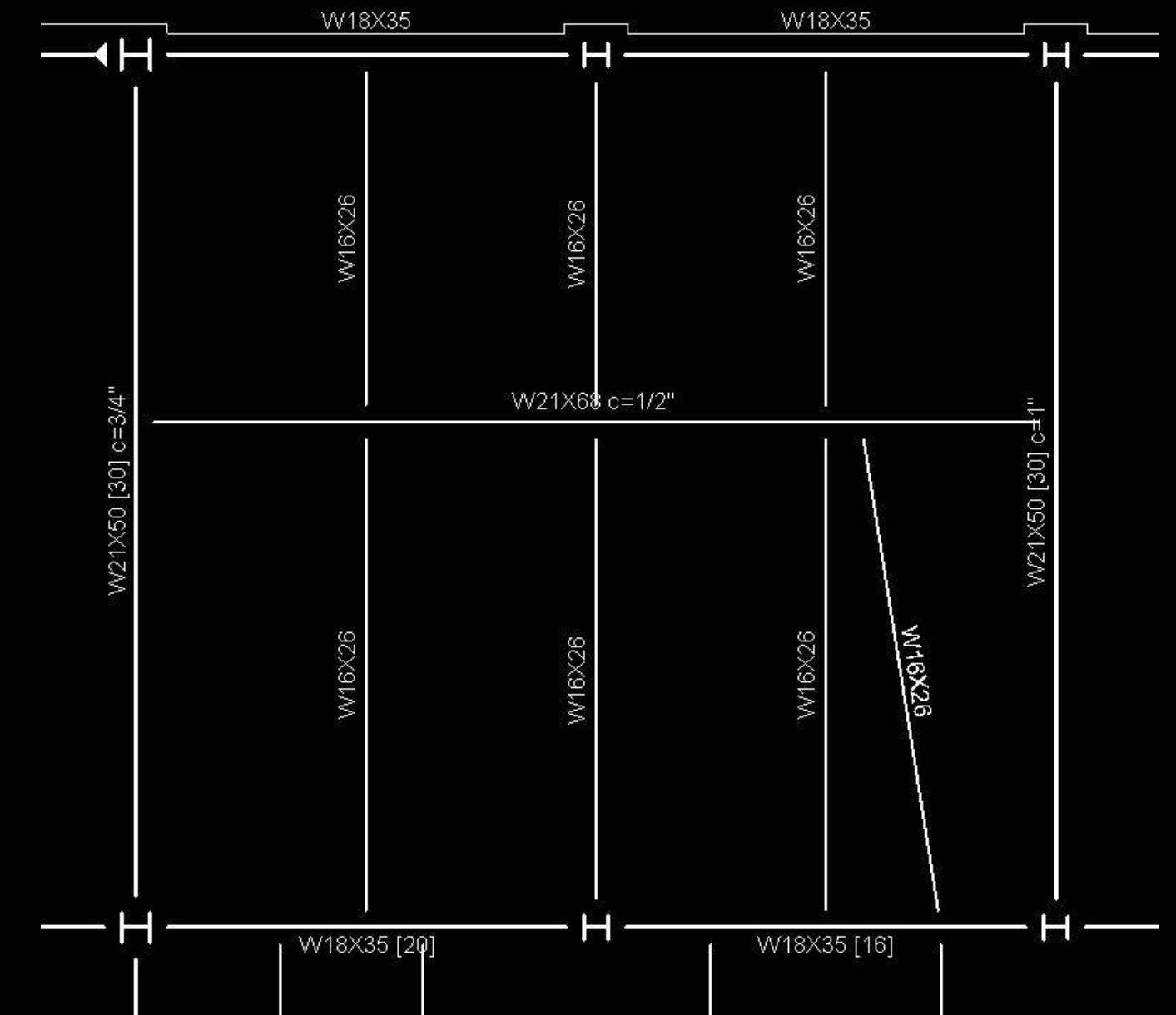


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## Gravity Design Floor Opening

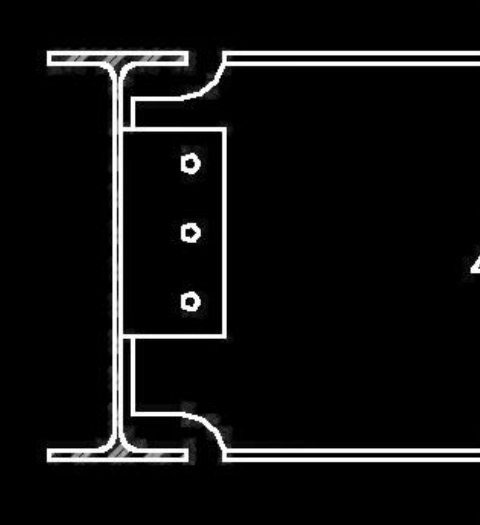
- Design as option
  - Open Section
  - Infill Area
- Design for each scenario
  - Beam Design
  - Column Design



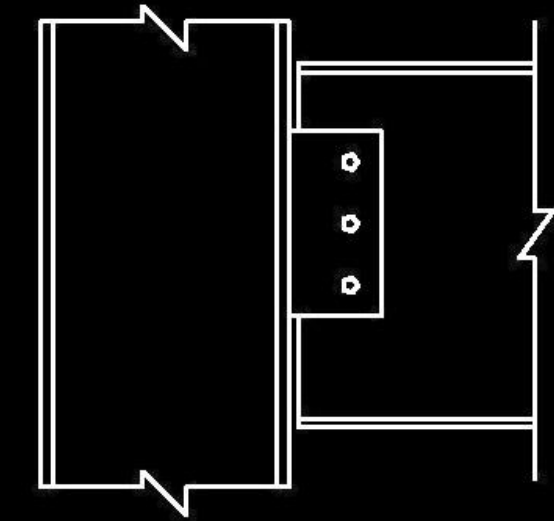
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## Gravity Design Connections

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Beam-to-Girder  
Shear Tab

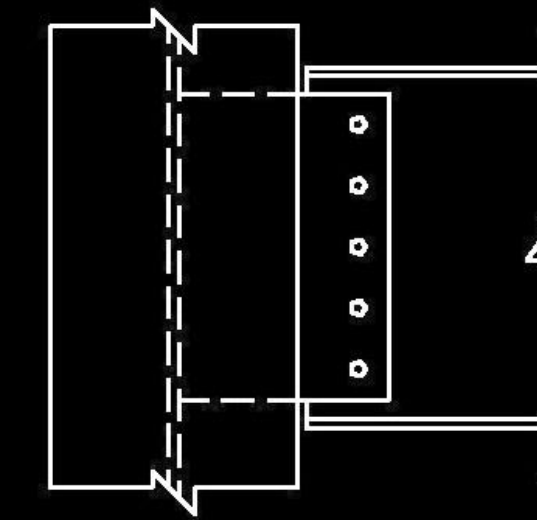
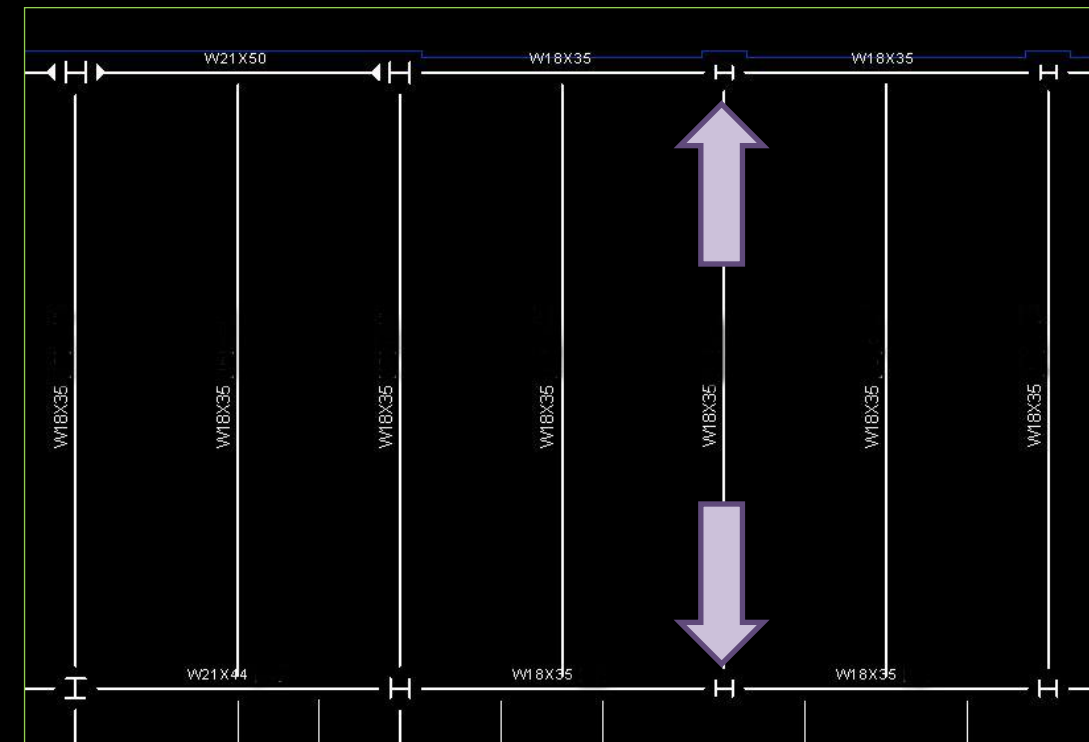


Beam-to-Column  
Shear Tab

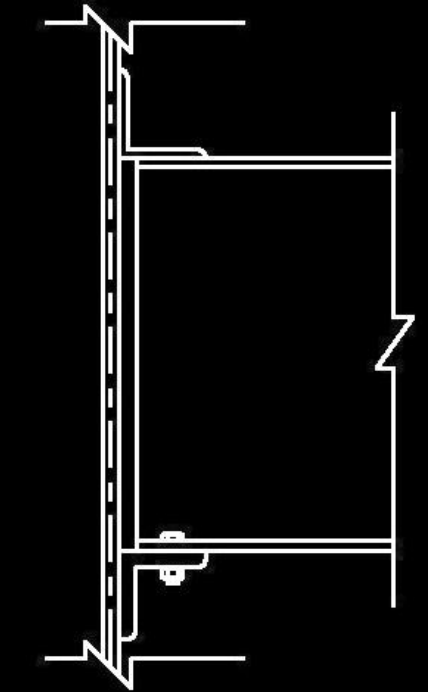
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- Beam-to-Column Extended Shear Tab (Upper Level)



- Beam-to-Column Unstiffened Seat (Lower Levels)



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## Lateral Design

- Wind – Method 2 of ASCE 7 (Chapter 6)
- Seismic – ELFP of ASCE 7 (Chapter 11)
  - Seismic design category
  - Seismic base taken at plaza level
- Wind controlled both strength and serviceability



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## Lateral Design Load Comparison

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- Building height increased
  - Wind loads increased
- Building weight reduced
  - Seismic loads decreased
- Wind controls

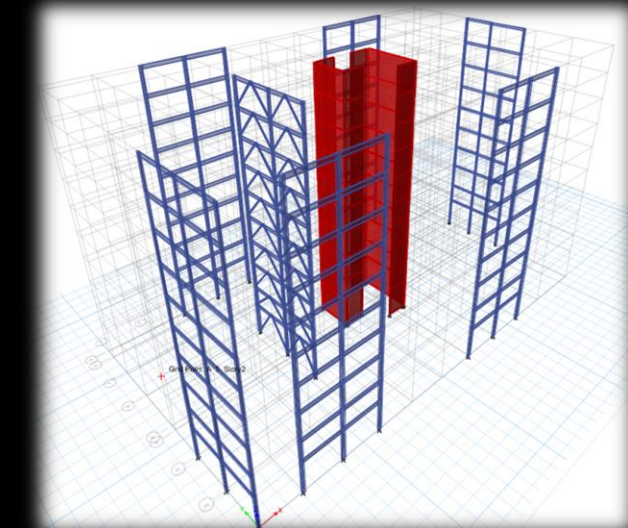
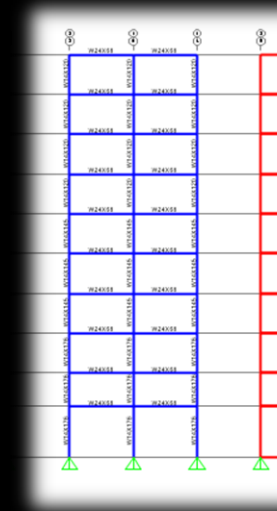
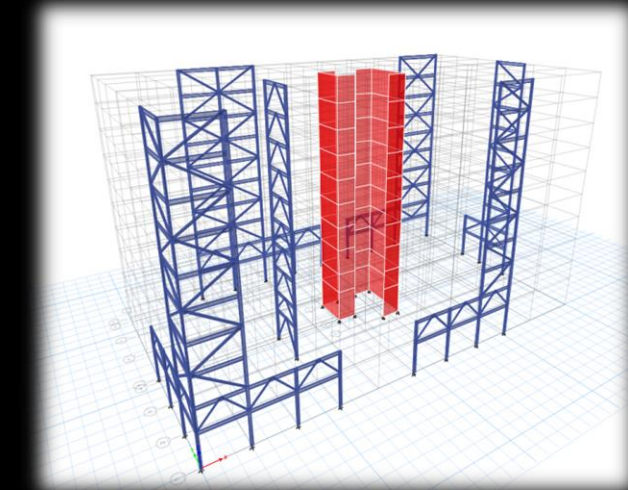
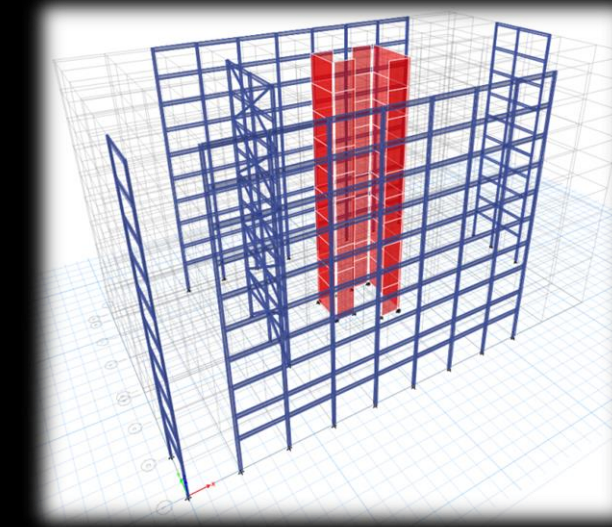
Base Shear (kips)		
	Concrete	Steel
Wind N-S	247	265
Wind E-W	497	536
Seismic N-S	643	442
Seismic E-W	643	479

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- ❑ **Architectural study**
  - ❑ **Eliminated exterior braced frames**
- ❑ **Structural investigation**
  - ❑ **Isolate lateral system**
  - ❑ **Determine efficient design**

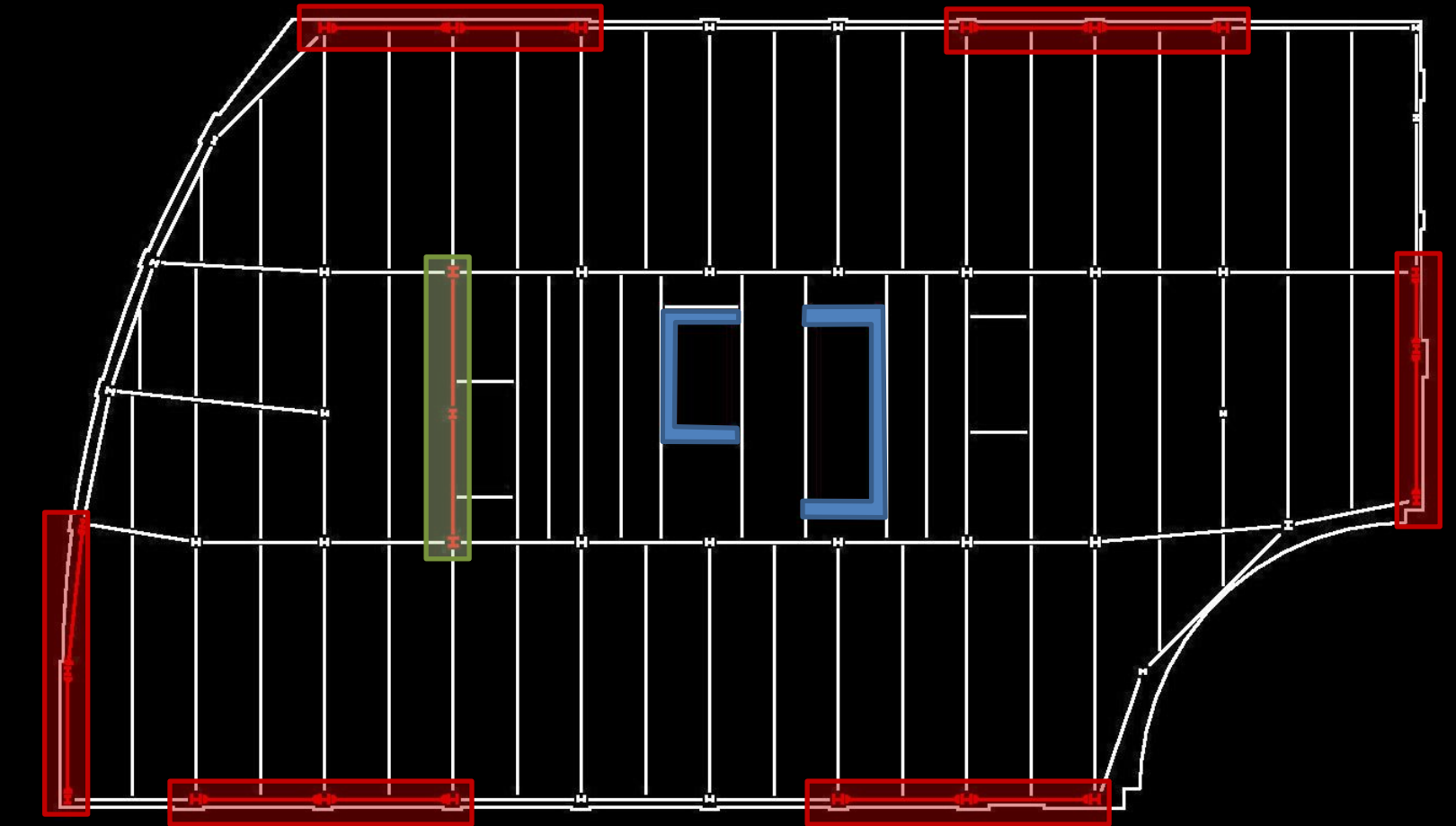


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- Concrete core shear walls
  - Architectural concerns
- Perimeter steel moment frames
  - Retain open floor plan/exterior views
- Centrally braced frame
  - Realign center of rigidity

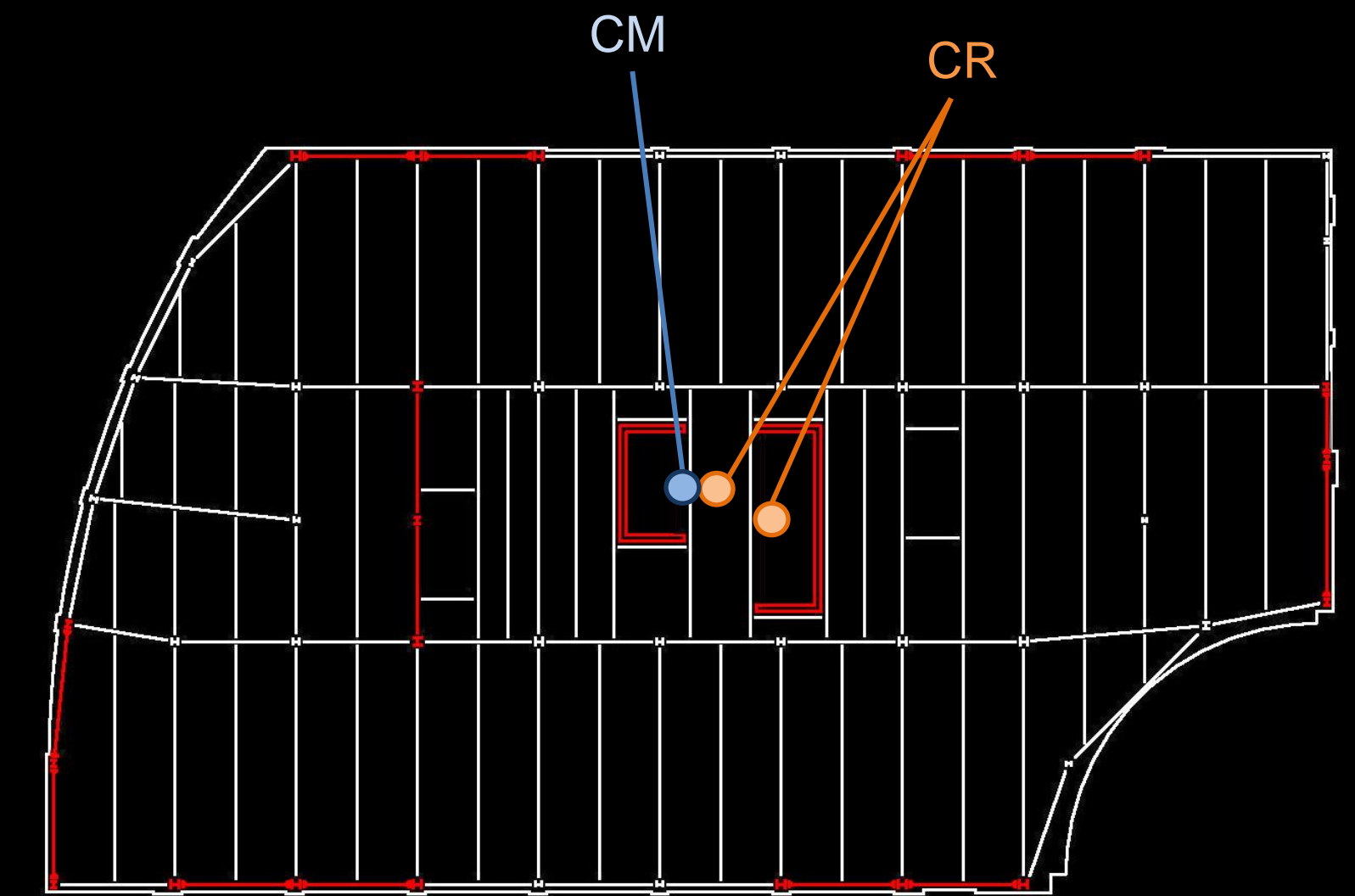


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Original ecc. = 17.5'

Redesigned ecc. = 3.5'

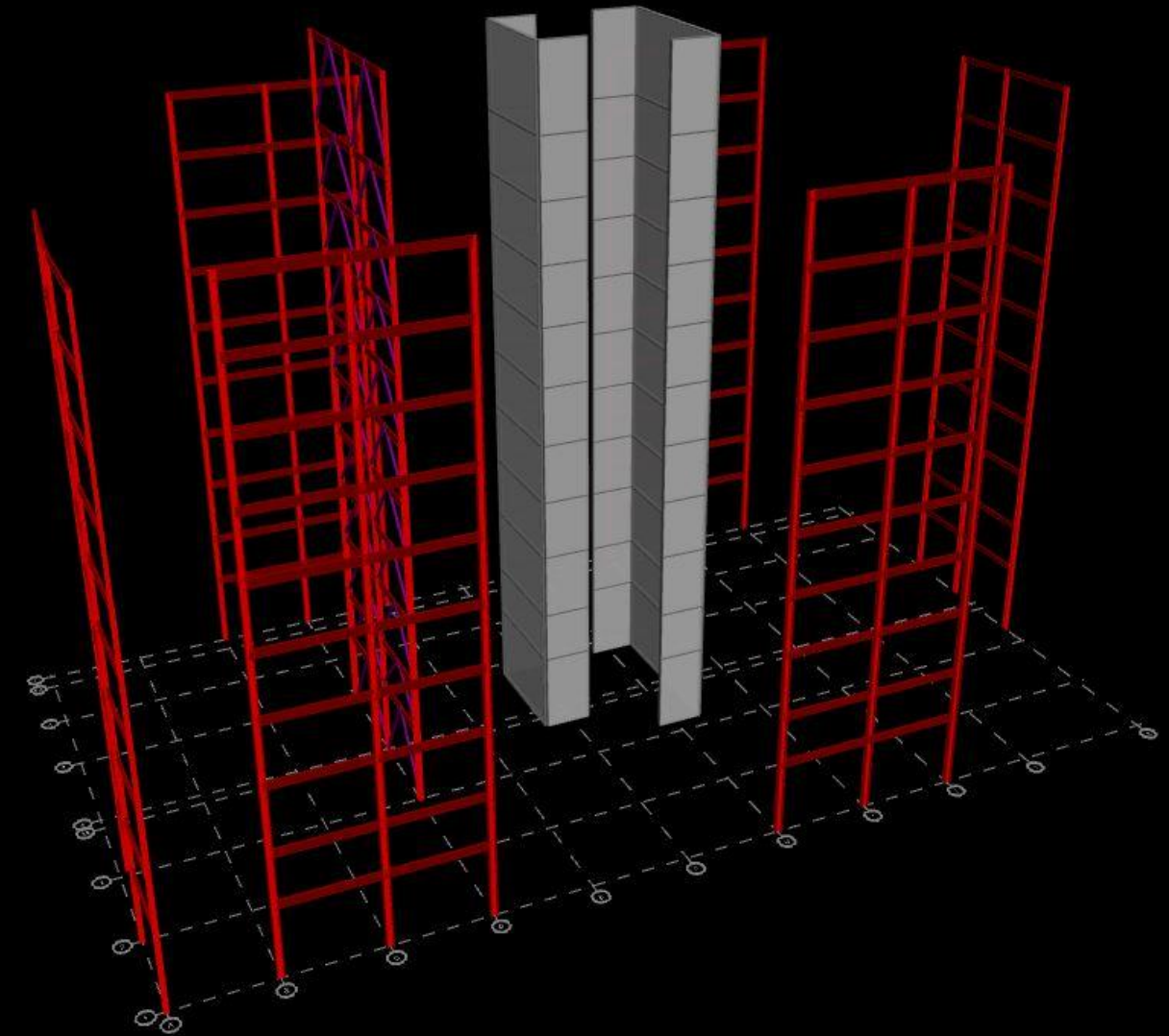
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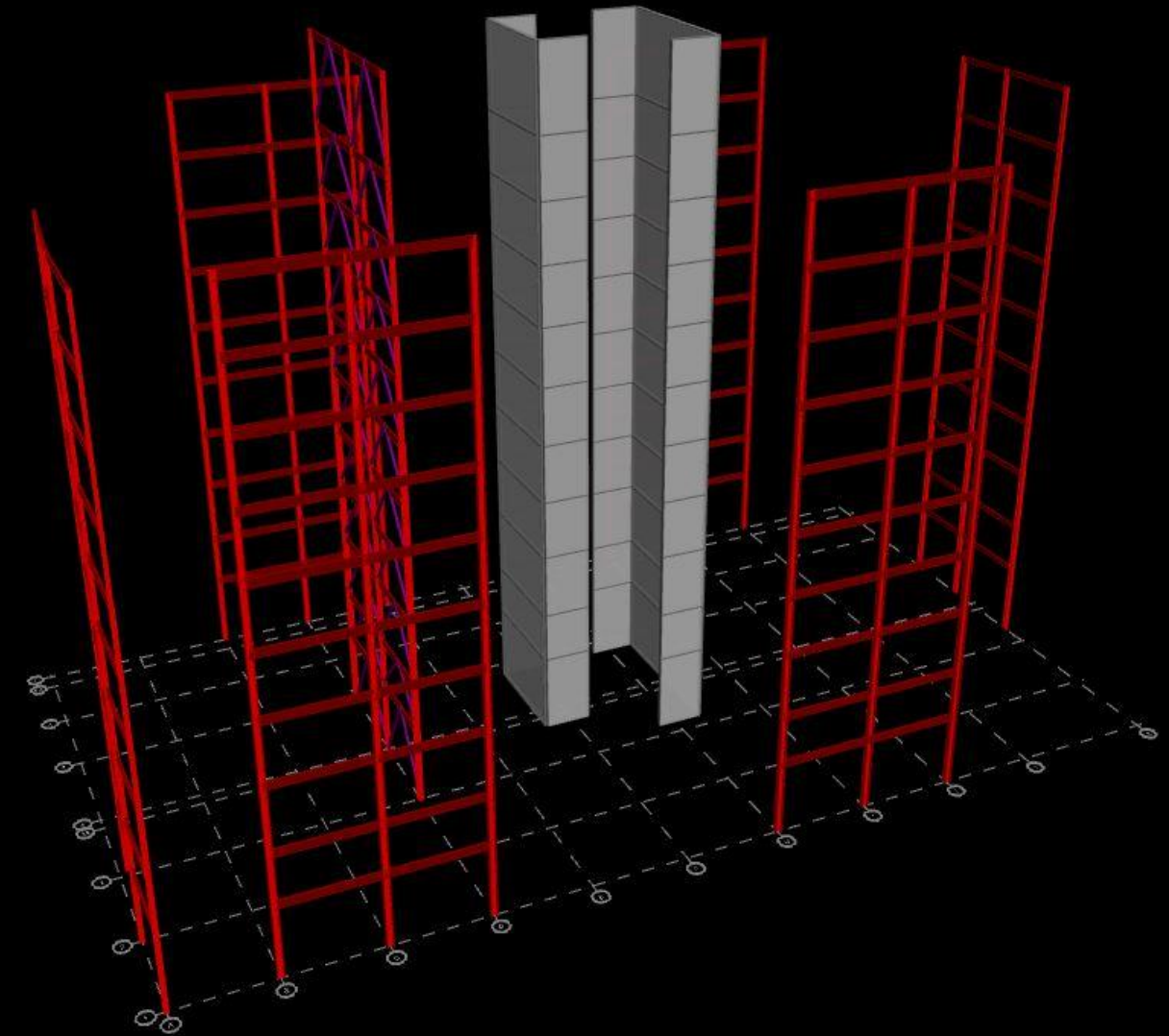
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## Lateral Design

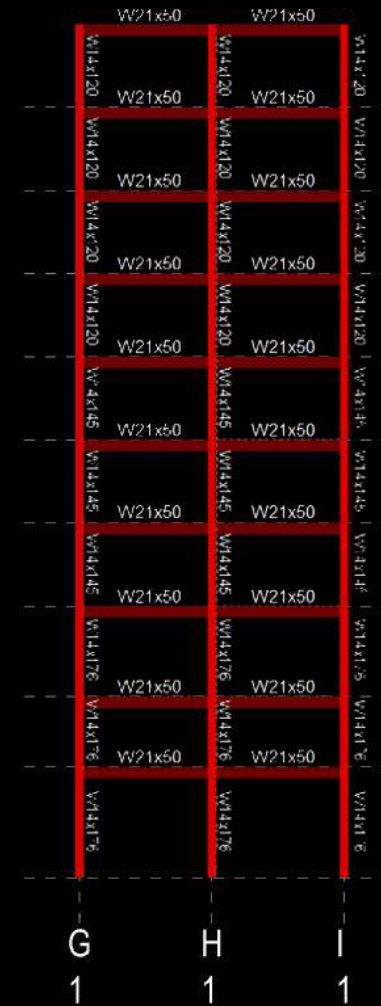
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- Rigid diaphragm assumption
- Walls neglect out of plane stiffness
- Concrete stiffness modifies as per ACI 318-11
- P-Delta Checks
- Drift Checks



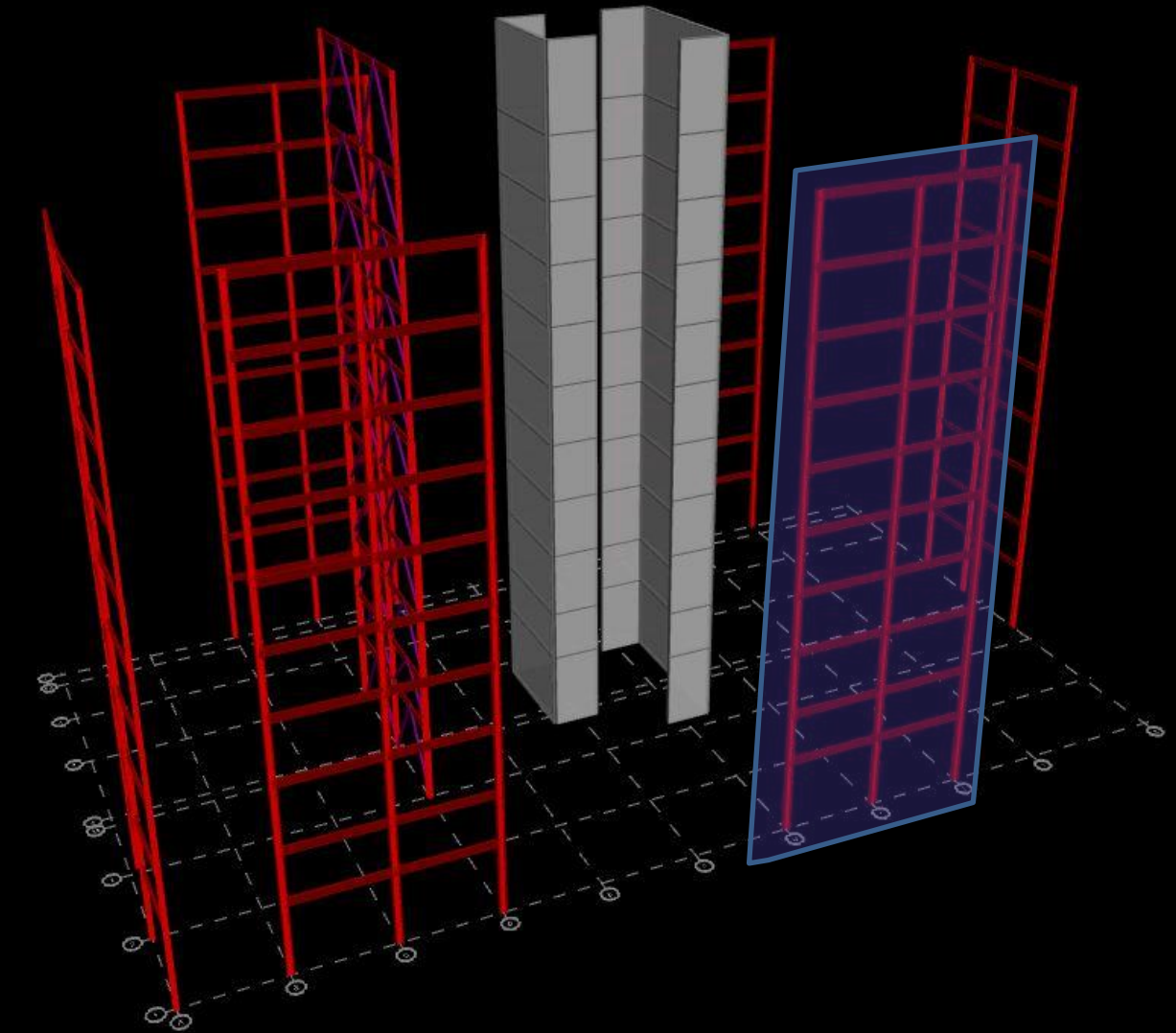
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## Lateral Design Moment Frame

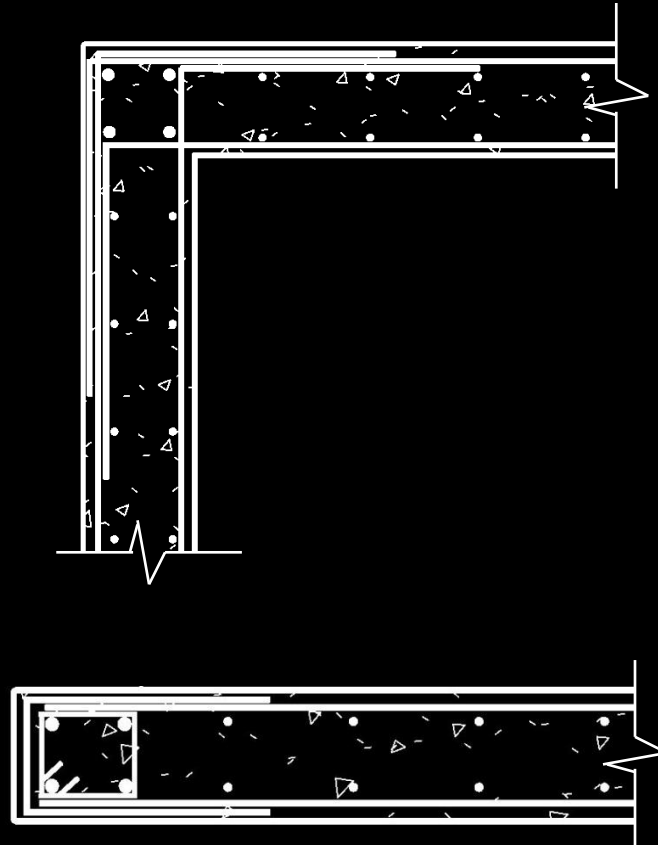
- Strong column – Weak beam
- Serviceability controls design
  - Wind drifts
- Perimeter frames
  - Further mitigate torsion effects





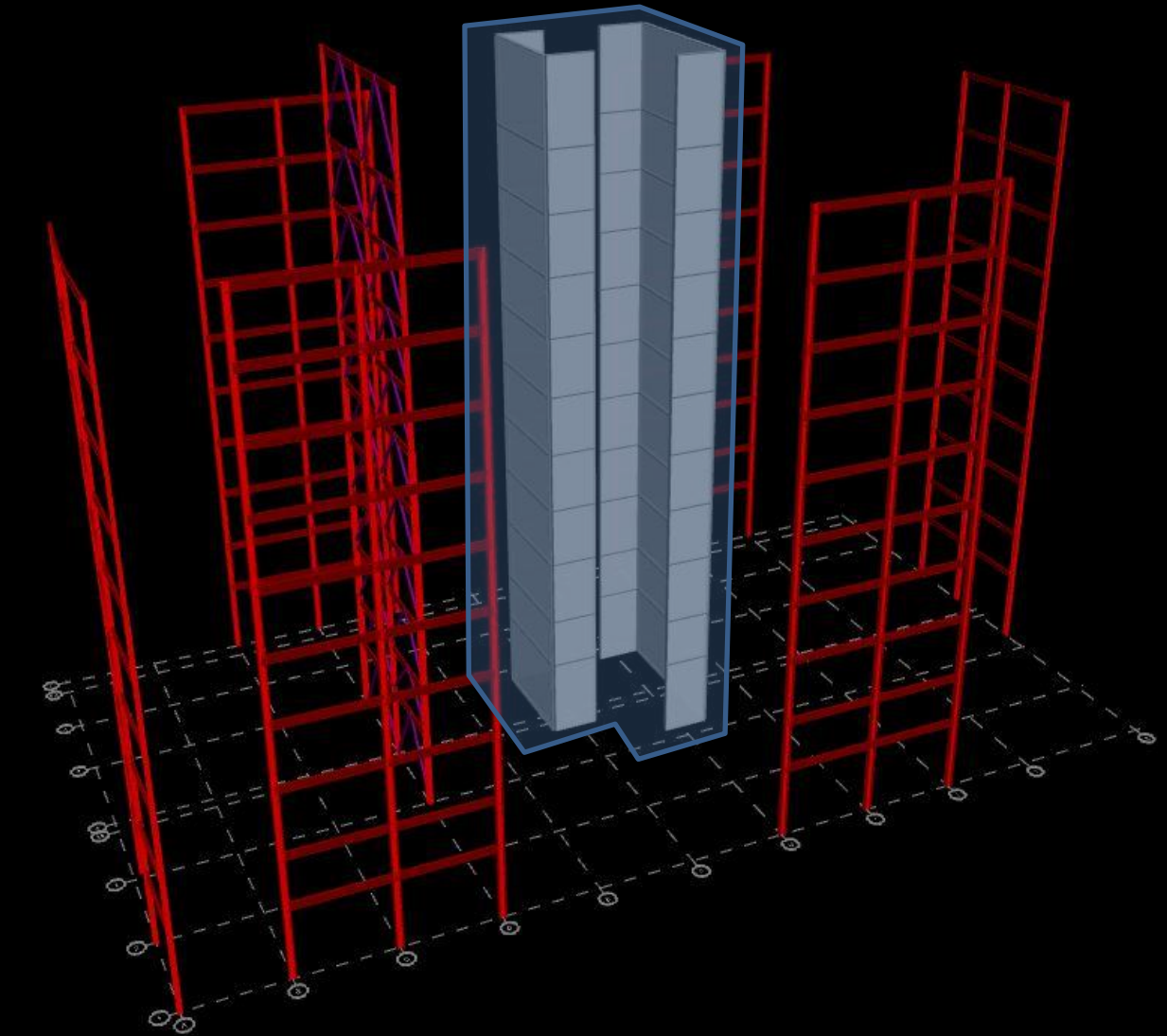
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## Lateral Design Shear Walls

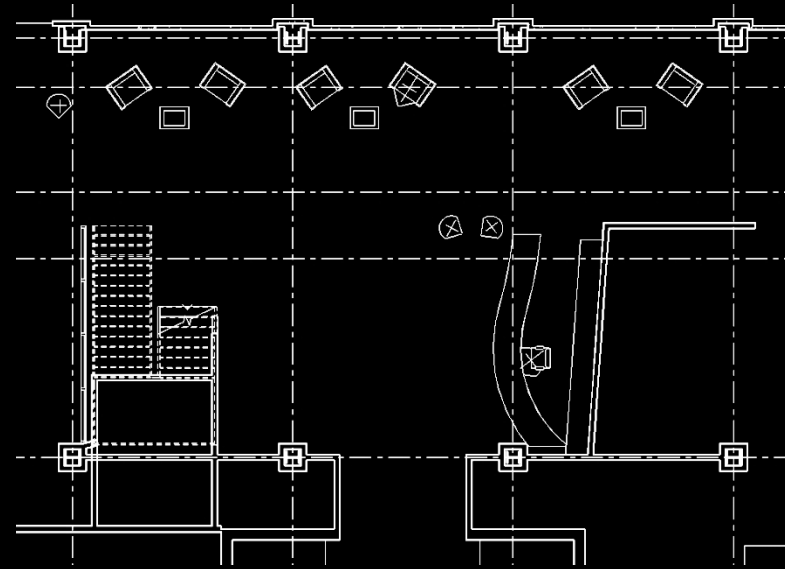
- ❑ Controlling load combination
  - ❑  $0.9D + 1.6W$
- ❑ Wall Thickness – 12"
- ❑ #4 @ 12" o.c. EW
- ❑ Boundary reinforcing for flexure



# Rockville Metro Plaza II

## Architectural Study

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- ❑ Produces exciting lobby space
- ❑ Connects levels more intimately



- ❑ Creates sitting room mezzanine
- ❑ Adds to the open feel of the space



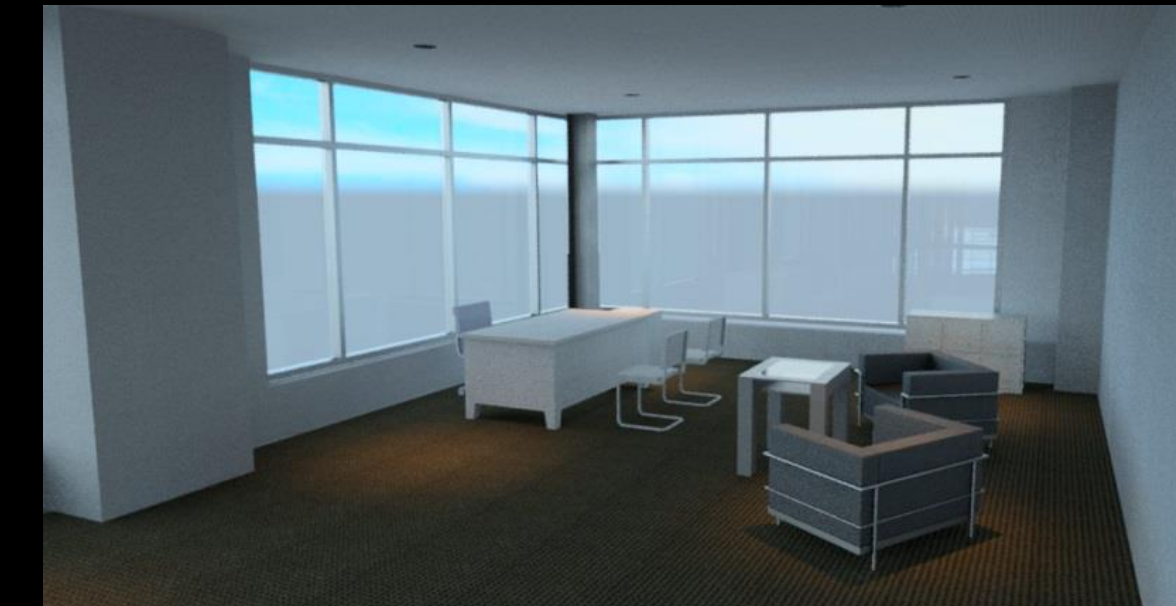
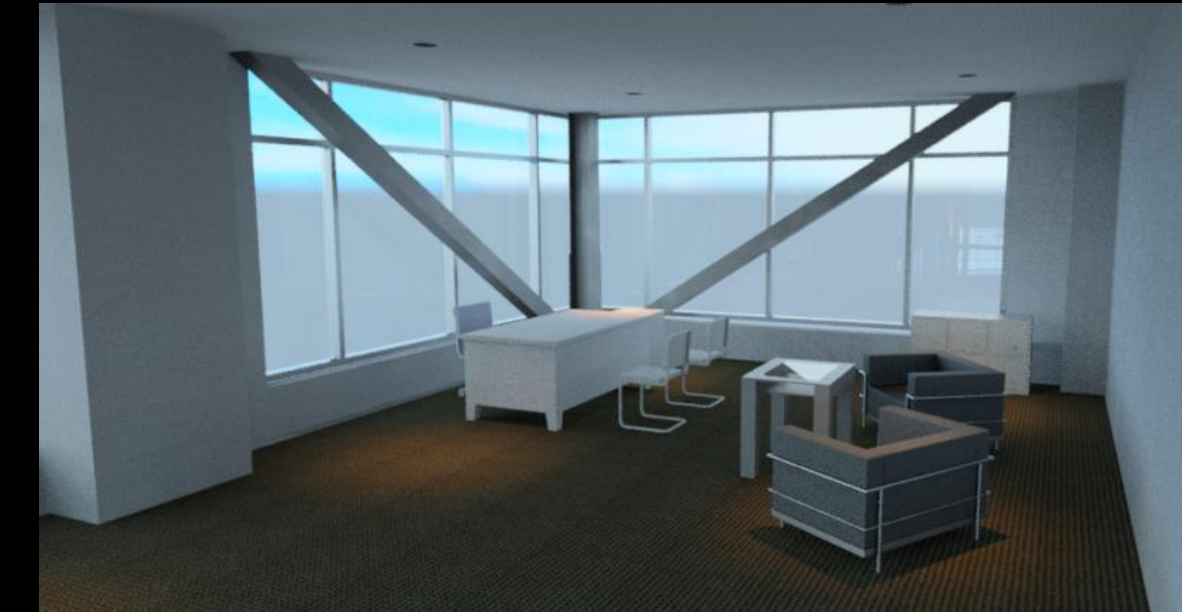
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- ❑ **Exterior Braced Frames**
  - ❑ Obstruct exterior views
  - ❑ Obstruct building entrances
  - ❑ More expensive façade (if built integrally)
- ❑ **Interior braced frames**
  - ❑ No walls for placement
  - ❑ Hinder flow of open floor plan
- ❑ **Conclusion to employ moment frames**



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## Construction Study

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- Detailed estimate calculated for each system**
- Cost of structure reduced by 5%**
- Predicted schedule reduction of 11 months**

Concrete Option Summary	
	Tot. Incl O&P
Concrete Formwork	\$3,237,060
Structural Concrete	\$985,143
Placing Concrete	\$470,352
Finishing Concrete	\$306,404
Reinforcing	\$1,226,880
<b>Total</b>	<b>\$6,225,841</b>

**\$26.55 per sf**

Steel Option Summary	
	Tot. Incl O&P
Steel Deck	\$736,339
Welded Wire Fabric	\$126,631
Placing Concrete	\$107,610
Finishing Concrete	\$225,122
Concrete Topping	\$724,614
Steel Beams	\$2,379,232
Steel Columns	\$1,133,117
Shear Studs	\$41,754
Fireproofing Beams	\$267,472
Fireproofing Columns	\$138,234
<b>Total</b>	<b>\$5,880,130</b>

**\$25.07 per sf**

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## Conclusion

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- Design Viable Steel System**
- Maintain Architecture**
- Reduced Cost**
- Shorten Schedule**
- Increased Building Height
  - Over Zoning
- Further Coordination Required
  - Architecture
  - MEP



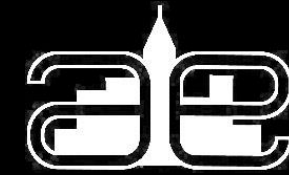
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# Acknowledgements

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- Cagley and Associates
  - Frank Malits
  - Daniel Camp
- Foulger-Pratt
- AE Department
- Family and Friends



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## Questions/Comments

