



# ORANGE REGIONAL MEDICAL CENTER

Middletown, New York

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Structural Option  
AE 482 – Senior Thesis  
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# ORANGE REGIONAL MEDICAL CENTER

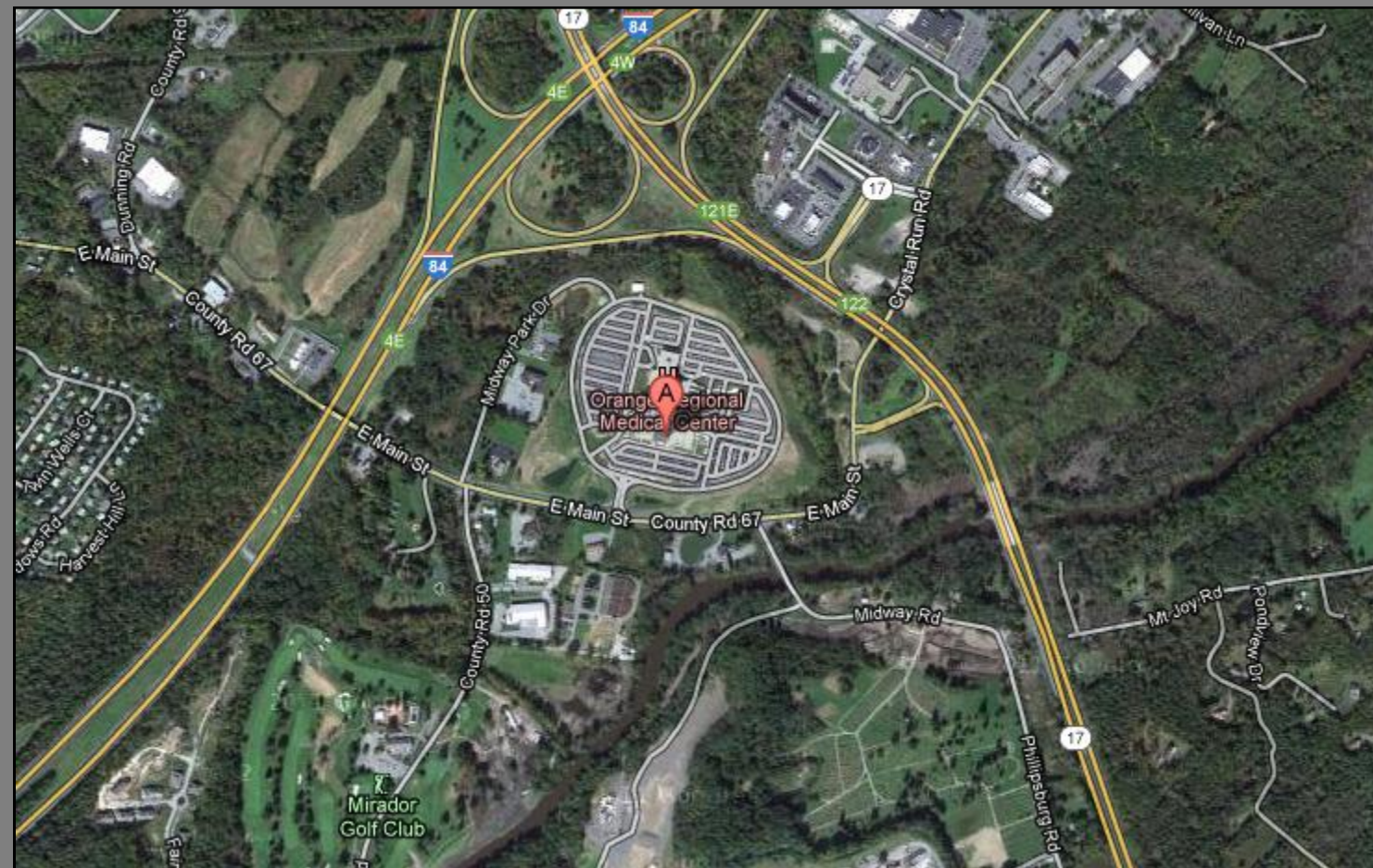


## PRESENTATION OBJECTIVES

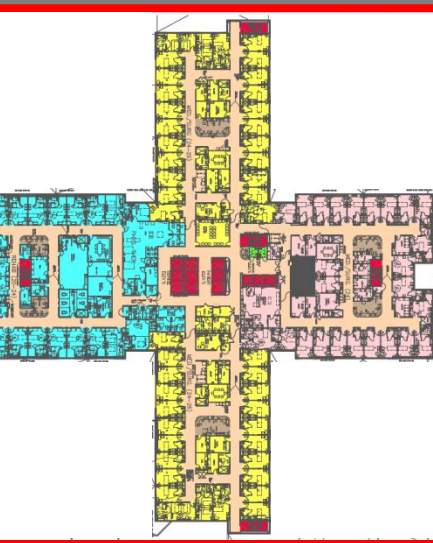
- **Introduction**
- Proposal
- Structural Depth
- Architecture Breadth
- Conclusions



## Existing Building



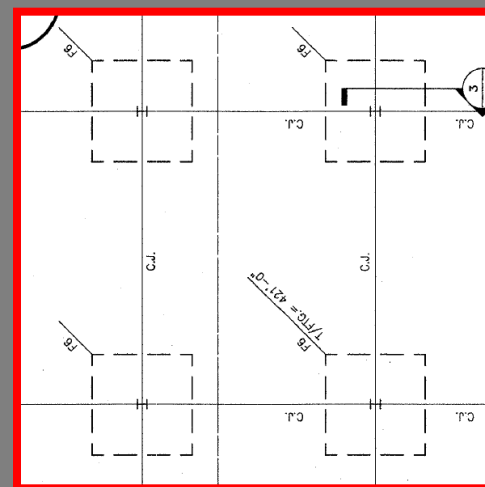
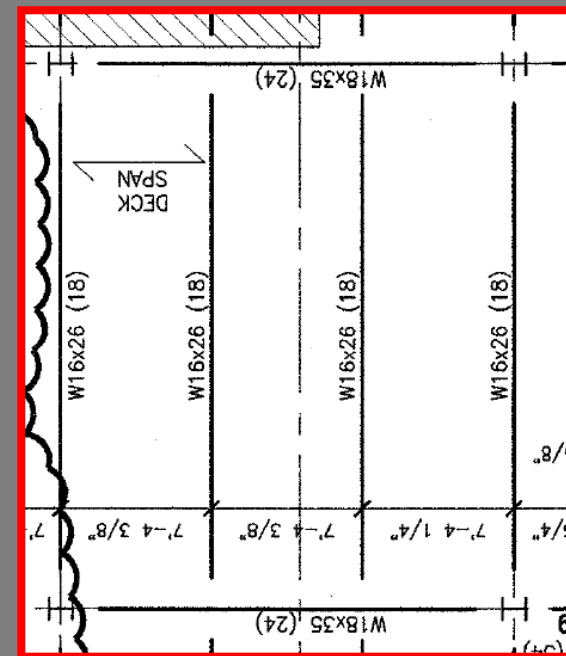
Google Maps



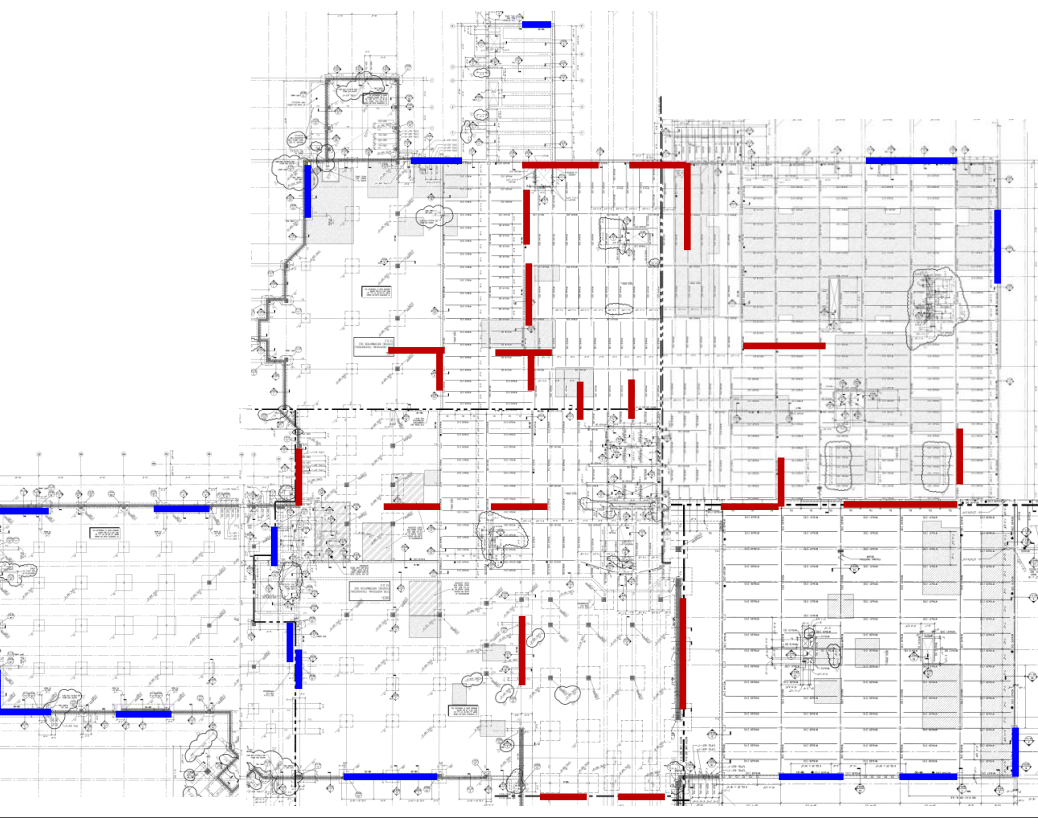
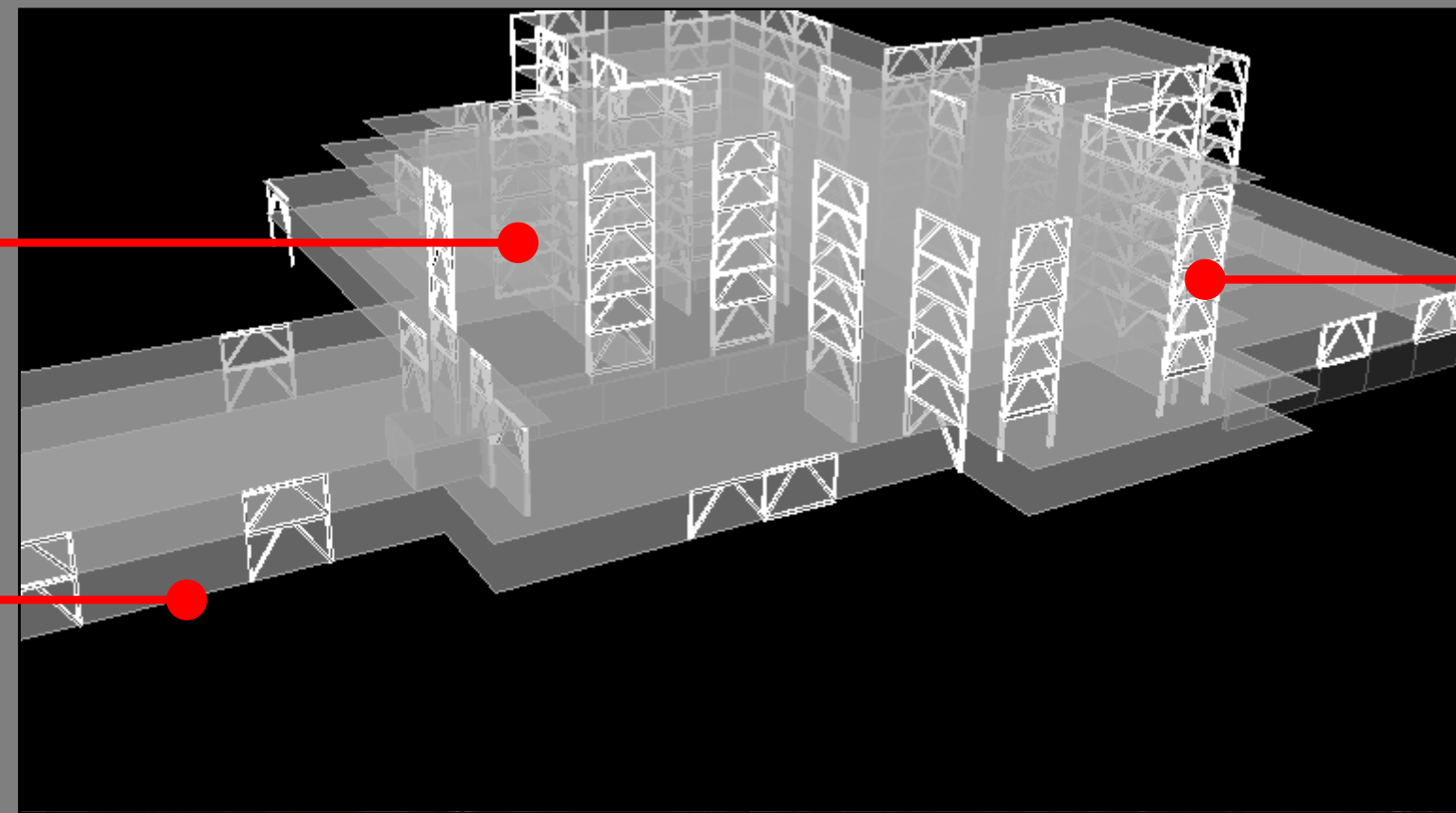
- Designed and constructed by HBE
- \$220 million bare building
- 600,000 SF
- 722,000 SF with future additions
- 7 stories (97.5 ft tall)
- Constructed:  
March 12, 2008  
to  
April 22, 2011

## GRAVITY SYSTEM

- Composite steel beams  
Typically W16x26
- Composite 2VLI20 deck
- Columns typically W12's  
Splices at 2<sup>nd</sup> and 4<sup>th</sup> stories
- Max Span: 30 ft  
Typical Bay: 26' x 22'



## Existing Building



- Full Height Braces
- Lower Level Braces

## LATERAL SYSTEM

- 48 eccentrically braced frames
- 2 concentrically braced frames
- Shear walls from ground to first floor

## FOUNDATIONS

- Spread Footings

## Structural Depth

- Determine if concrete flat slab system is less expensive
- Take advantage of moment frames to eliminate significant amount of braced frames
- Perform gravity and lateral analysis to meet strength, drift, and deflection criteria

## Proposal

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## Architecture Breadth

- Address occupant concerns
  - Rearrange medical departments
  - Remove structural braces from windows
- Continue hospital's goal of patient comfort
  - Relocate healing garden

## Structural Depth

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## Construction Management Breadth

- Cost Analysis
  - Existing Steel Structure
  - Redesigned Concrete Structure
- Schedule Analysis
  - Concrete construction
  - Comparison to steel

## Architecture Breadth

- Address occupant concerns
  - Rearrange medical departments
  - Remove structural braces from windows
- Continue hospital's goal of patient comfort
  - Relocate healing garden

## LOADS USED

- Dead: 145 psf
- Live: 100 psf
- Snow: 28 psf

## Gravity Design

- Used CRSI Handbook to determine initial sizing
- Hand calculations for pure axial sizing

## Structural Depth

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## Lateral Design

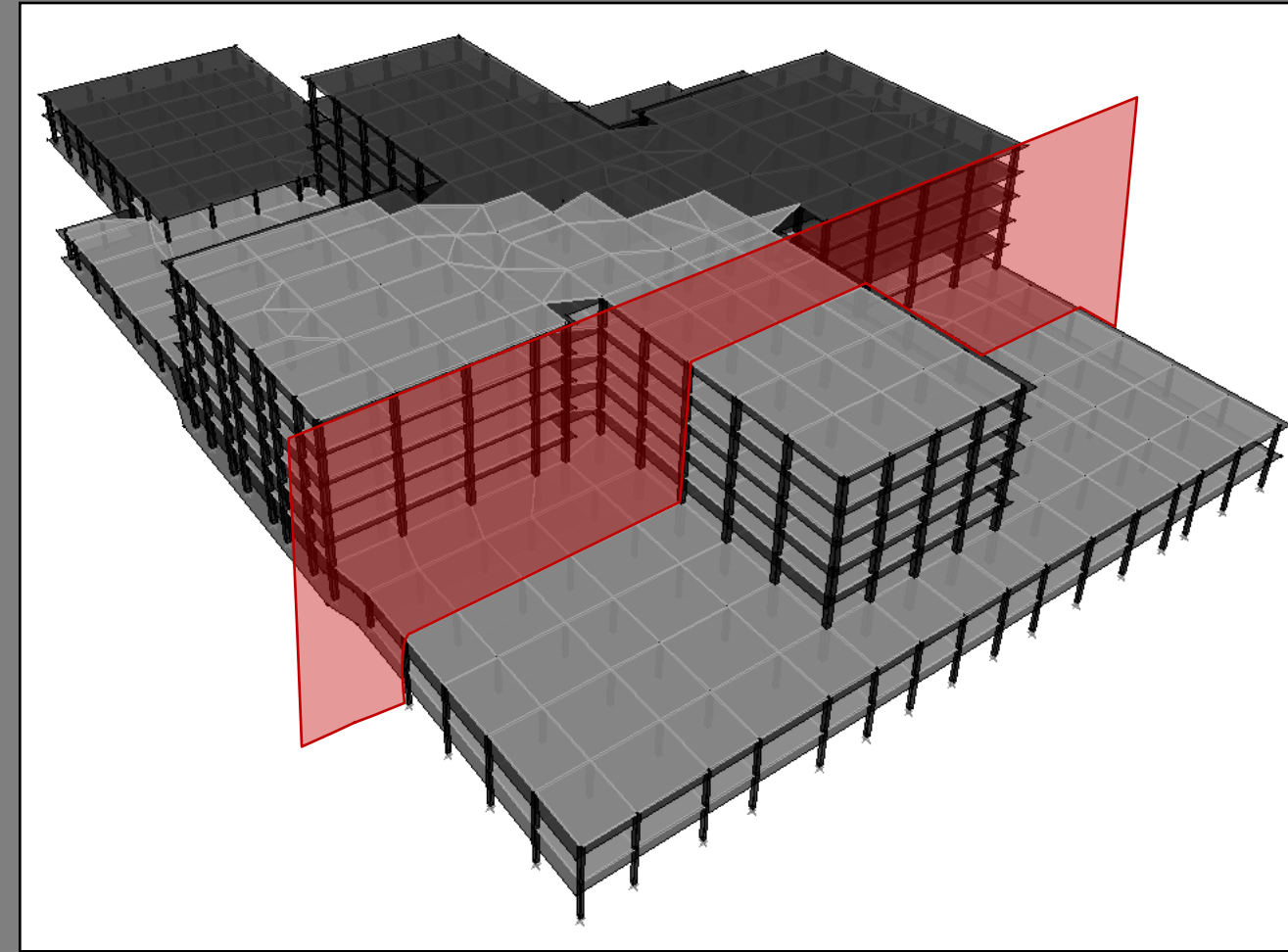
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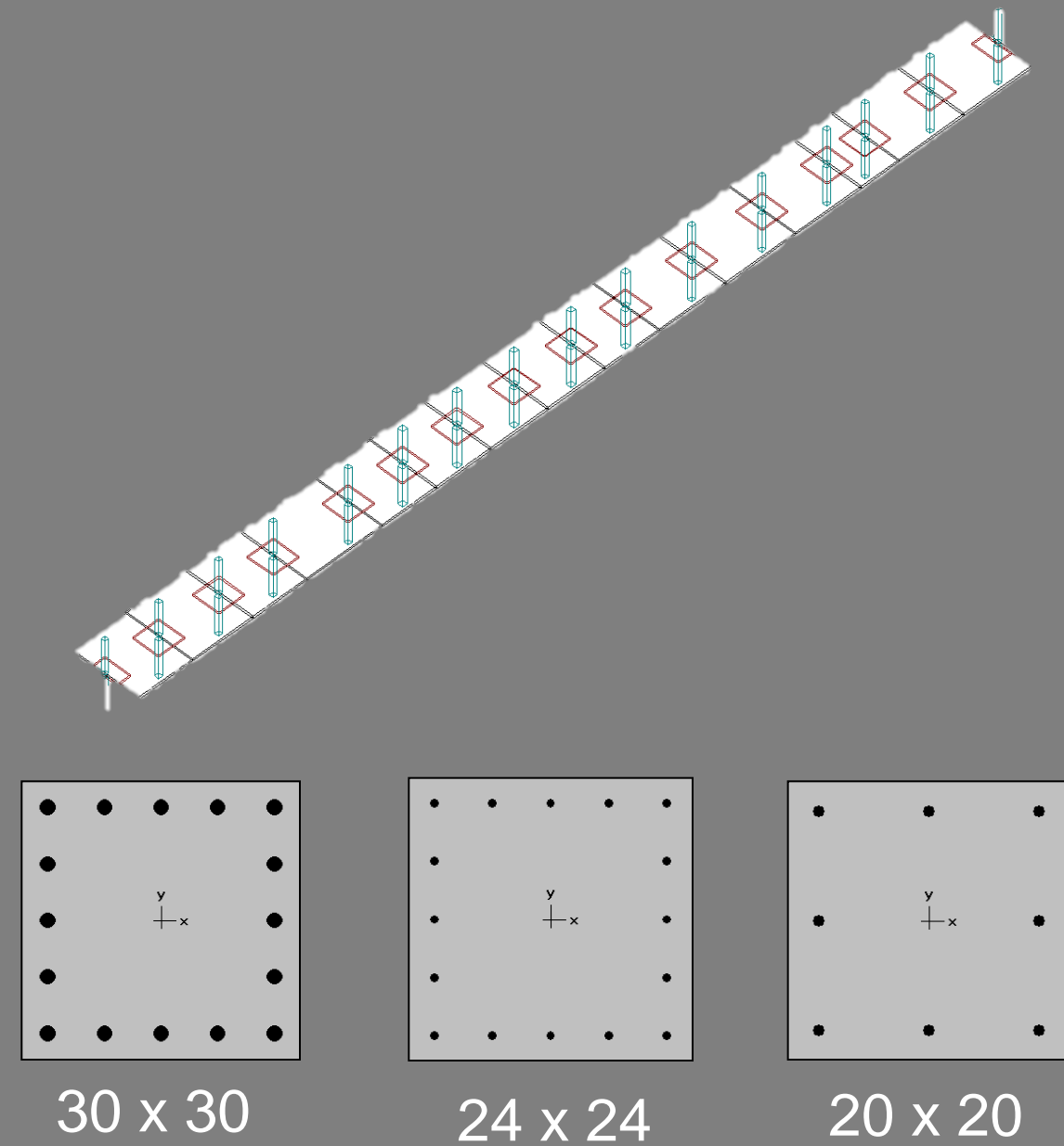
## Structural Depth



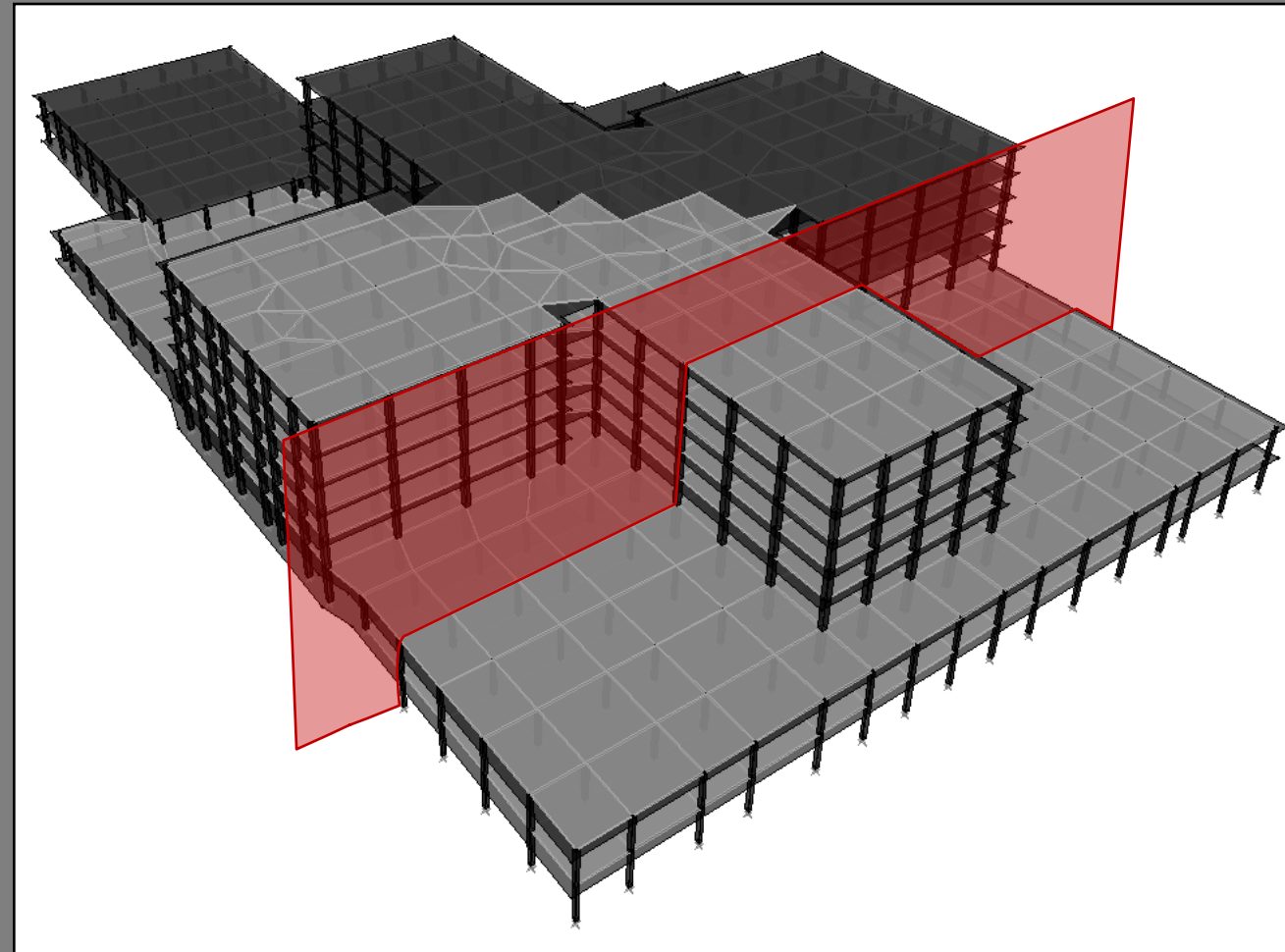
## Lateral Design

- Ran portal method for preliminary forces



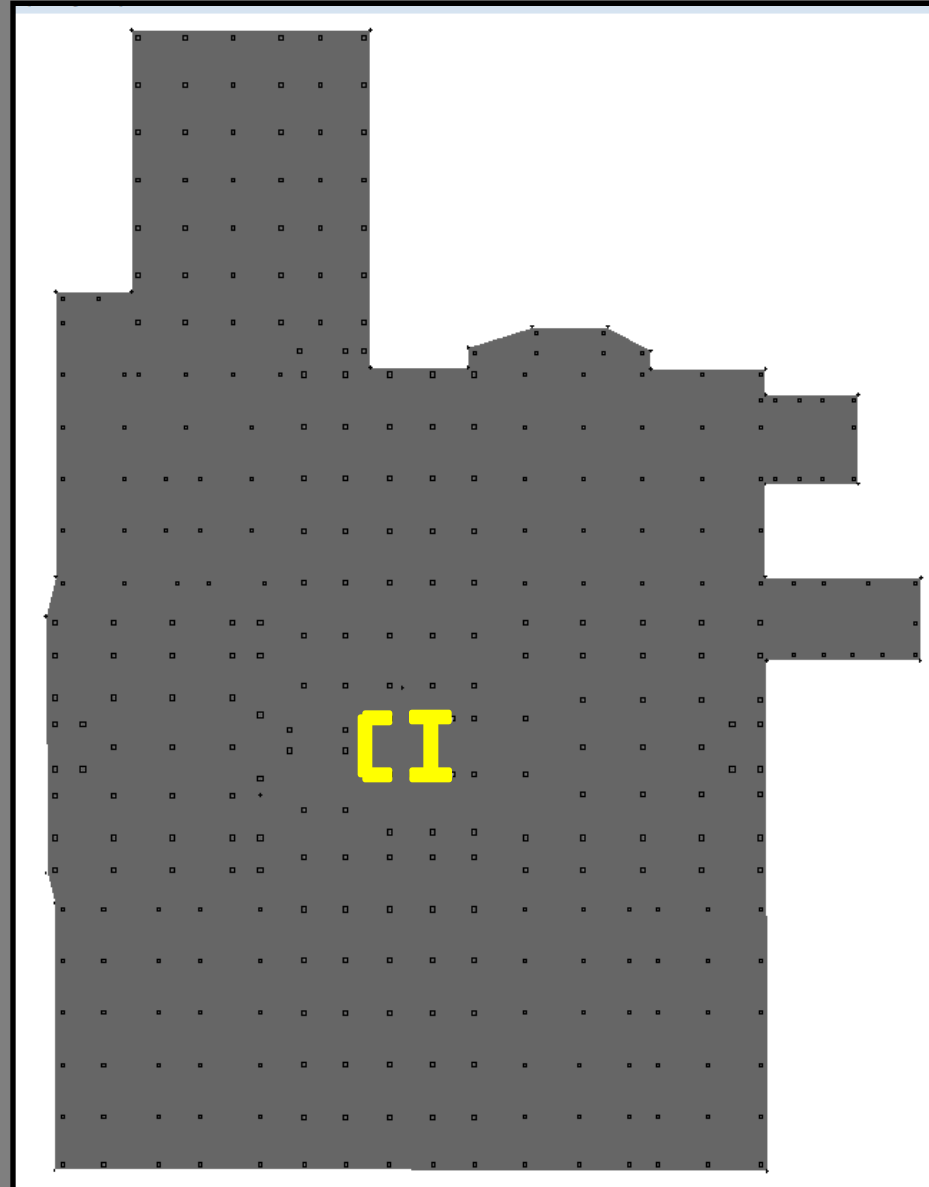
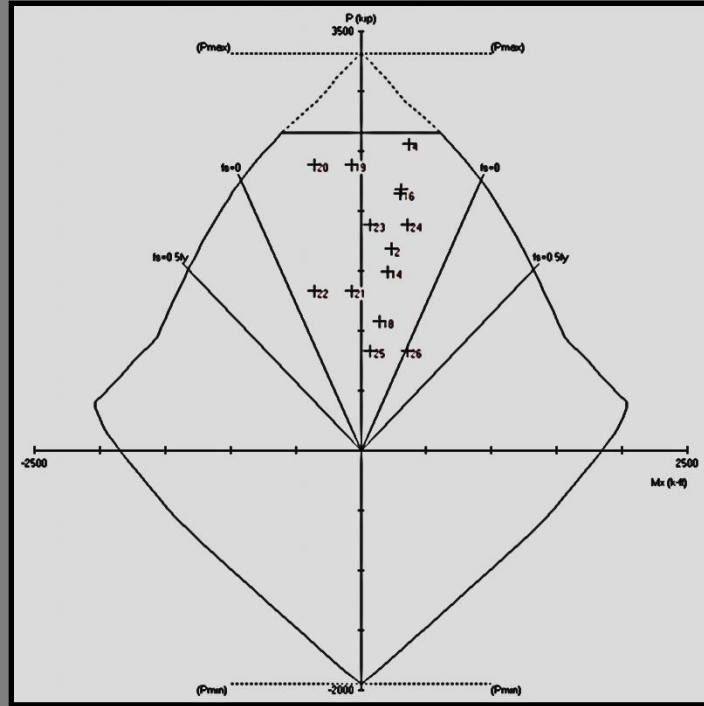


## Structural Depth

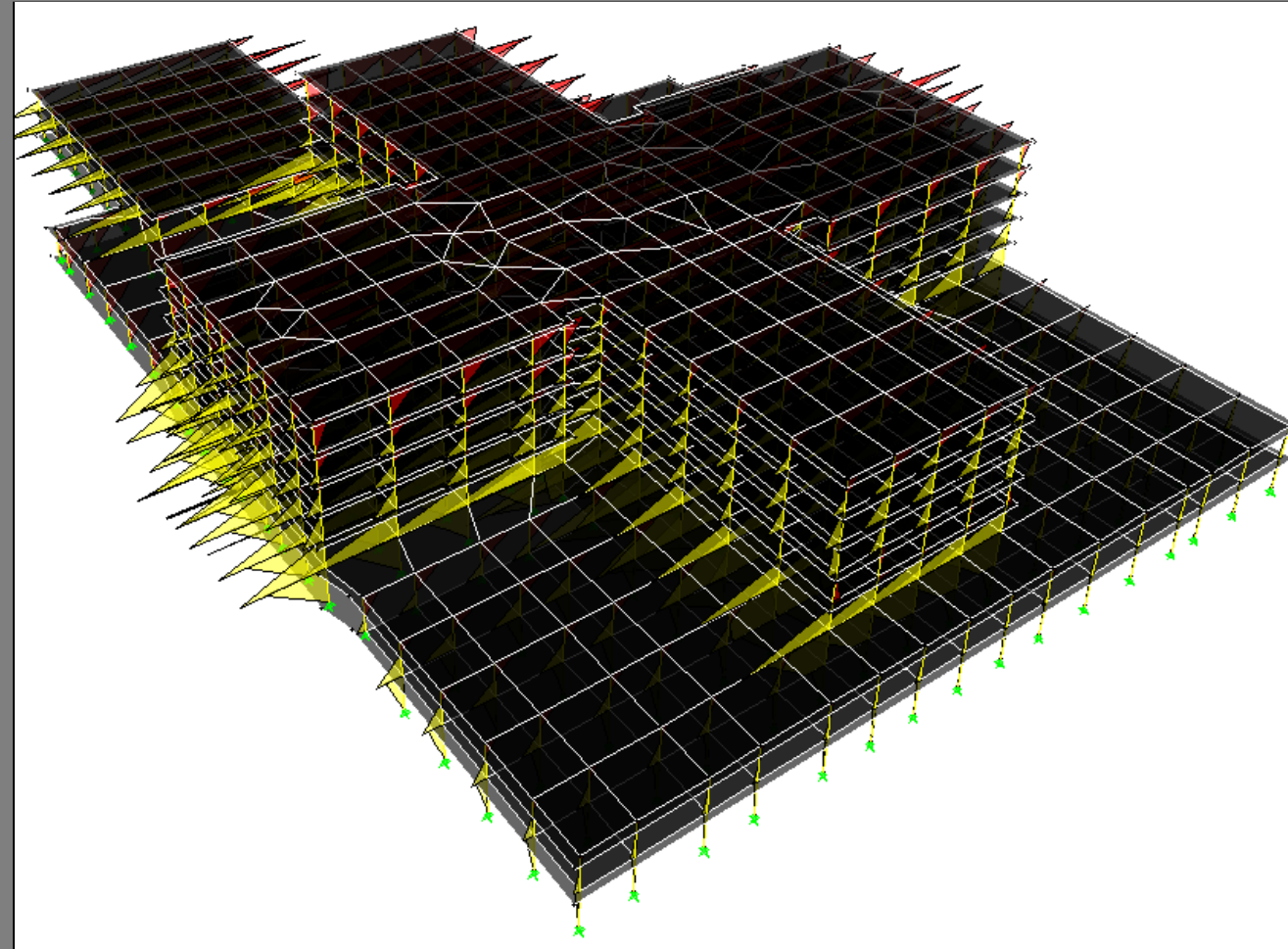


## Lateral Design

- Ran portal method for preliminary forces
- Designed square columns using spColumn
- Sizing became an iterative process between ETABS, spColumn, and spot checks by hand
- Final sizes entered into spSlab to check slab and design reinforcement



## Structural Depth



## Lateral Design

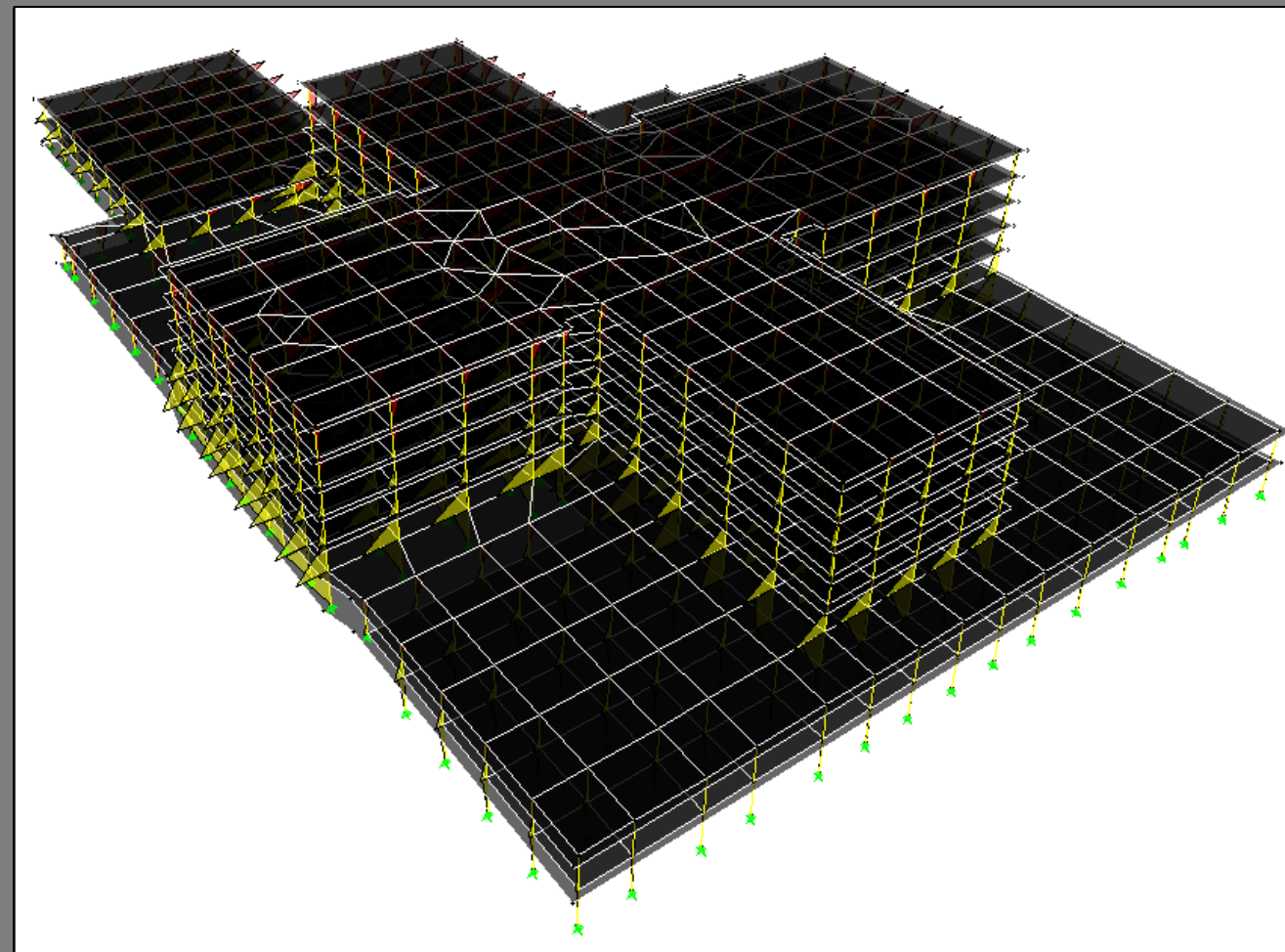
- System had to meet acceptable drift values from seismic load (predominant load)
- Column forces had to fall within interaction diagram
- Geometry caused spike in moment forces at second story
- Addition of shear walls was most effective option

Relative Stiffness	
North/South Direction	
A	0.144
B	0.155
	29.90%
East/West Direction	
D	0.077
C	0.055
F	0.067
E	0.057
	25.60%

#### Seismic Story Drifts

Story	Load	hsx	ETABS Drift X	ETABS Drift Y	Drift X (in)	Drift Y (in)	Allowable	Pass?
Roof	EQx	162	0.004541	0.001415	1.23	0.38	1.62	Yes
Roof	EQy	162	0.001369	0.002426	0.37	0.66	1.62	Yes
6	EQx	156	0.004993	0.001664	1.30	0.43	1.56	Yes
6	EQy	156	0.001628	0.00286	0.42	0.74	1.56	Yes
5	EQx	156	0.005257	0.001855	1.37	0.48	1.56	Yes
5	EQy	156	0.001821	0.003191	0.47	0.83	1.56	Yes
4	EQx	156	0.005039	0.001755	1.31	0.46	1.56	Yes
4	EQy	156	0.00172	0.003134	0.45	0.81	1.56	Yes
3	EQx	156	0.00576	0.00149	1.50	0.39	1.56	Yes
3	EQy	156	0.002393	0.002678	0.62	0.70	1.56	Yes
2	EQx	156	0.005363	0.002279	1.39	0.59	1.56	Yes
2	EQy	156	0.001512	0.002283	0.39	0.59	1.56	Yes

## Structural Depth



## Shear Walls

- Shear walls dropped moment under column capacity
- From ASCE7-10, lateral resistance now defined as dual system
- Drift values fell within criteria

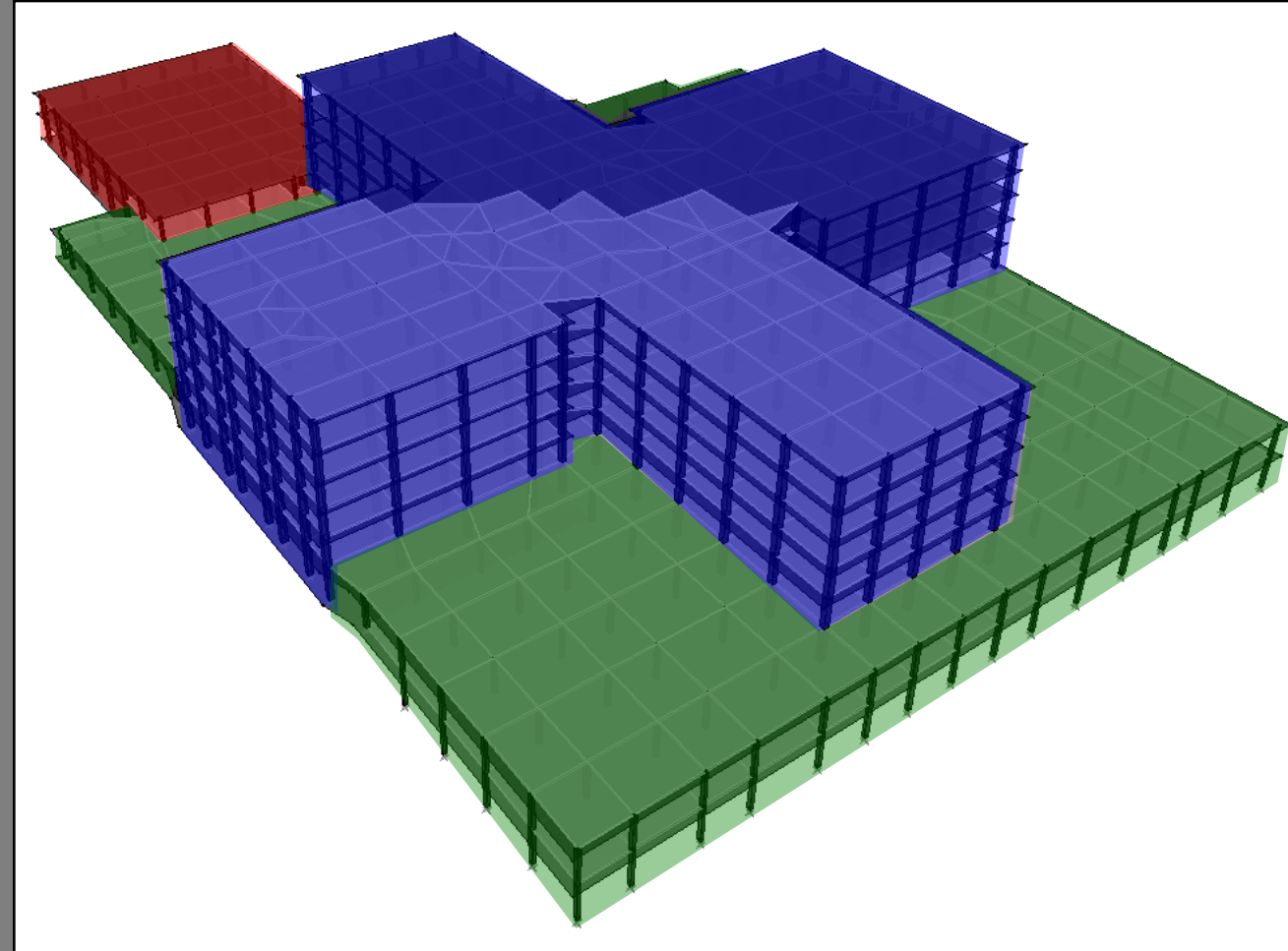
## Columns

- 30 x 30's with 16 # 14 bars
- 24 x 24's with 16 # 6 bars
- 20 x 20's with 8 # 7 bars

## Cost and Schedule Impacts

- Adds \$10 million to structure costs
- Adds 6 weeks to construction schedule

## Structural Depth – Final Design



## Shear Walls

- Full height, 16 " thick, 6,000 psi concrete

## Flat Slab and Drop Panels

- 10", 4,000 psi flat slab
- 10' wide by 8.25" deep drop panels

## Architecture Breadth

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




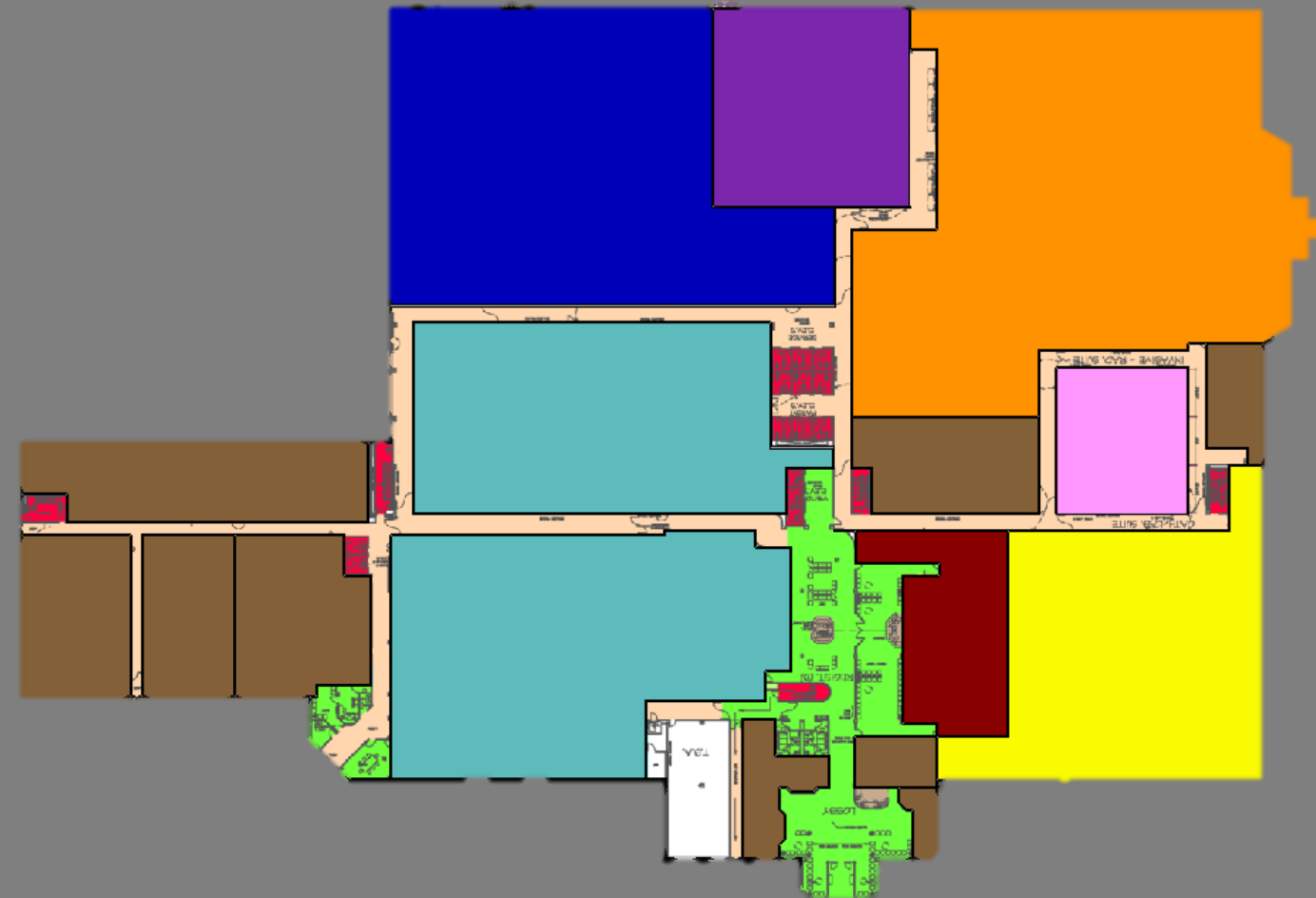
# Architecture Breadth



**Emergency Room**

**Main Hospital Entrance**

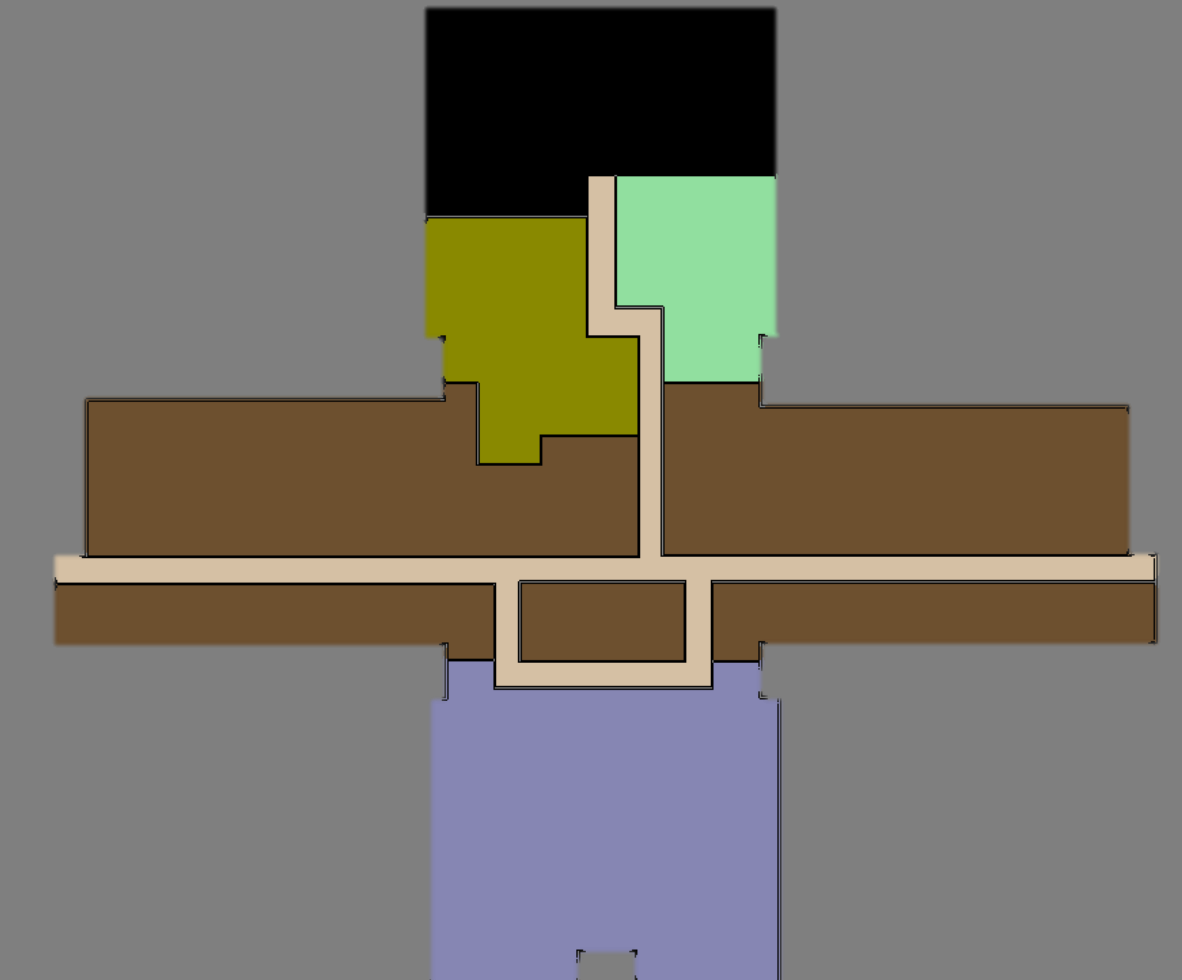
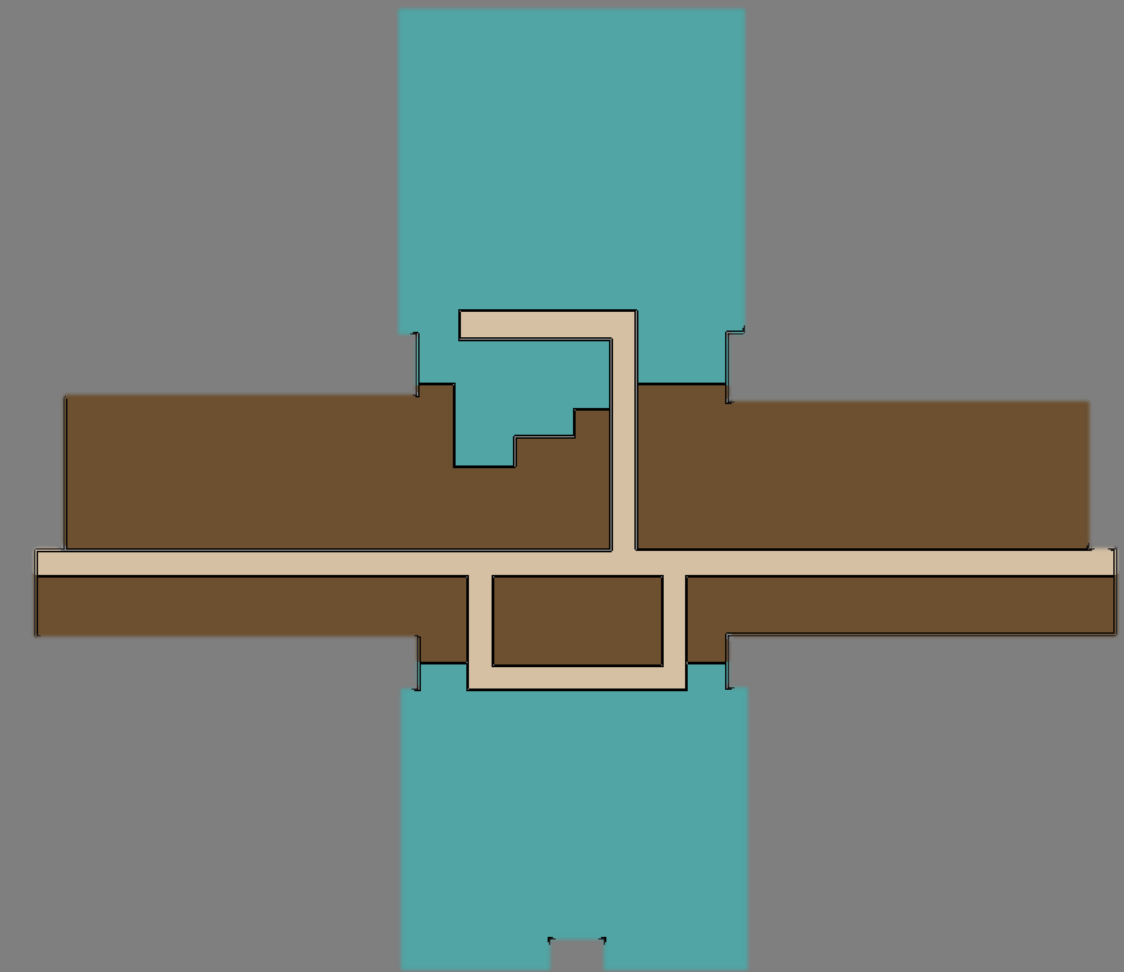
- |  |   |   |
|--|---|---|
|  ER           |  ICU             |  PACU        |
|  OR          |  SDS            |  Financial  |
|  Outpatient |  Diag. Imaging |  Endoscopy |

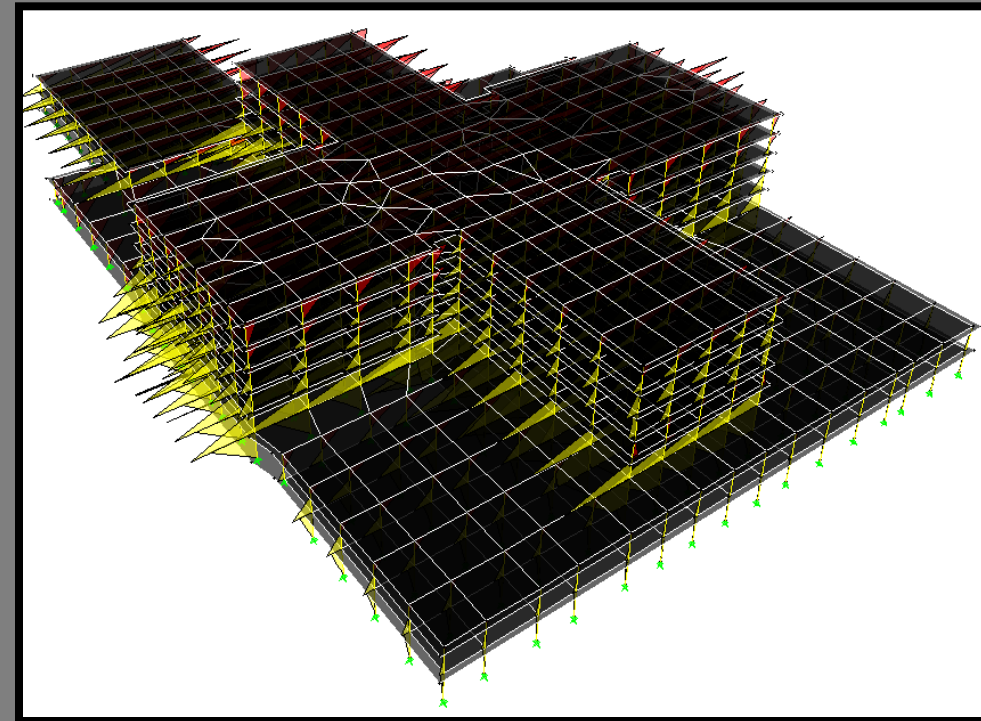




- NOTE: All entrances are handicapped accessible
- ICU
  - Diag. Imaging
  - Endoscopy
  - Invasive Radiation
  - Non-invasive Cardiology

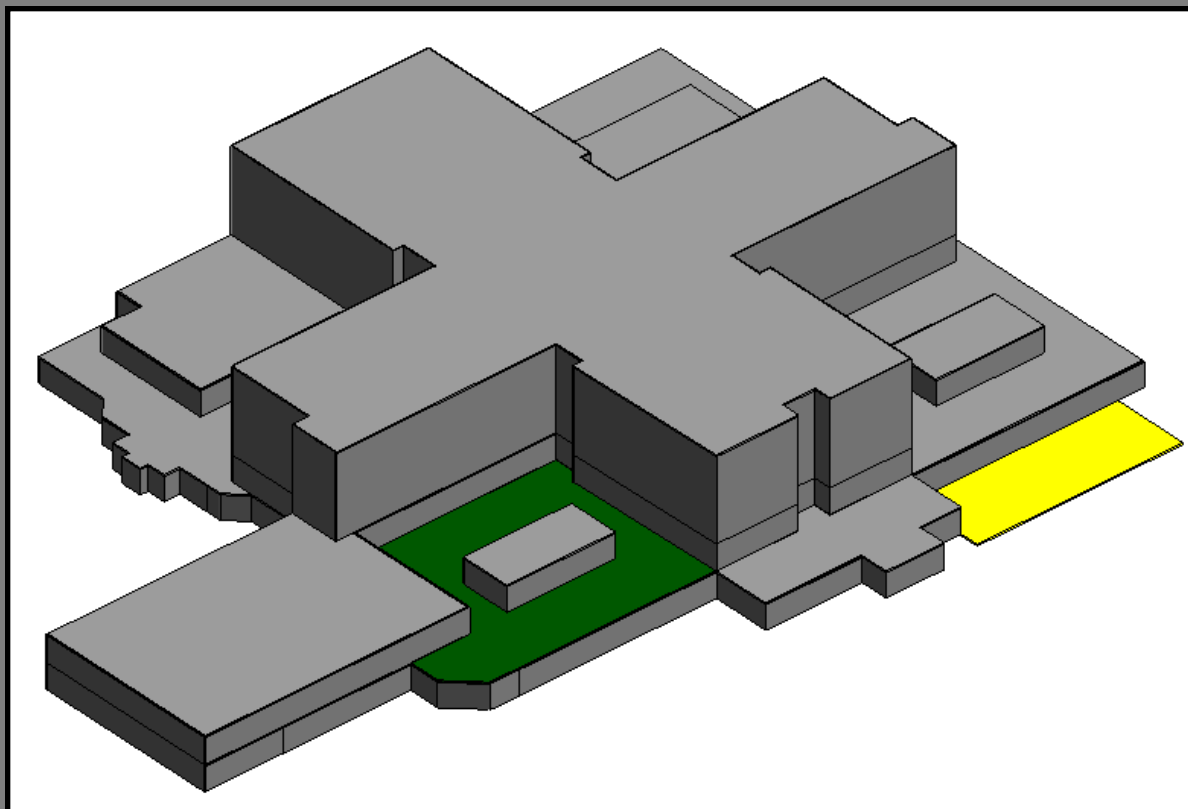
## Architecture Breadth





- Added weight at second story would require upsizing of structure

## Architecture Breadth



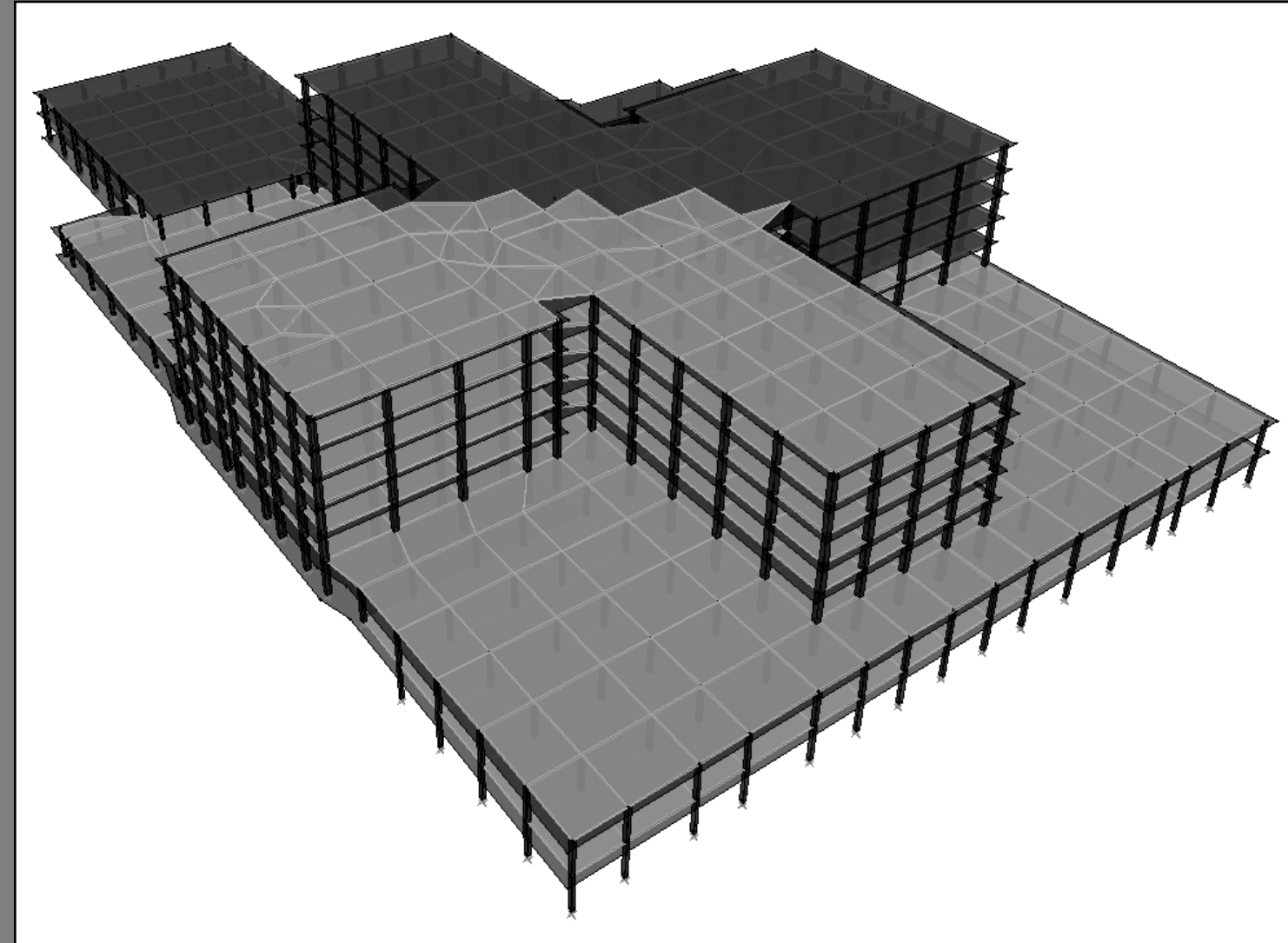
## Healing Garden

 Existing location

 New Location

- Better views from patient windows
- Easily accessible at new location





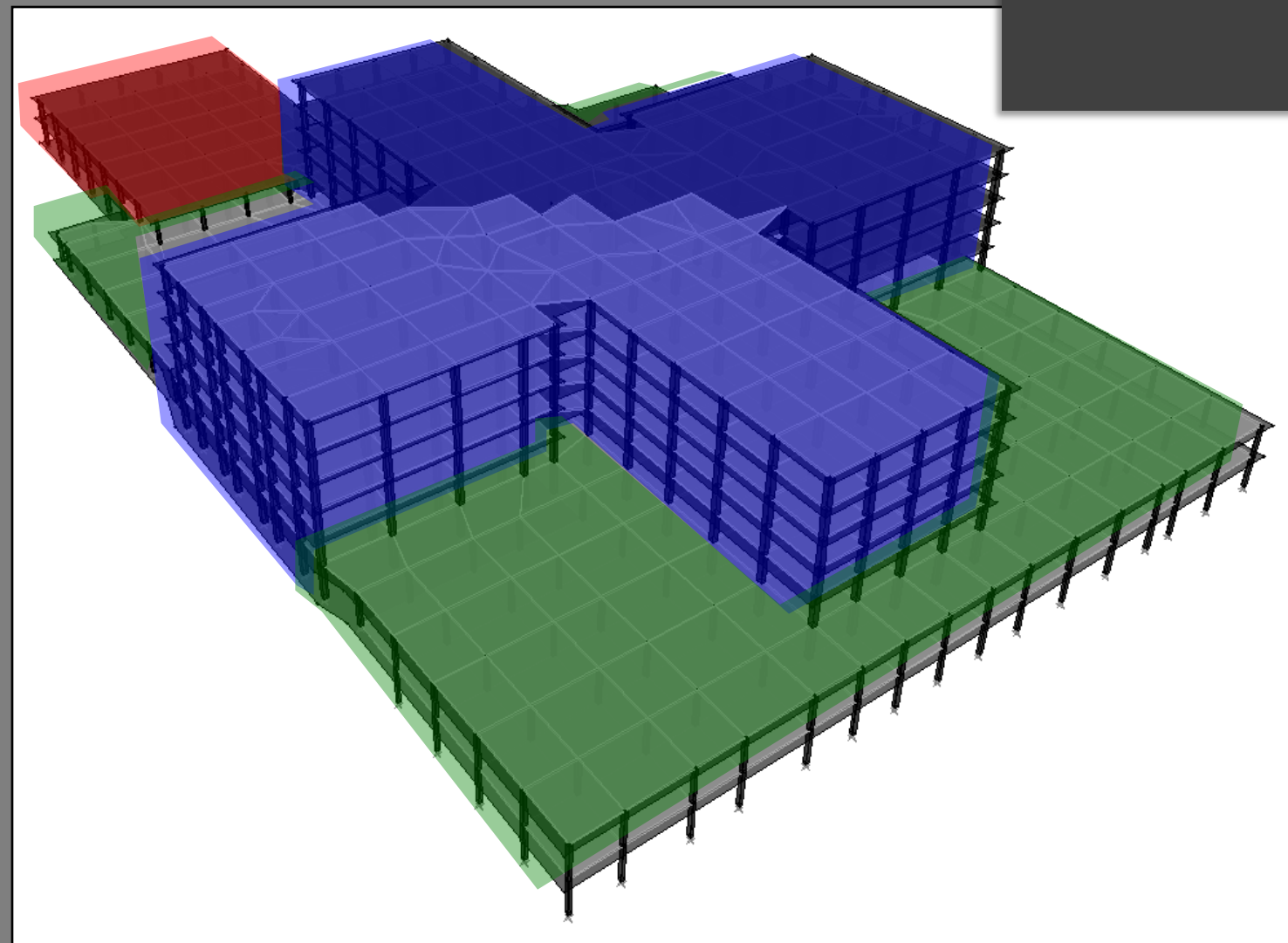
## Conclusions

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## Concrete Flat Slab System

- Meets all requirements to withstand gravity and lateral loads
- Overall, could be an effective system
- Not right for Orange Regional Medical Center
  - Outside of maximum budget
  - Longer construction



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MEDICAL CENTER

Thank You



## Existing Steel Costs

Steel System Costs			
Item	Quantity	Unit	Total
Columns & Beams	122771	L.F.	7032700
Metal Decking	823310	S.F.	1893613
Concrete	8259	C.Y.	187892
Shear Studs	130361	Ea.	243775
Fireproofing	946081.09	S.F.	1455160
			<b>10813141</b>

## Cost Data

## Concrete Flat Slab Costs

Concrete System Costs			
Item	Quantity	Unit	Total
Columns	12682	C.Y.	5398917
Slab & Drops	31840.3	C.Y.	14504849
Shear Wall	-	-	219227
			<b>20122993</b>