

Howard County General Hospital

Patient Tower Addition

Columbia, MD



Kelly M. Dooley
Penn State Architectural Engineering
Structural Option

Project Location



Located in Columbia,
Maryland

Intersection of Little
Patuxent Pkwy and
Cedar Ln

Part of HCGH's Campus
Development Plan

Adjacent to the south
side of the existing
hospital

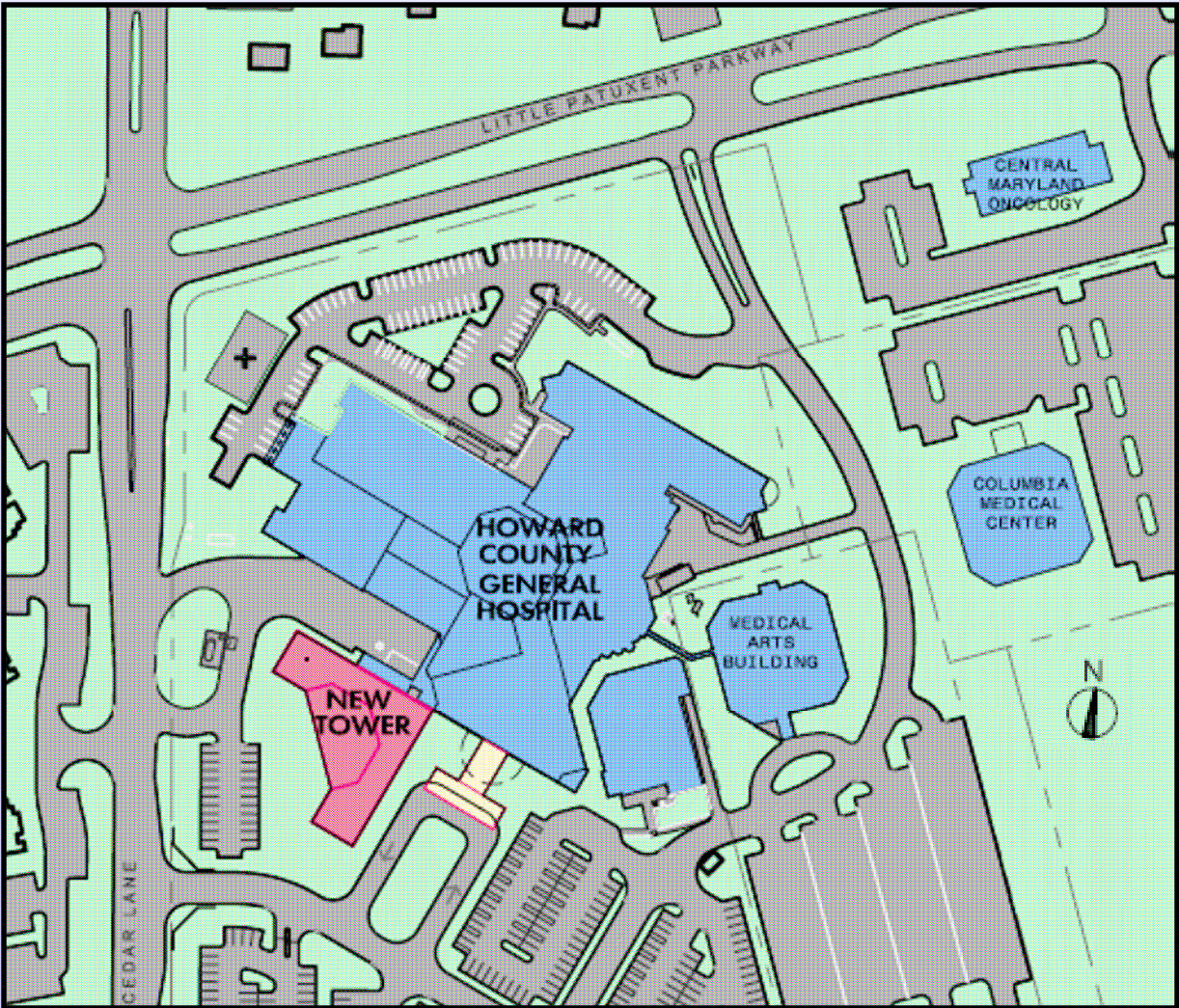


Photo taken from: <http://www.HCGH.org>

Building Statistics



Size: Approximately 115,000 SF

Owner: John Hopkins Medicine

Height: 88.5' from 1st floor to penthouse roof

Delivery: CM @ Risk

Cost: GMP of almost \$40 million

Envelope: Precast, Aluminum Panels, Glass

Function: Hospital





Project Team



CM: Whiting-Turner

Architects/Planners: Wilmot/Sanz Inc.

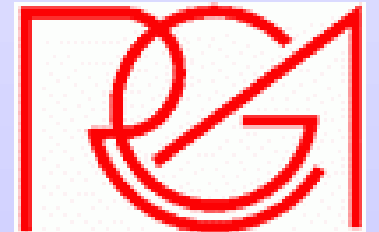


Structural Engineer: Rathgeber/Goss Associates



MEP Engineer: Leach Wallace Associates, Inc.

Civil Engineer: Joyce Engineering Corp.





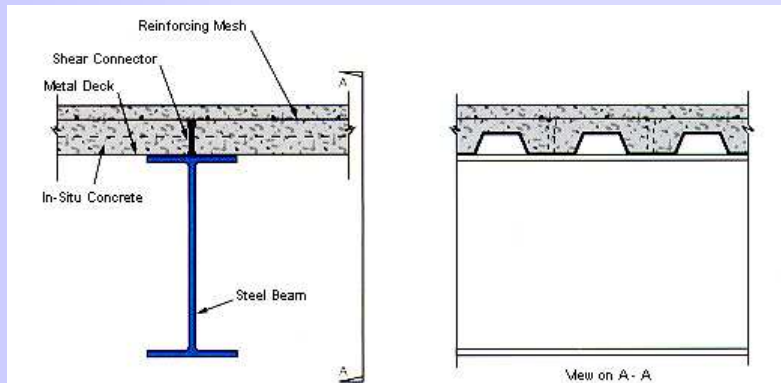
Existing Structural System

Composite steel with
concrete on metal deck

3 ¼" LW concrete

2" 18 gage metal deck

¾" diameter shear studs





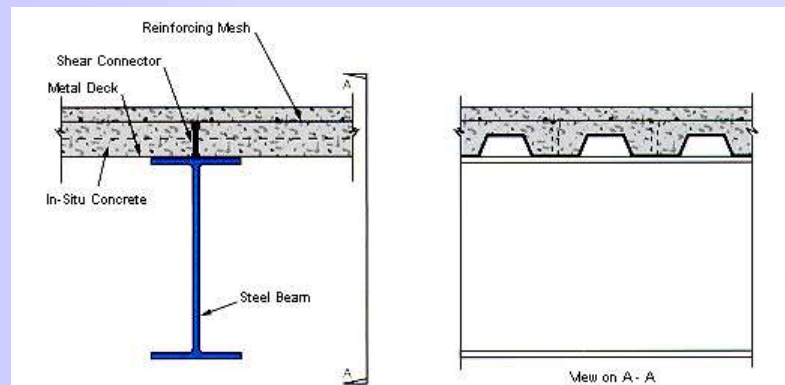
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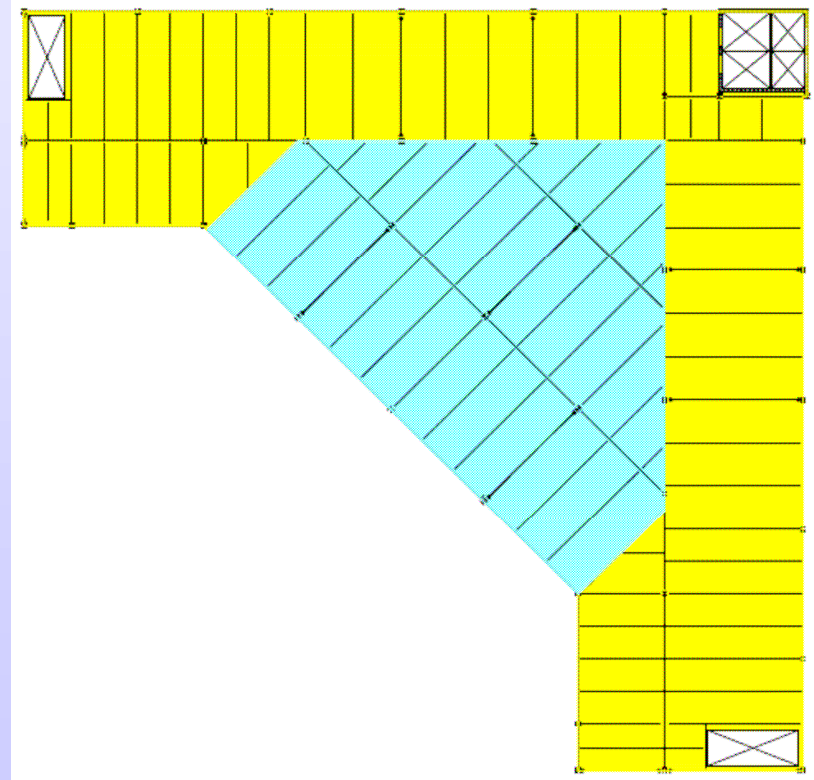
3 ¼" LW concrete

2" 18 gage metal deck

¾" diameter shear studs



Framing in two different directions





Existing Structural System

29' by 29' typical bays

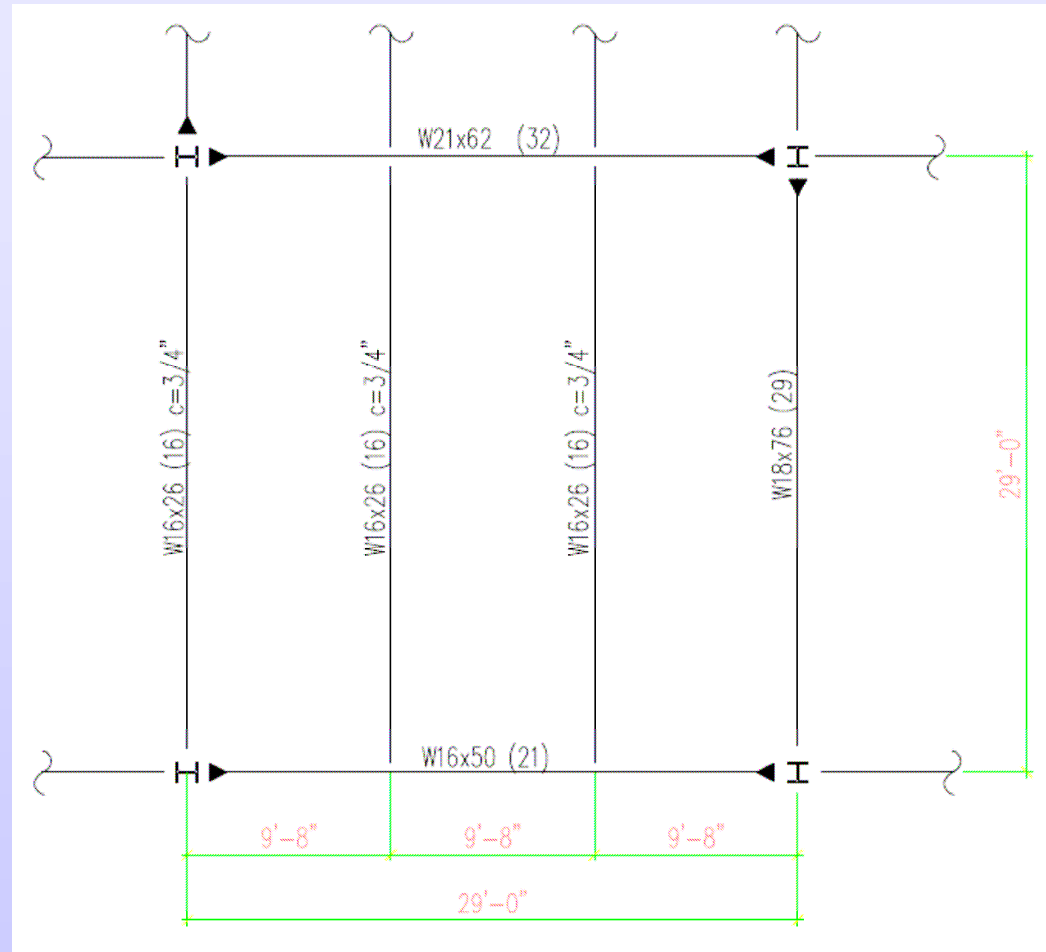
3 typical infill beam sizes

W12x19

W14x22

W16x26

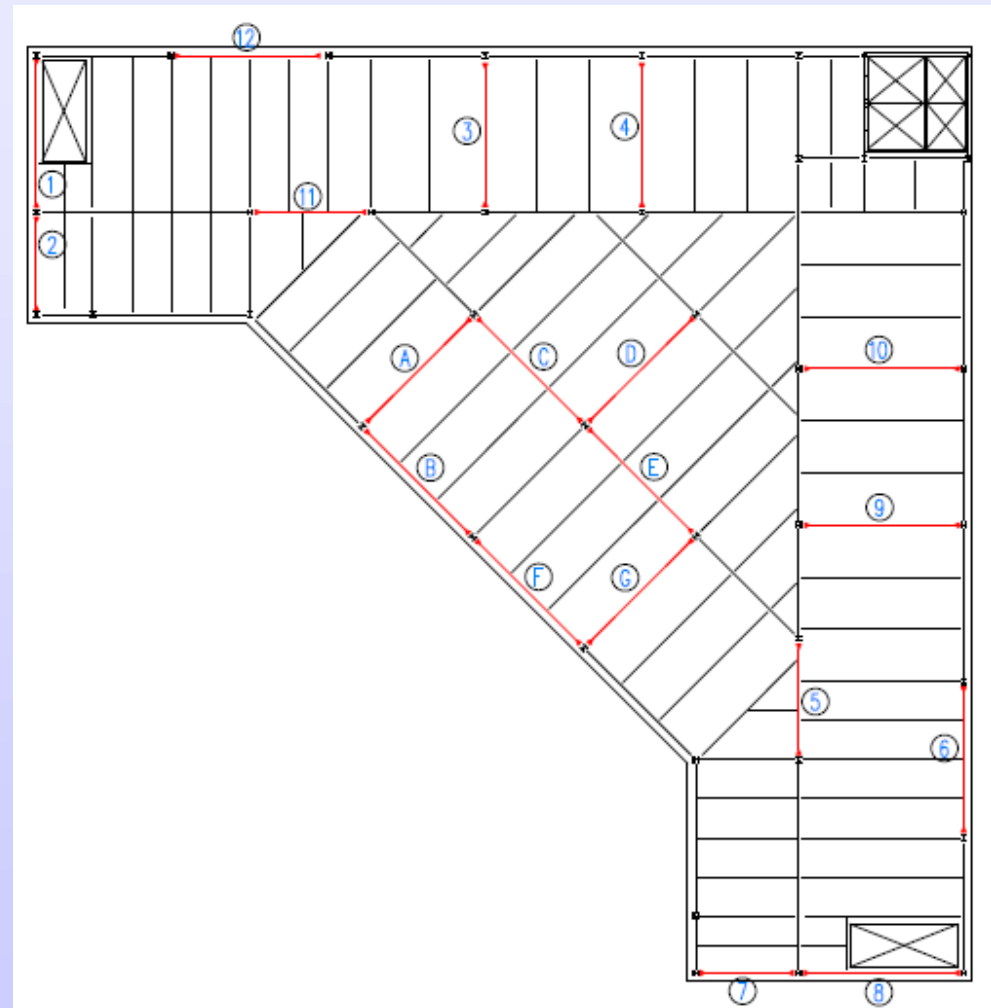
Wide range of girder sizes





Existing Lateral System

19 moment frames per floor
8 along the perimeter
11 interior
Wide range of cross sections
W12s to W24s
Symmetrical about building's
diagonal axis

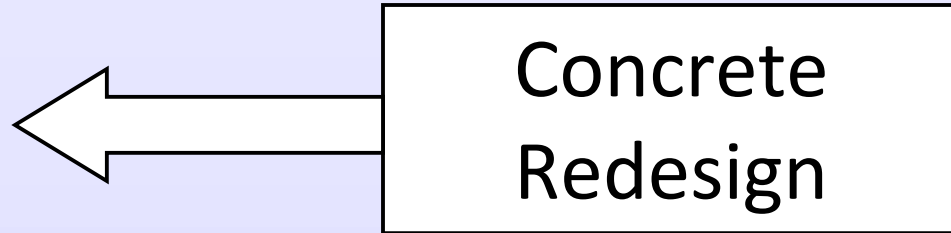




Design Issues/Concerns

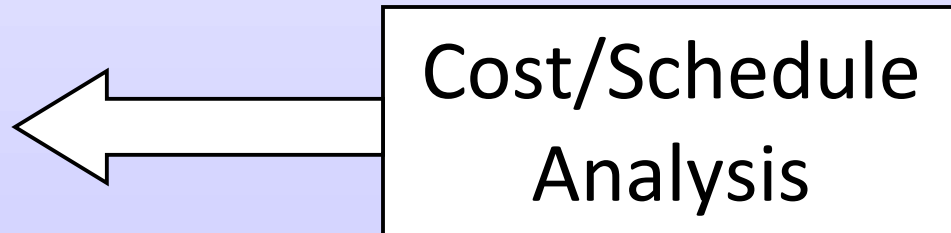
Structural:

- 100 psf live load
- Wind drift
- Floor plan flexibility
- (30) 2" slab depressions at each typical floor



Construction Management:

- Building cost
- Inefficiency of construction



Acoustics:

- Sound transmission for patient privacy
- Reverberation time



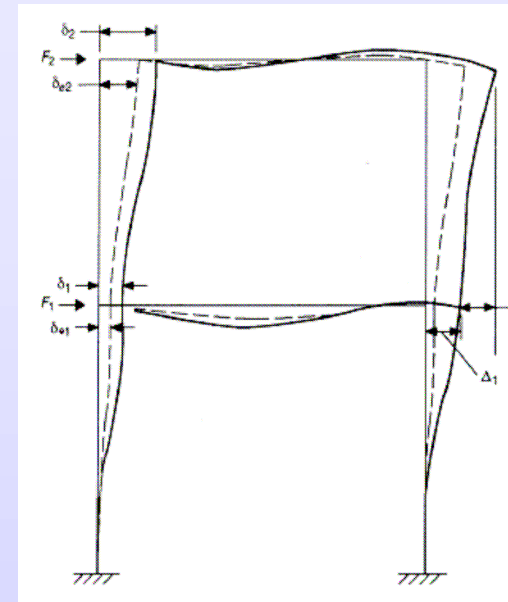
Recommendation Criteria

Structural:

Adequately perform under 100 psf live load

Resolve drift issue

Maintain floor plan flexibility





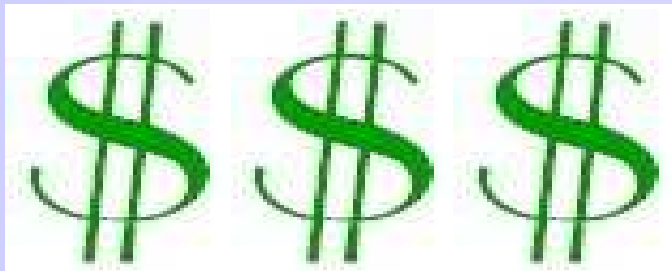
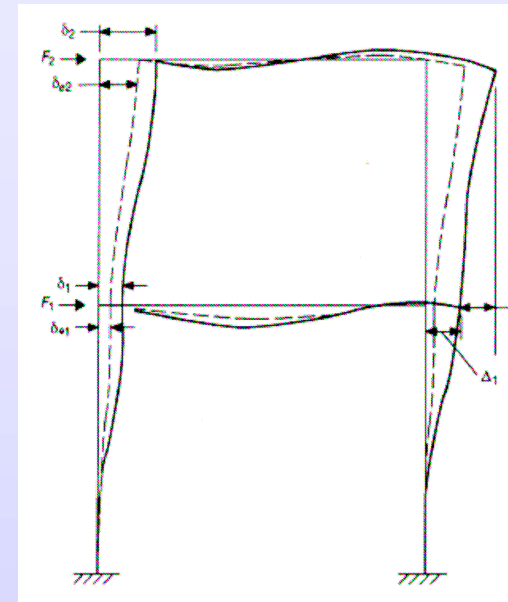
Recommendation Criteria

Structural:

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Construction Management:

Reduce building cost

Improve construction efficiency

Maintain/Shorten construction schedule



Proposed Concrete System

Two-Way Flat Slab

10" NW concrete slab

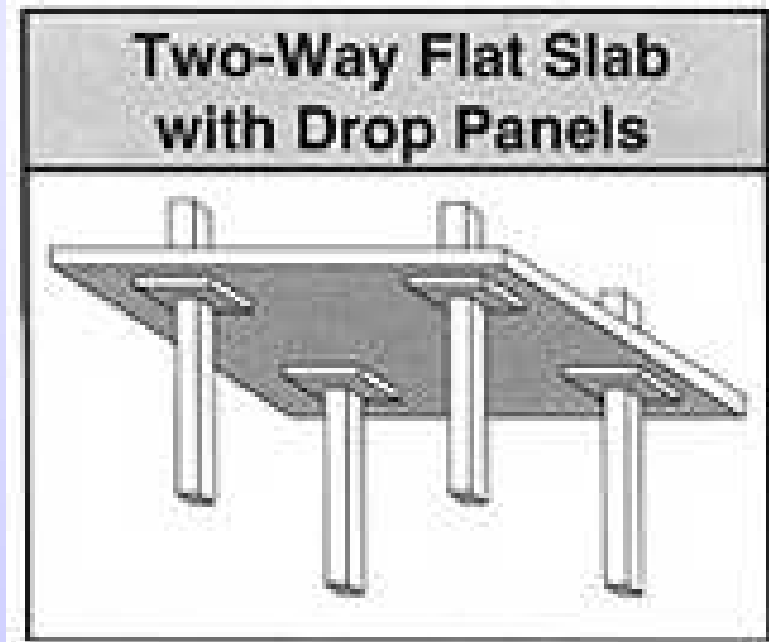
Typical 9'-8" by 9'-8" by 6"
thick drop panels

$f'_c = 5000$ psi

Square Concrete Columns

24" by 24"

$f'_c = 5000$ psi



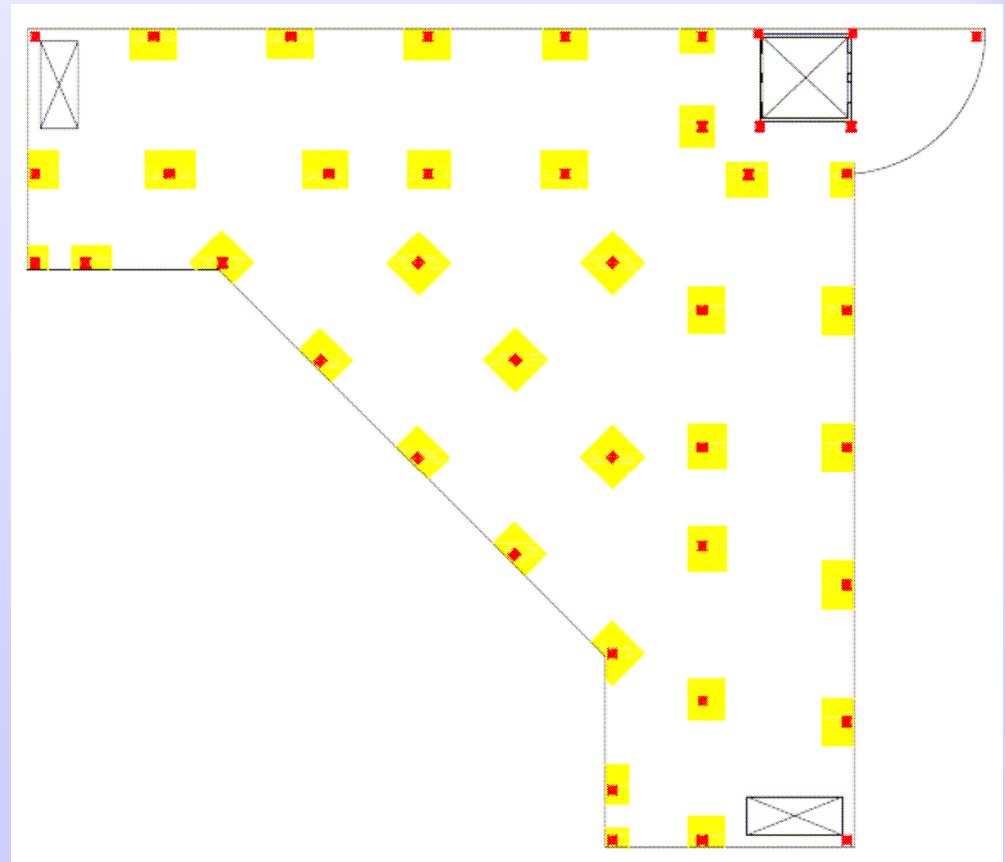


Two-Way Flat Slab Design

Typical Column Strip Top Reinforcing

(14) #7 interior

(12) #7 exterior





Two-Way Flat Slab Design

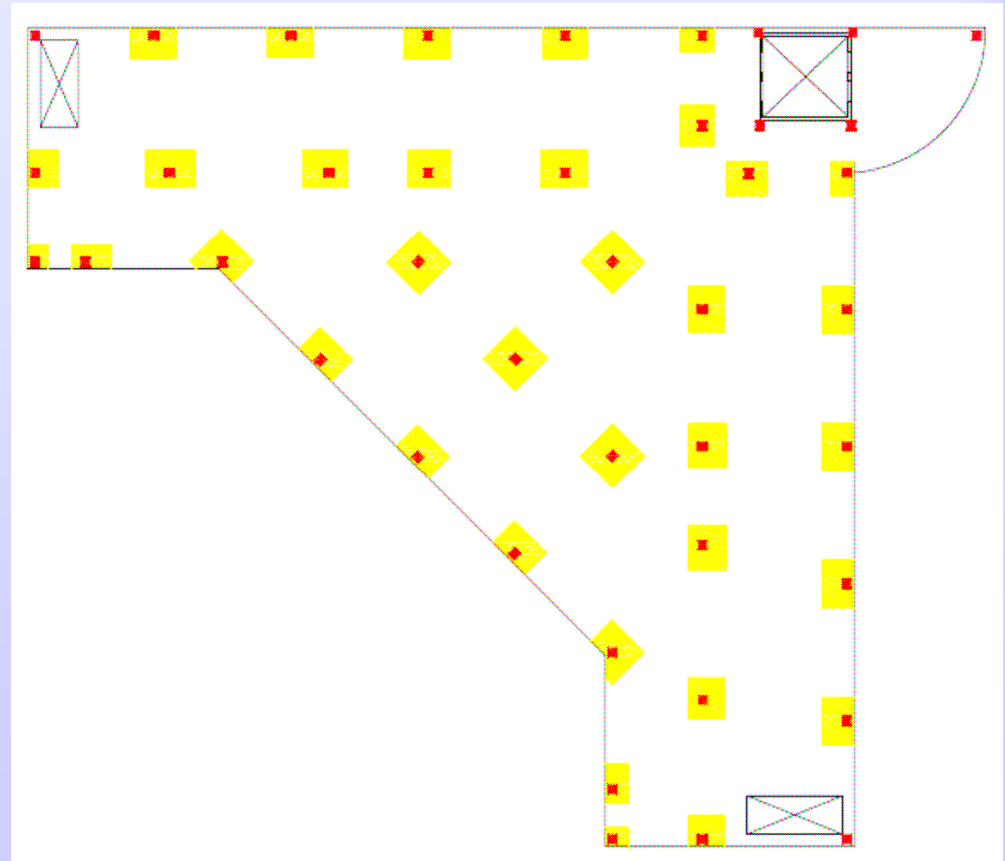
Typical Column Strip Top Reinforcing

(14) #7 interior

(12) #7 exterior

Typical Middle Strip Top Reinforcing

(10) #7 for 14.5 ft width





Two-Way Flat Slab Design

Typical Column Strip Top Reinforcing

(14) #7 interior

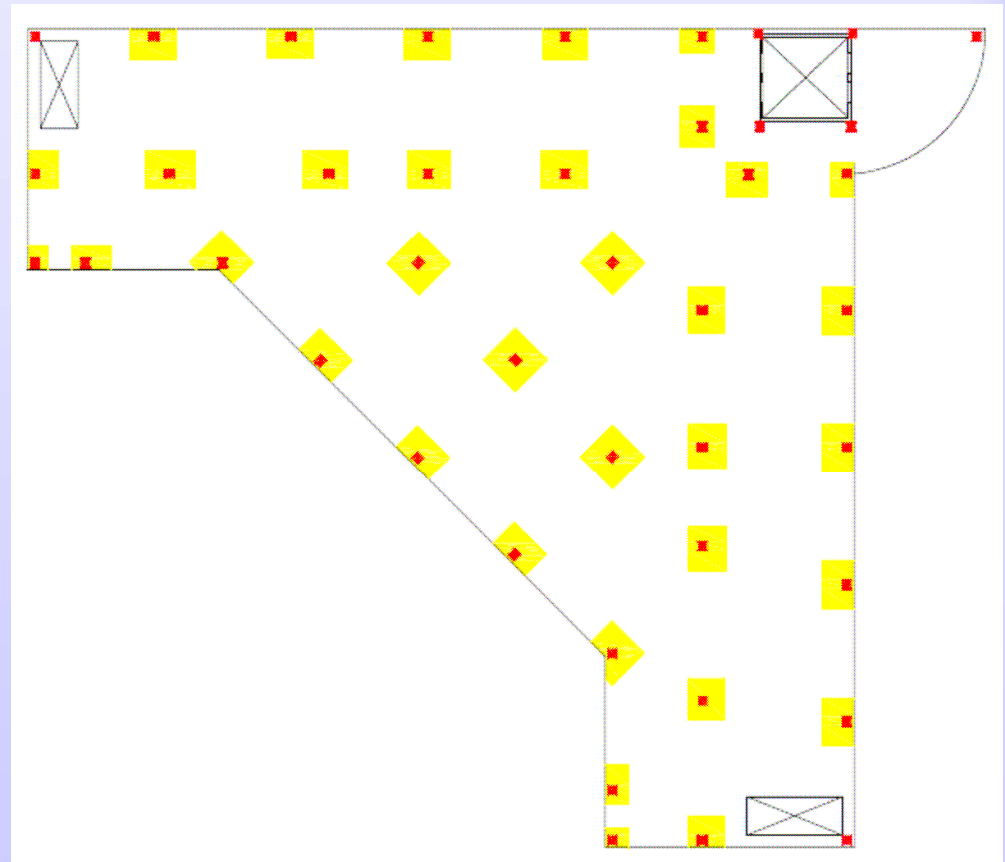
(12) #7 exterior

Typical Middle Strip Top Reinforcing

(10) #7 for 14.5 ft width

Typical Bottom Reinforcing

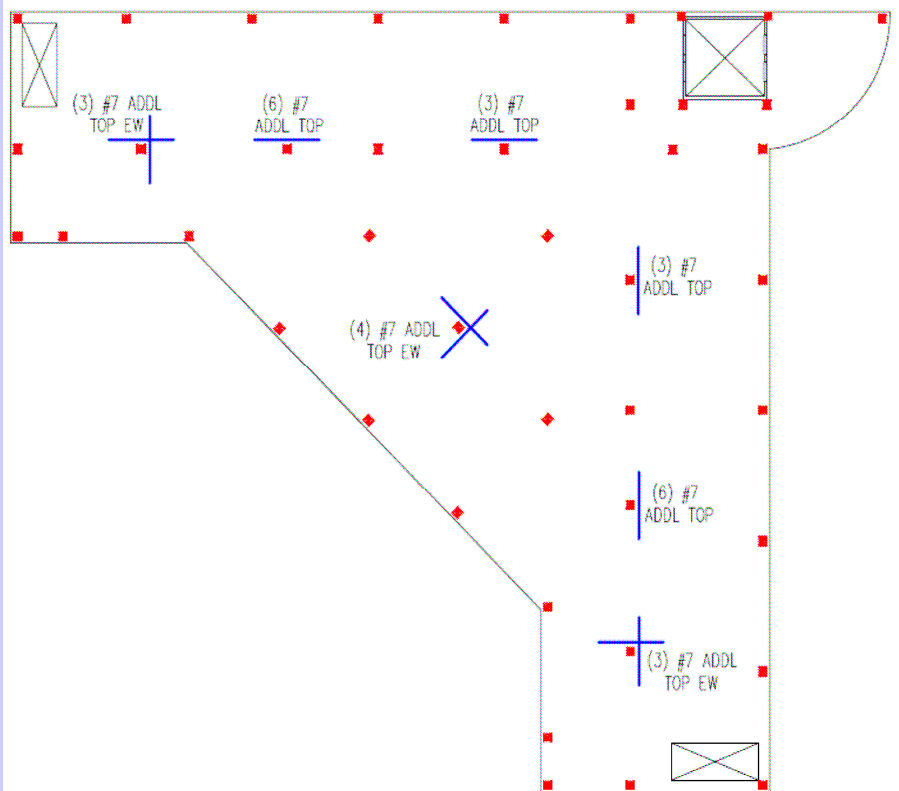
#6@10" oc EW



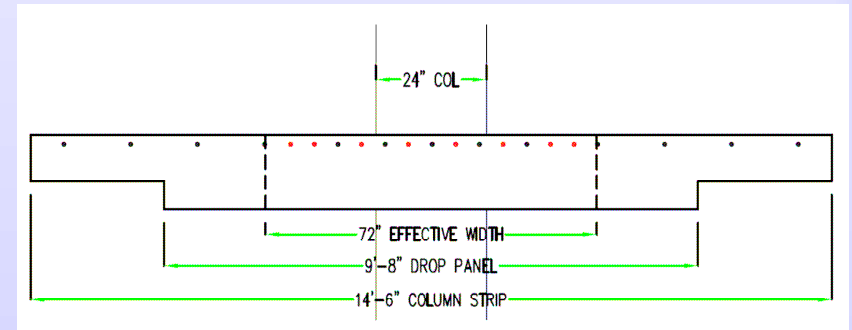


Two-Way Flat Slab Design

Additional top steel @ select interior columns



Additional top steel @ all exterior columns for unbalanced moment transfer at end span



Continuous top steel at short spans adjacent to long spans



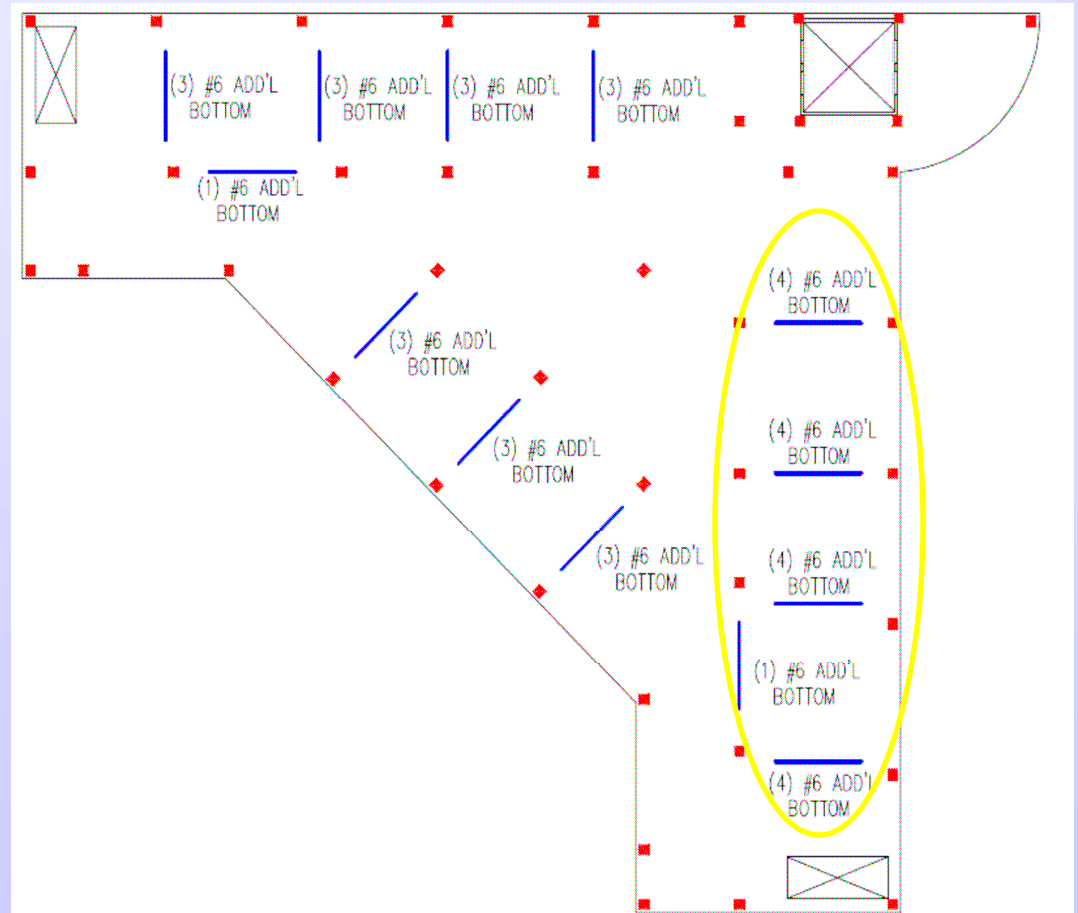
Two-Way Flat Slab Design

Additional bottom steel @
long spans

30.5' spans critical for
deflection

$$\text{max} = 0.923''$$

$$< l/360 = 1.02''$$





Concrete Column Design

24" by 24" columns with
(8) #8 reinforcing

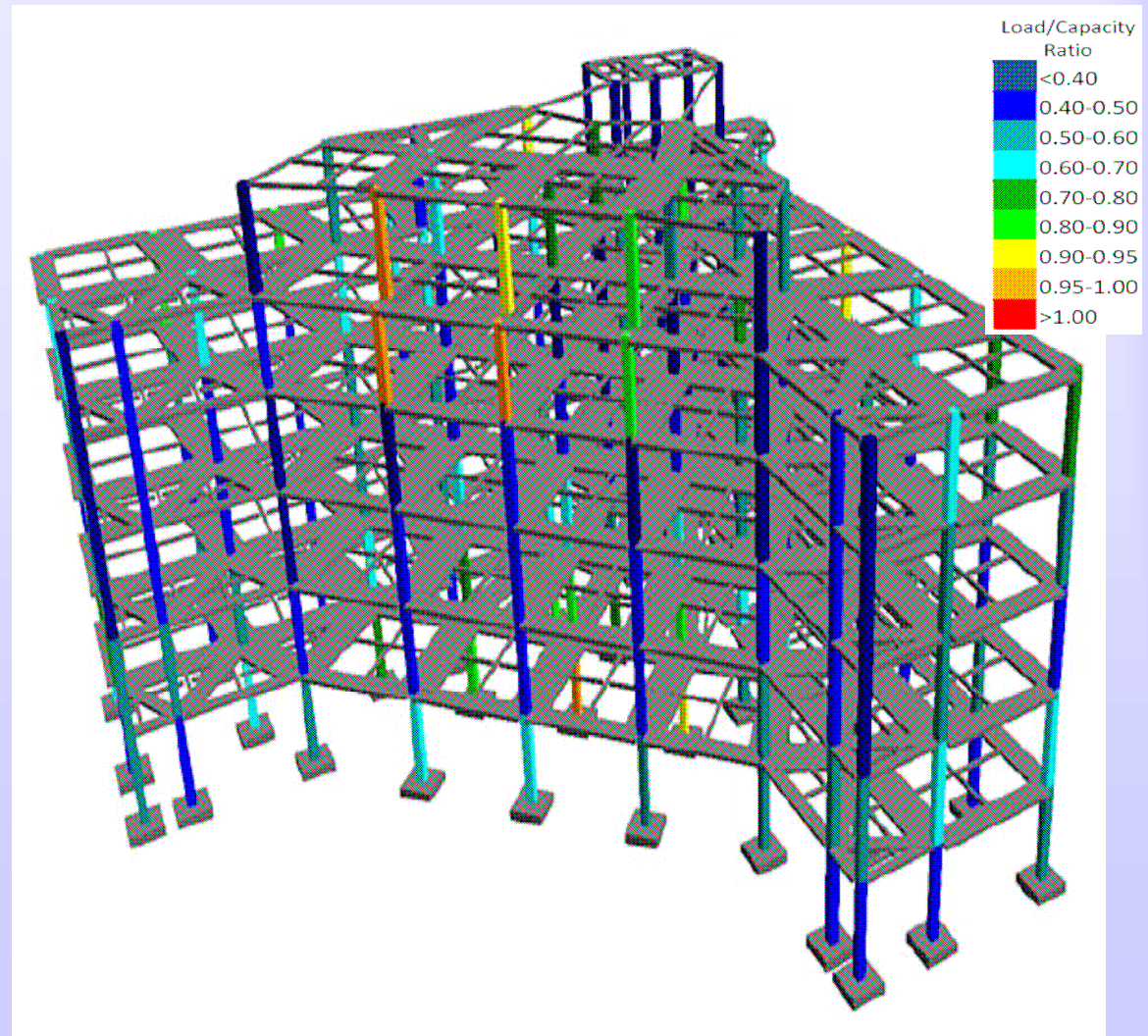
Columns @ base controlled
by gravity load

$$1.2D + 1.6L$$

Columns @ upper levels
controlled by wind load

$$1.2D + 0.5L \pm 1.6W$$

$$0.9D \pm 1.6W$$





Concrete Beam Design

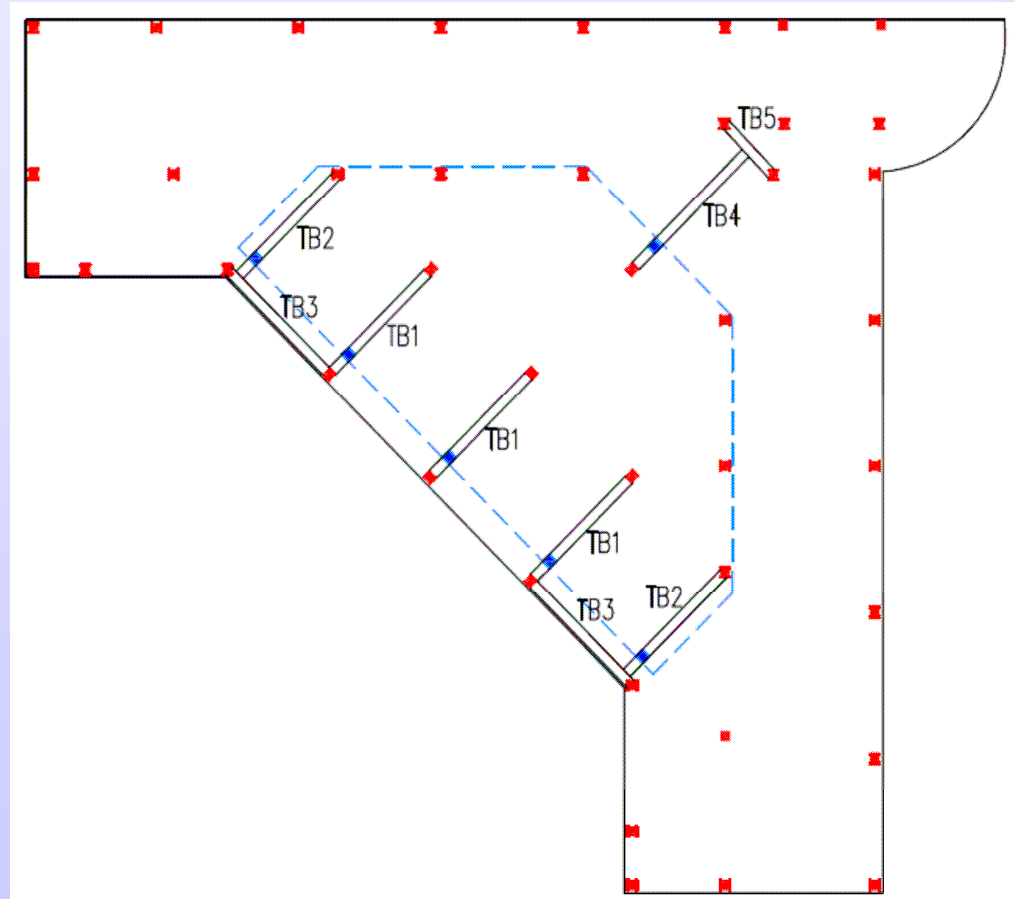
Transfer Beams @ Main Roof

TB1 – TB5

Beams @ Slab Opening

EB1

Beam	B	H	Flex. Reinf.	Stirrups
TB1	24	32	(10) #9	#4
TB2	24	32	(10) #9	#4
TB3	24	32	(6) #9	#3
TB4	24	32	(8) #9	#3
TB5	24	32	(6) #7	#3
EB1	24	16	(4) #7	#3





Cantilevered Slab/Beam Design

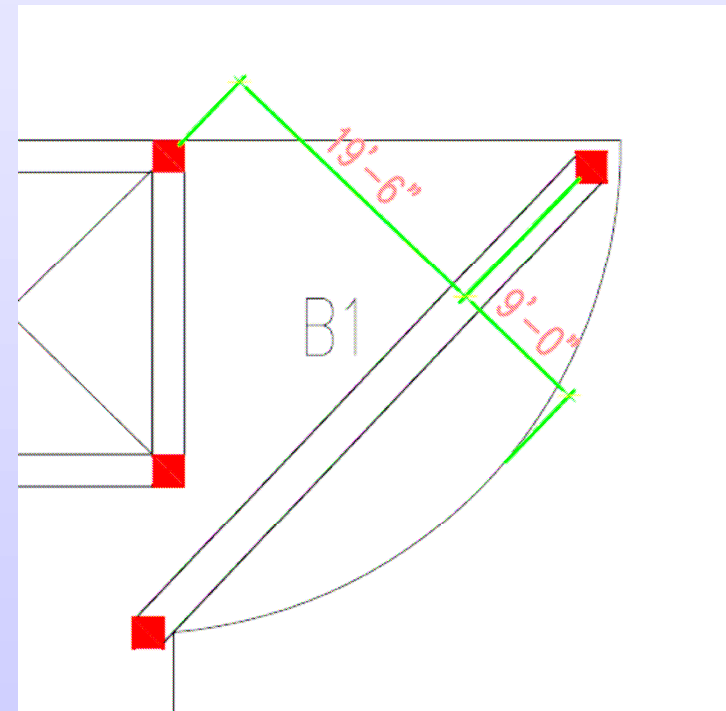
One-way quarter-circular slab at waiting room/lobby

8" slab - maximum deflection of 0.21"

top bars - #6@12" oc

bottom bars - #6@18" oc

Supported by 24" by 32" deep beam with (8) #9 bars



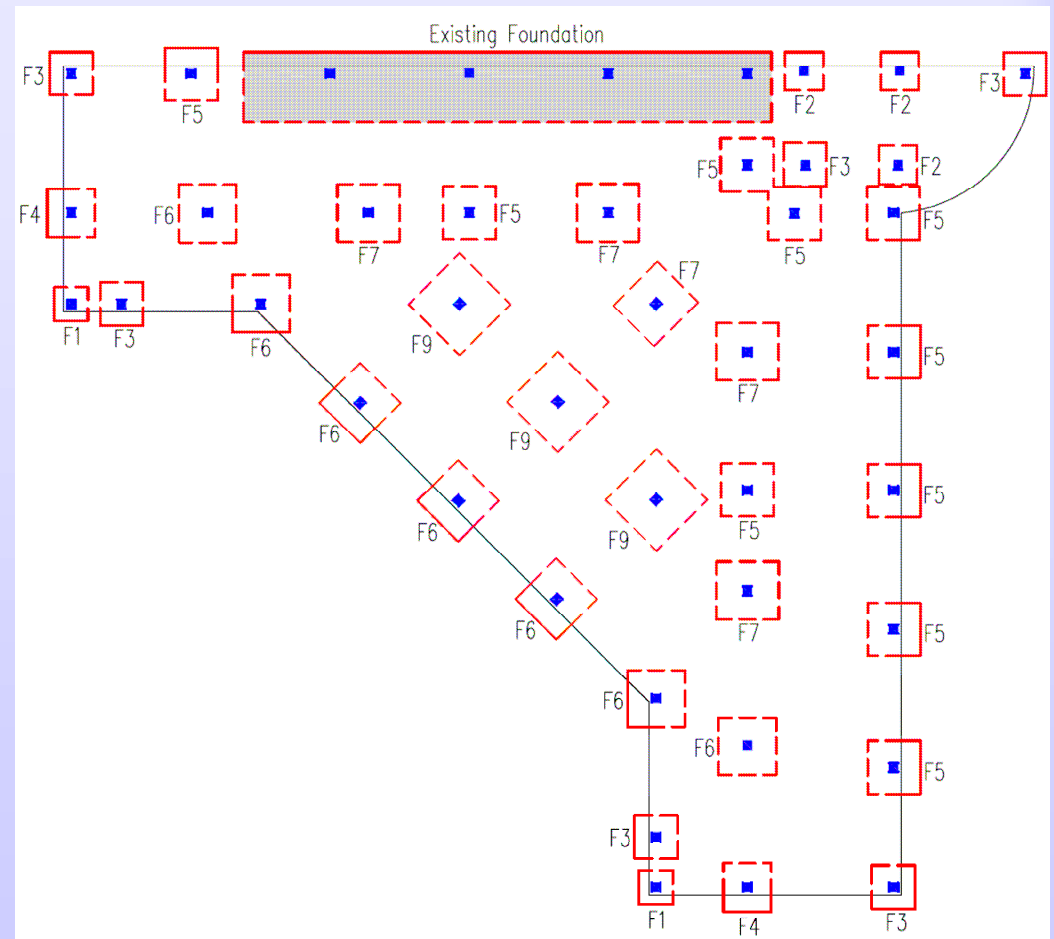
Foundation Design



Increased footing sizes due to increased building weight

4 columns @ north tied into existing retaining wall footing

Ftg #	L (ft)	W (ft)	t (ft)	Reinf
F1	7	7	1.5	#6@12" EW
F2	8	8	2	#6@10" EW
F3	9	9	2	#6@10" EW
F4	10	10	2	#6@8" EW
F5	11	11	2.5	#7@10" EW
F6	12	12	2.5	#7@8" EW
F7	13	13	3	#7@8" EW
F8	15	15	3.5	#8@10" EW





Drift Check

Wind Drift

	Story Height (ft)	Total Drift (in)	Allowable H/400 (in)	Floor to Floor Height (ft)	Story Drift (in)	Allowable H _{story} /400 (in)
PH Roof	88.5	1.02	2.66	18	0.1	0.54
Main Roof	70.5	0.92	2.12	16.5	0.14	0.50
4th Floor	54	0.78	1.62	18	0.23	0.54
3rd Floor	36	0.55	1.08	18	0.3	0.54
2nd Floor	18	0.25	0.54	18	0.25	0.54



Drift Check

Wind Drift

	Story Height (ft)	Total Drift (in)	Allowable H/400 (in)	Floor to Floor Height (ft)	Story Drift (in)	Allowable H _{story} /400 (in)
PH Roof	88.5	1.02	2.66	18	0.1	0.54
Main Roof	70.5	0.92	2.12	16.5	0.14	0.50
4th Floor	54	0.78	1.62	18	0.23	0.54
3rd Floor	36	0.55	1.08	18	0.3	0.54
2nd Floor	18	0.25	0.54	18	0.25	0.54

Seismic Drift

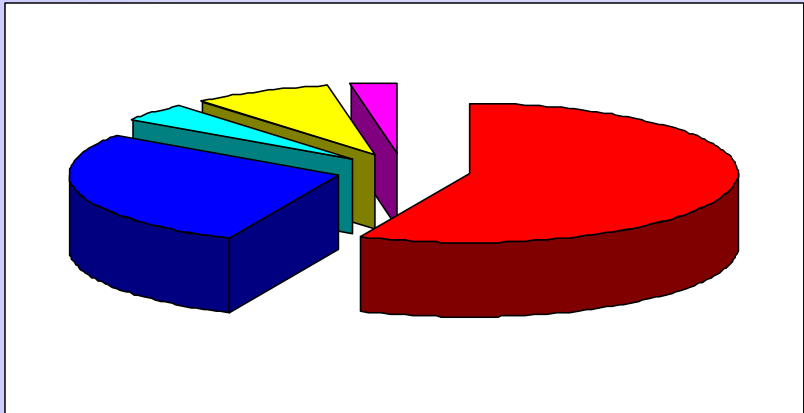
	Story Height (ft)	Floor to Floor Height (ft)	Total Drift (in)	Story Drift (in)	Actual Drift Ratio	Allowable Drift Ratio
PH Roof	88.5	18	1.23	0.17	0.0008	0.0075
Main Roof	70.5	16.5	1.06	0.19	0.0010	0.0075
4th Floor	54	18	0.87	0.29	0.0013	0.0075
3rd Floor	36	18	0.58	0.33	0.0015	0.0075
2nd Floor	18	18	0.25	0.25	0.0012	0.0075

Cost Comparison



Composite Steel System:

Structural Steel	\$1,369,783
Concrete Slab on Metal Deck	\$676,710
Foundations	\$101,702
Fireproofing	\$203,500
Moment Connections	\$66,600
Total Cost	\$2,418,295













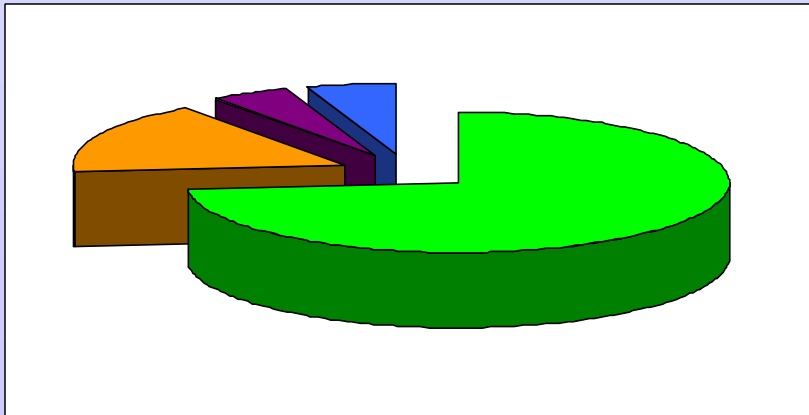
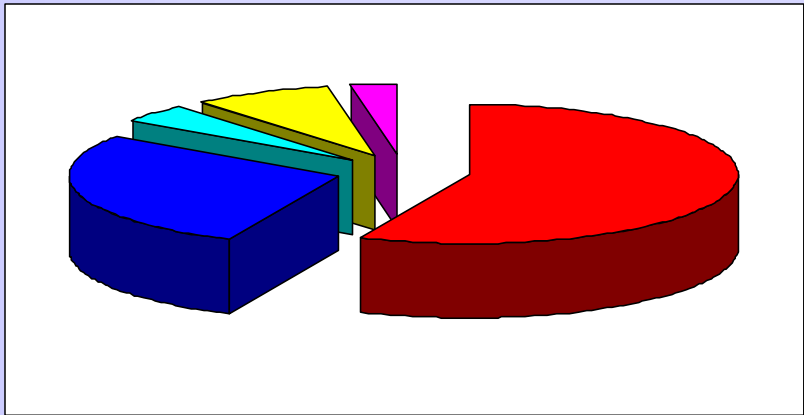
Cost Comparison

Composite Steel System:

Concrete System:

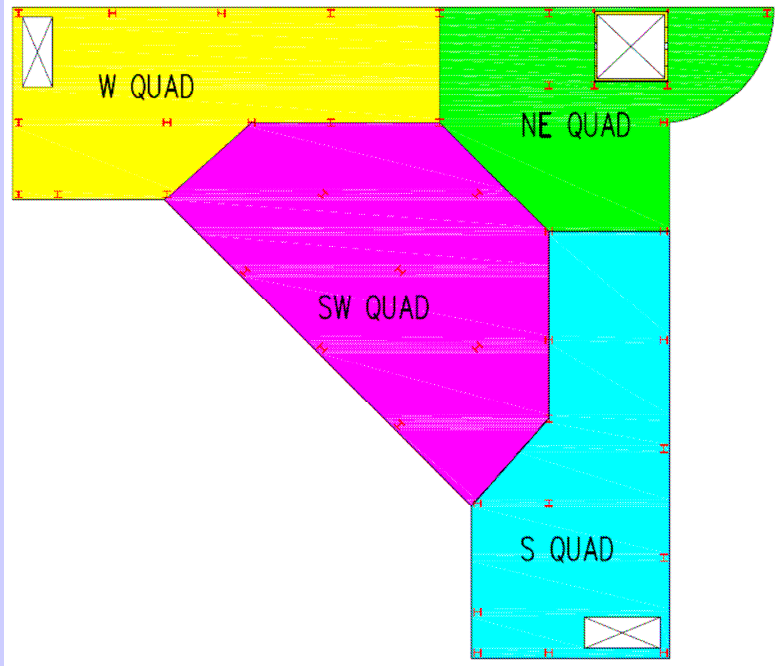
	Structural Steel	\$1,369,783		Two-Way Flat Slab	\$1,418,373
	Concrete Slab on Metal Deck	\$676,710		Concrete Columns	\$321,179
	Foundations	\$61,580		Concrete Beams	\$94,523
	Fireproofing				\$101,702
	Moment Connections				
Total Cost					\$1,935,777

**Concrete System Saves
Almost \$500,000!!!**





Schedule Comparison



Existing Steel Schedule:

Divided floors into four quads

Structural “skeleton” completed in approximately
16 weeks

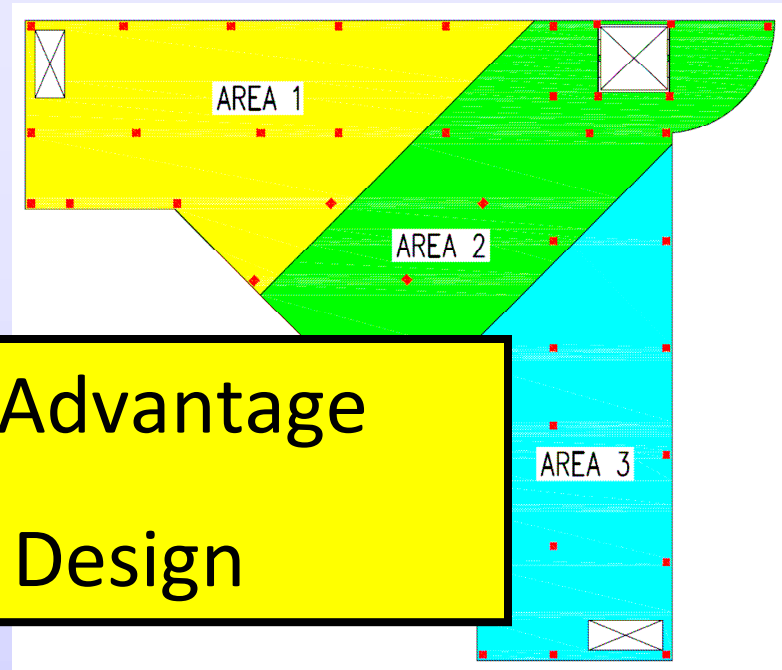


Schedule Comparison

Proposed Concrete Schedule:

Divided floors into three areas

Concrete frame
approximately



**No Schedule Advantage
for Either Design**

ID	Task Name	Duration	Start	Finish	January							
					12/16	12/23	12/30	1/6	1/13	1/20	1/27	
4	F/R/P Flat Slab 1st Floor, 1	3 days	Thu 12/27/07	Mon 12/31/07								
5	Strip Flat Slab 1st Floor, 1	1 day	Mon 1/7/08	Mon 1/7/08								
6	F/R/P Flat Slab 1st Floor, 2	3 days	Mon 12/31/07	Wed 1/2/08								
7	Strip Flat Slab 1st Floor, 2	1 day	Wed 1/9/08	Wed 1/9/08								
8	F/R/P Flat Slab 1st Floor, 3	3 days	Wed 1/2/08	Fri 1/4/08								
9	Strip Flat Slab 1st Floor, 3	1 day	Fri 1/11/08	Fri 1/11/08								
10	F/R/P Columns 1st Floor, 1	2 days	Tue 1/8/08	Wed 1/9/08								
11	F/R/P Columns 1st Floor, 2	2 days	Thu 1/10/08	Fri 1/11/08								
12	F/R/P Columns 1st Floor, 3	2 days	Mon 1/14/08	Tue 1/15/08								

Recommendation Criteria

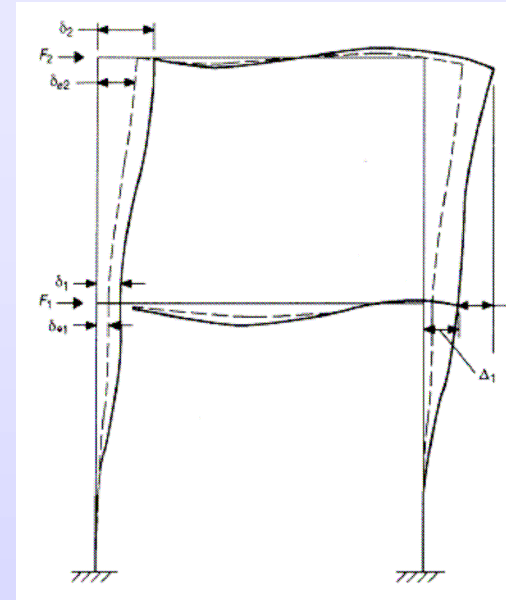


Structural:

Adequately perform under 100 psf live load

Resolve drift issue

Maintain floor plan flexibility



Construction Management:

Reduce building cost

Improve construction efficiency

Maintain/Shorten construction schedule



Recommendation Criteria

Structural:

Adequately perform under 100 psf live load



Resolve drift issue



Maintain floor

**Recommend Proposed
Concrete System**

Construction Management:

Reduce building cost



Improve construction efficiency



Maintain/Shorten construction schedule





Questions?

