William W. Wilkins Professional Building

Columbus, Ohio

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Senior Thesis Presentation Spring 2007

Structural Option

William W. Wilkins Building

Introduction

Existing Structure

- Floor System
- Lateral System

Proposal

Structural Redesign

- Gravity
- Lateral
- Cost & Schedule

Photovoltaic's

Summary and Conclusions

William W. Wilkins Building

- 6 story medical office building
- ~ 112,000 sq. ft.
- Occupant: Grant Riverside
- Façade:
  - brick veneer
  - precast concrete panels
  - spandrel glass

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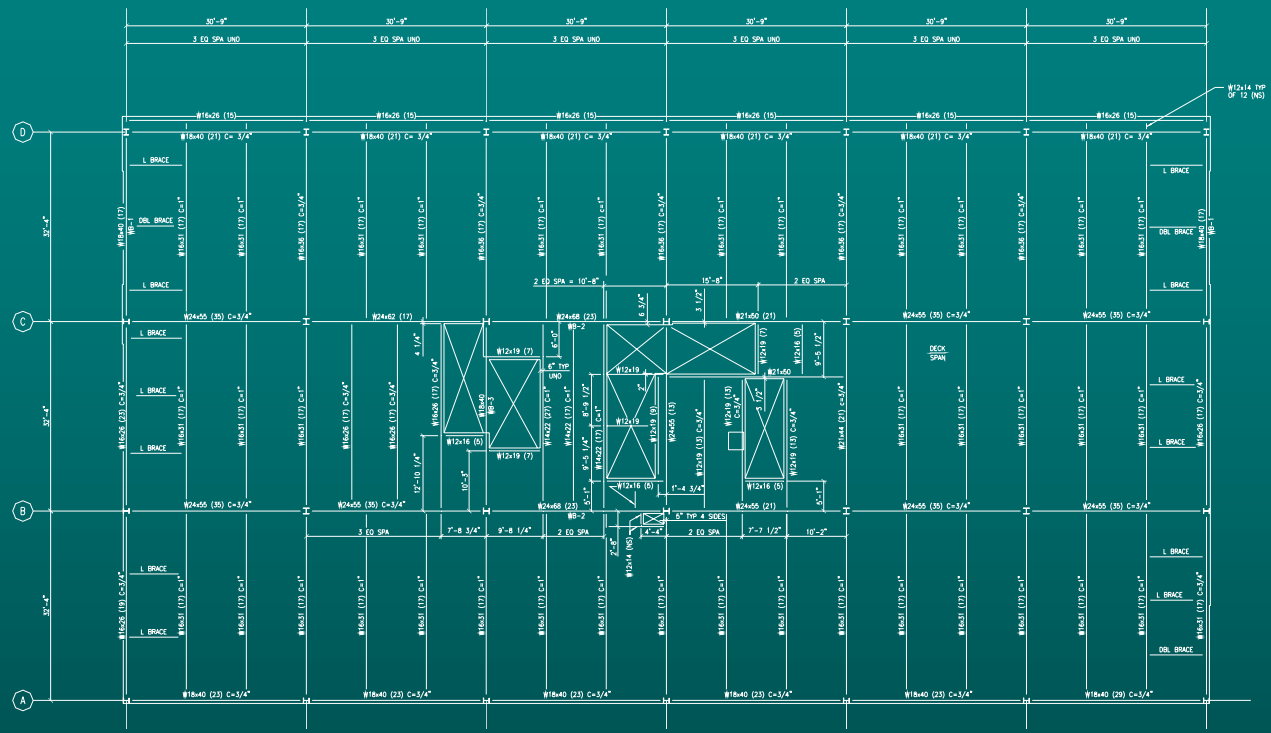
Summary and Conclusions



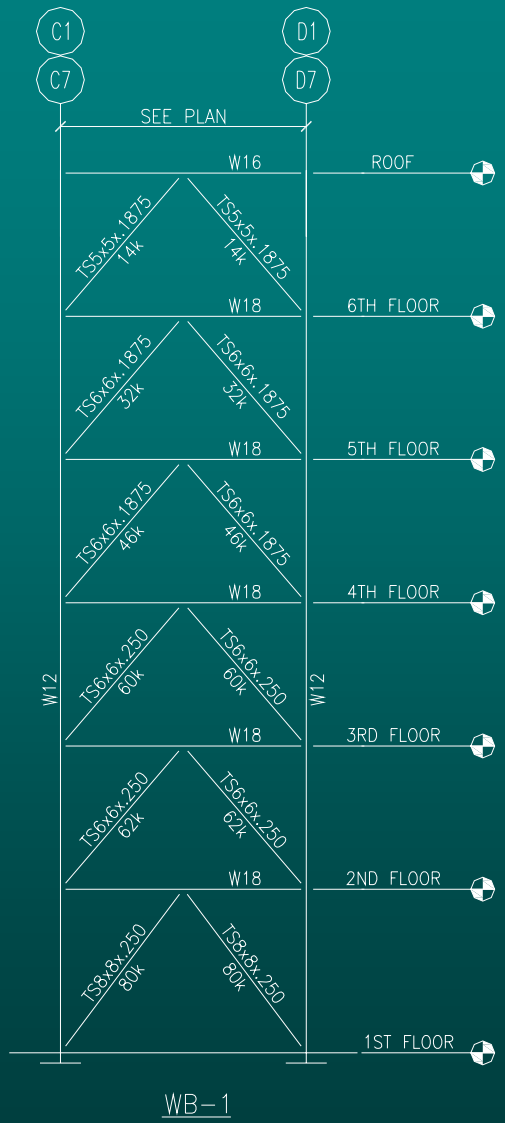
- 3.5” slab over 2” steel deck
- 6x6-W2.1xW2.1 WWF

Framing:

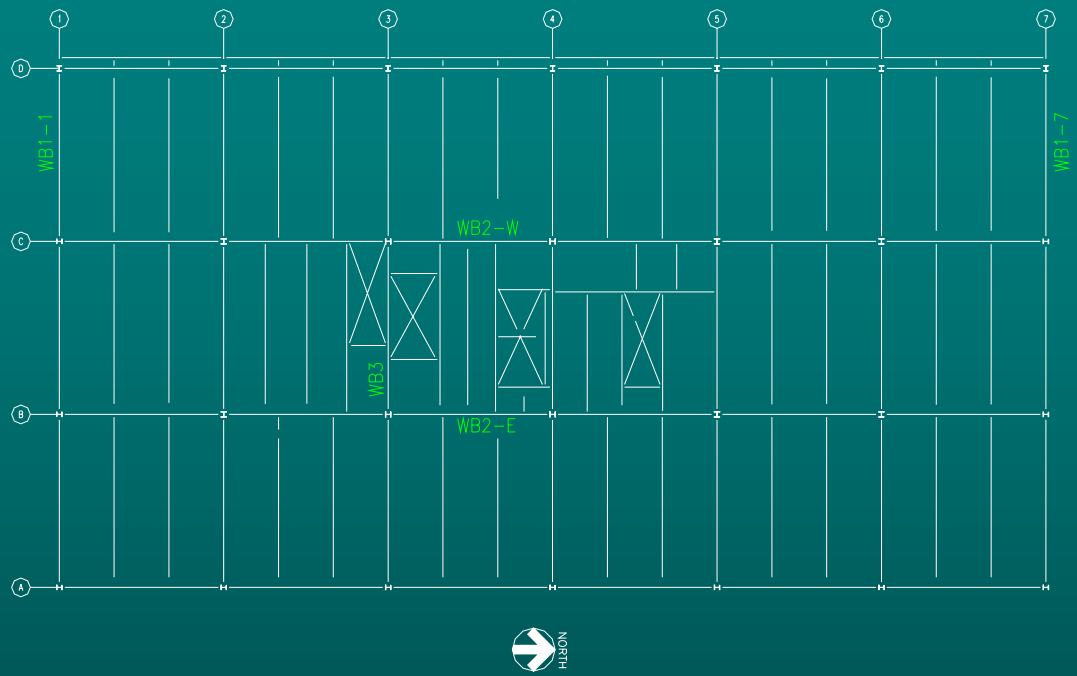
- W16x31 with 17 studs
- W24x55 with 35 studs

Columns:

- W12’s



WB–1



Steel Braces

- Columns – W12x58 to W12x136
- Beams – W18x40 or W24x68
- Braces – HSS5x5x.1875 to HSS8x8x.25

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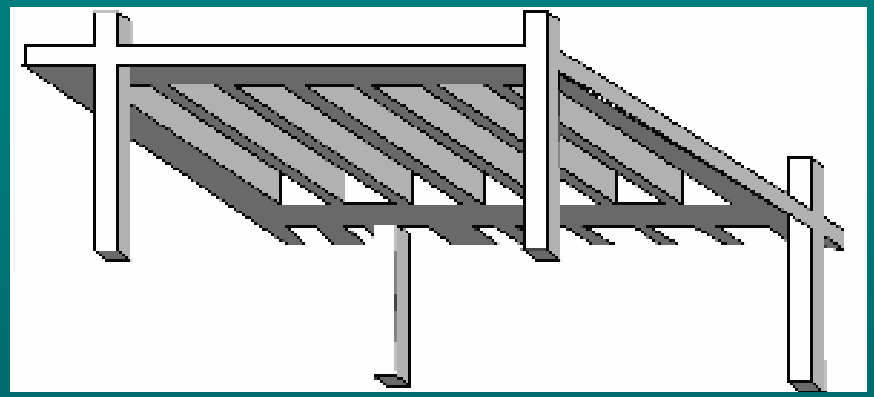
Floor System:

Skip-Joists

- Fast construction
- Easy formwork
- Comparable member depth
- Comparable cost
- Available work force



Lateral System:

- Intermediate concrete moment frame
- Inherent properties of concrete

Codes:

- IBC 2003
- ASCE 7-05
- ACI 318-05

Design Criteria:

- Cost
- Constructability
  - Ease of construction
  - Schedule
- Building Weight
- Architecture
  - Flexible floor plan
  - Windows

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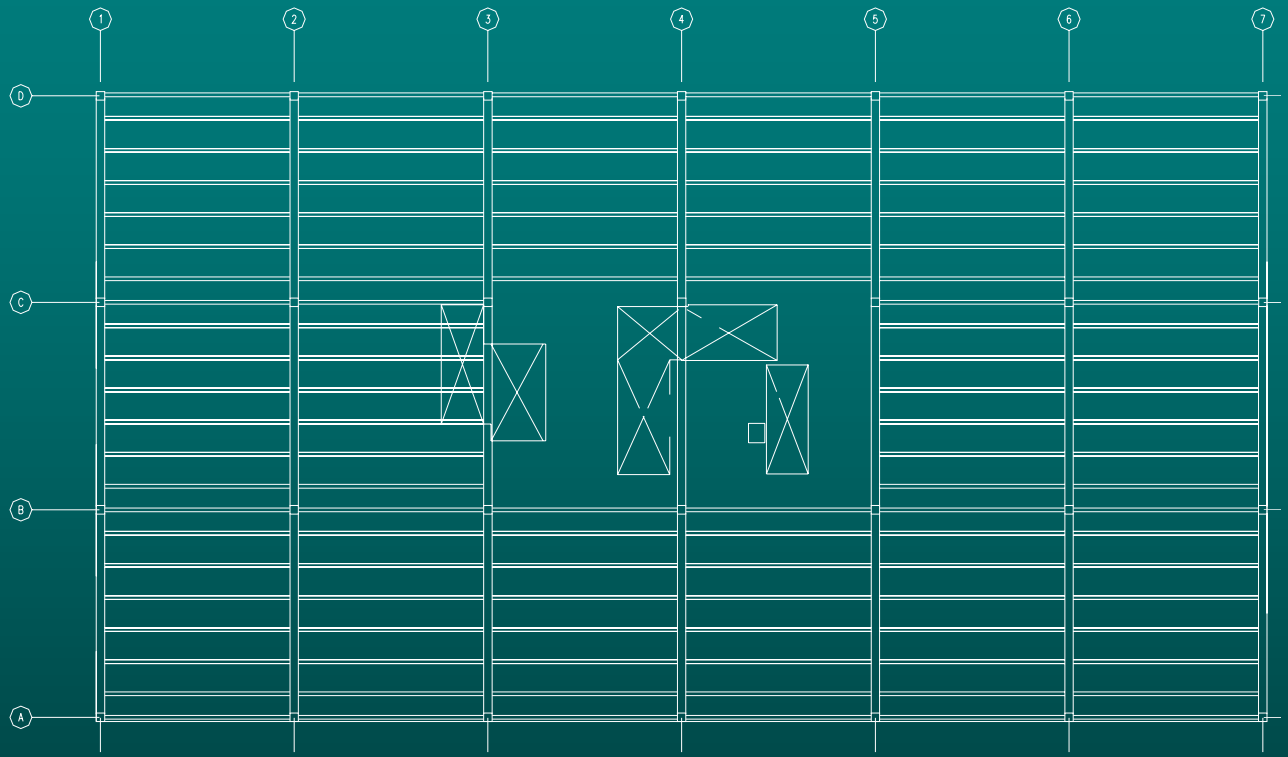
Summary and Conclusions

- Typical Floor Layout



Skip-joist system:
- 53” + 7”
- 4.5” thick slab

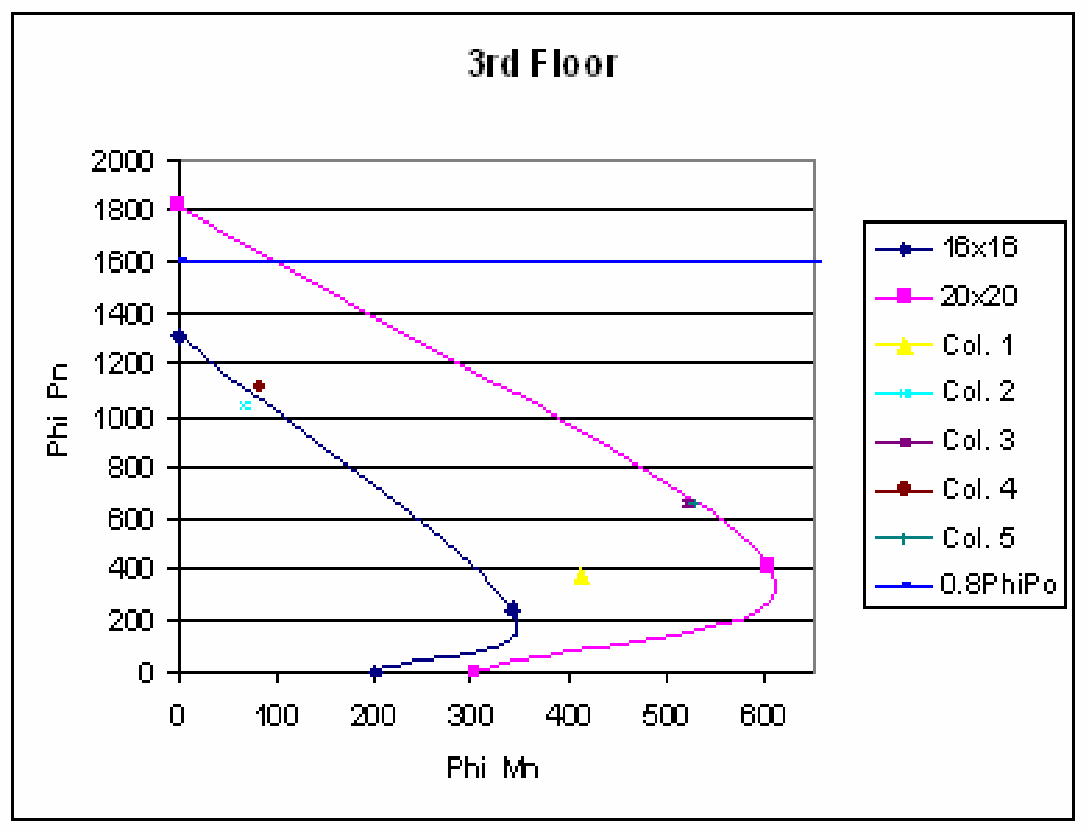
Joists:
- 7”x14”
- 7”x16”
- 8”x16” or 10”x16”

Girders:
- 16”x26”

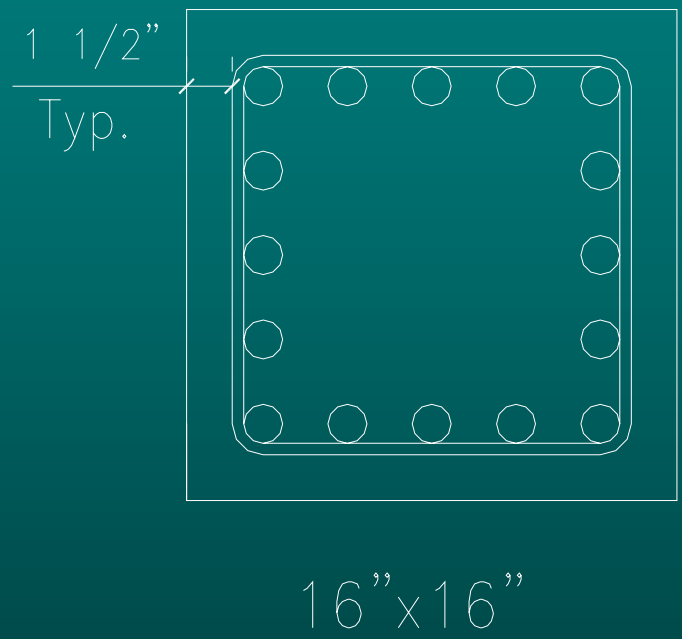
- Flexural reinforcement:
  - #7, #8
  - #9, #10

- Spacing requirements for shear:
  - S ≤ d/4
    ≤ 8 øf
    ≤ 24 øs
    ≤ 12”

Shear Reinforcement			
	Size	# and spacing (in.), ends	Spacing for middle (in.)
Floor Joist	# 3	(1) @ 2, (6) @ 4	9
Roof Joist	# 3	(1) @ 2, (6) @ 4	9
Ext. Floor Joist	# 3	(1) @ 2, (6) @ 4	9
Floor Girder	# 4	(1) @ 2, (16) @ 5, (9) @ 9	11
Roof Girder/ Ext. Floor Girder	# 4	(1) @ 2, (10) @ 5, (7) @ 8	11
Ext. Roof Girder	# 4	(1) @ 2, (10) @ 5	11



- Typical Reinforcement:



- Column sizes range from 16x16 to 22x22

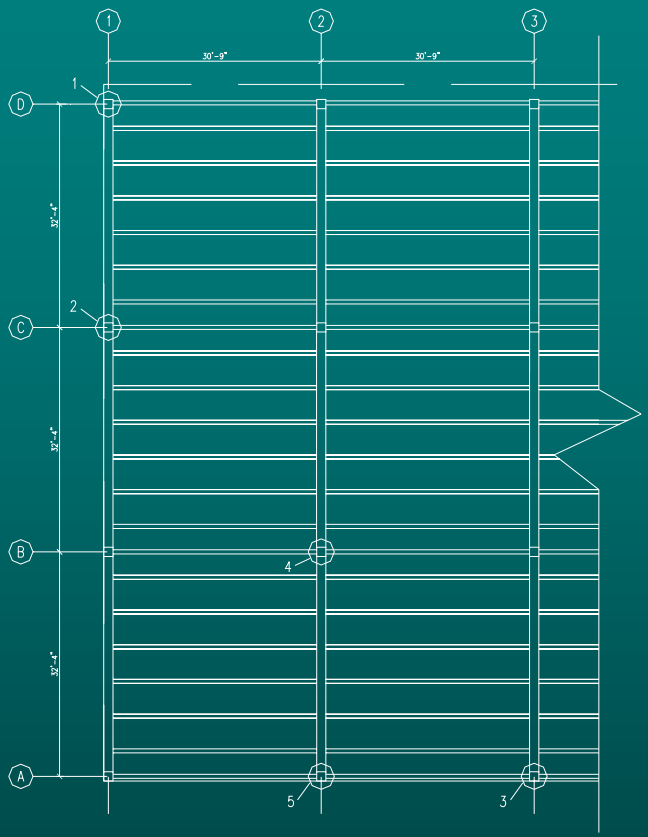
Seismic Loads

Story	F_x(k)
2	9.53
3	20.29
4	31.70
5	43.66
6	56.16
R	53.07

- Wind controls East/West
- Seismic controls North/South

Wind Loads

$P=qGCp - q_i(GCp_i)$						
	Windward		Leeward		Total	
height	N-S	E-W	N-S	E-W	N-S	E-W
0-15'	6.83	6.83	-4.68	-7.04	11.51	13.87
20'	7.43	7.43	-4.68	-7.04	12.11	14.47
25'	7.91	7.91	-4.68	-7.04	12.59	14.95
30'	8.39	8.39	-4.68	-7.04	13.07	15.43
40'	9.11	9.11	-4.68	-7.04	13.78	16.15
50'	9.71	9.71	-4.68	-7.04	14.38	16.75
60'	10.19	10.19	-4.68	-7.04	14.86	17.23
70'	10.67	10.67	-4.68	-7.04	15.34	17.71
80'	11.15	11.15	-4.68	-7.04	15.82	18.19
84.67	11.27	11.27	-4.68	-7.04	15.94	18.31



- Controlling lateral distribution to columns:

5th Floor Columns 20x20		
	N/S (k)	E/W (k)
W	1.83	3.86
E	2.85	2.85

- Available shear strength:

17.6^{k}

Column Schedule					
	1	2	3	4	5
6th Floor	16x16	16x16	16x16	16x16	16x16
5th Floor	20x20	16x16	20x20	16x16	20x20
4th Floor	20x20	16x16	20x20	16x16	20x20
3rd Floor	20x20	20x20	20x20	20x20	20x20
2nd Floor	22x22	22x22	22x22	22x22	22x22
1st Floor	22x22	22x22	22x22	22x22	22x22

- Intermediate Reinforced Concrete Moment Frame requirements:
  - So ≤ b/2
    ≤ 8 øv
    ≤ 24 øh
    ≤ 12”
  - lo ≤ ln/6
    ≤ b
    ≤ 18”
  - Transverse reinforcement requirements

Column Shear Reinforcement						
	Size	S_o	l_o	After l_o	d/2	Spacing used (in)
16x16	# 3	8	16	16	6.75	6
20x20	# 3	9	18	18	8.75	8
22x22	# 3	9	18	18	9.75	9

Existing System:

Cost:

- $1.8 Million

Schedule:

- 225 days ~ 45weeks

New System:

Cost:

- $1.4 Million
- $7/sq. ft.

Schedule:

- 300 days ~ 60weeks

Cost Savings:

- $400,000

Construction Duration:

- 75 day increase

~ 15 week increase

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Photovoltaic (PV): solar power technology that uses solar cells to convert energy from the sun into electricity.

- Have been used to power spacecrafts and satellites

- 4 GW of PV capacity worldwide

Façade vs. Roof

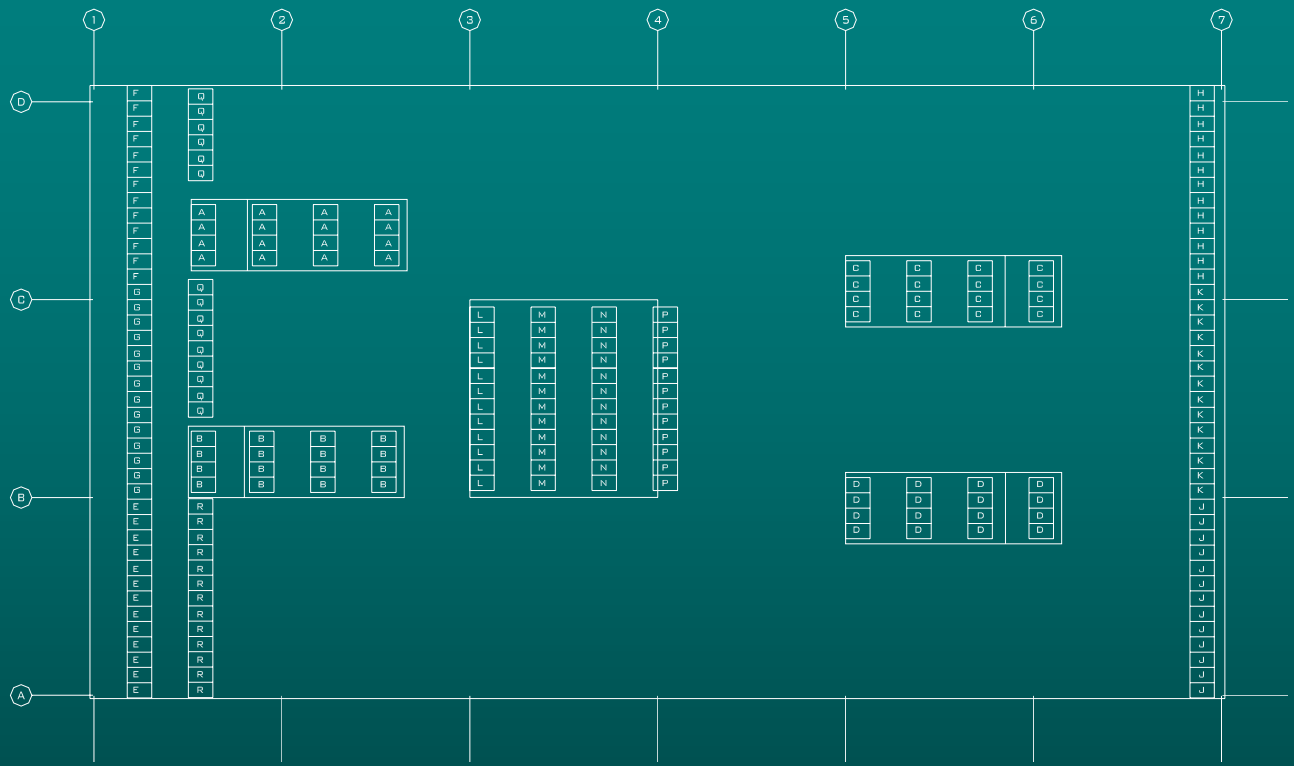
- Solar Wall PV/T
- SUNSLATES
- PV panels

PV Panel:

- BP Solar model 4175
  - 175W
  - Monocrystalline cells
  - 72 cells in 6x12 matrix

Inverter:

- Sunny Boy Grid-tie Inverter
  - 208V single phase
  - 3500W
  - 16 inverters used



- Shadow Length
- Placed on RTU and penthouse

- 220 panels
- Savings of $7,300/year
- Prevent ~ 50tons of CO_2/year

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Summary and Conclusions

	Original Design	New Design
Cost:	$1.8 Million	$1.4 Million
Schedule:	45 weeks	60 weeks
Ease of Construction:	Easy	Easy
Additional Fire Proofing Req'd?	Yes	No
Flexible Floor Plan?	Yes	Yes
Unobstructed Façade?	No	Yes
Available Labor?	Yes	Yes
Recommendation:	No	Yes

Justification

- ~ Available worker force
- ~ No lead time
  - – more flexibility in design process
- ~ Foundations
  - – less expensive to increase caisson diameter than switch from shallow
- ~ No bracing – unobstructed view
- ~ No additional fireproofing required
- ~ Maintain flexible floor plan

Architect and Main Engineer

CM/GC/Developer

Geotechnical Engineer

- AE professors and design professionals
- Family and friends


Questions?