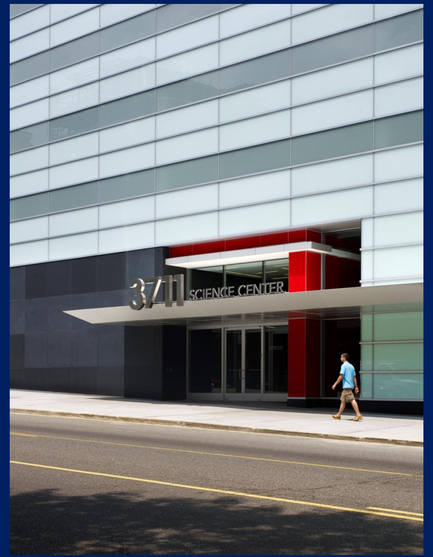

3711 Market Street

Philadelphia, PA

Zachary Yarnall I Structural Option
AE Senior Thesis I Spring 2010
Faculty Consultant I Professor Parfitt

Outline

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- Existing Building Information
- Problem Statement & Solution
- Structural Depth
- Construction Management Breadth Study

- Conclusions
- Acknowledgements
- Questions and Comments

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Existing Building Information

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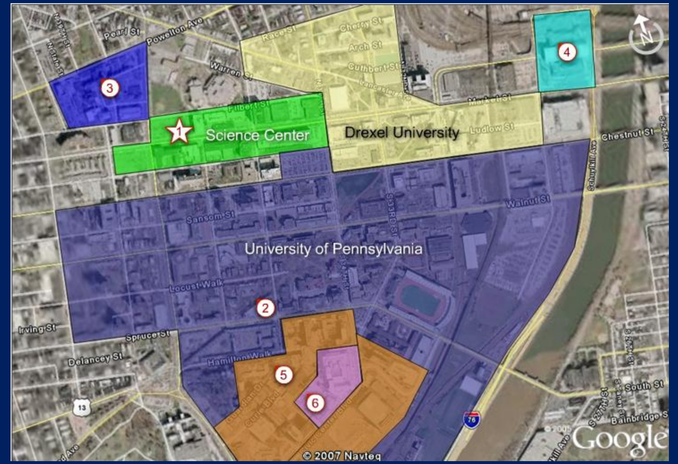
Location
- University City Science Center: a large urban research park in Philadelphia

Building Statistics
- Occupancy | Mixed occupancies, non-separated uses
- Size | 401,032 sq. ft.
- Stories | 10 stories plus penthouse
  includes offices, wet labs, retail space, and a 500 car parking garage



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Architectural Design Concept
- High performance frosted glass curtain wall along Market Street
- Brick façade along remainder of building

Sustainability
- LEED® certification
- Largest green roof in Philadelphia
- State of the art 35,00 sq. ft. PVC "Green" Roofing System

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Structural System

- 7-1/2" thick composite steel decking
  - Normal weight concrete
  - 18-gauge steel decking with ¾ " studs
- Cast-in-place reinforced concrete grade beams and piers
- Concentric steel braced frames consisted of HSS steel shapes
- Typical bays size ≈ 31'6" x 31'6"
- Varying concrete strengths ≈ 4 ksi, but 3 ksi in some locations

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Project Goals

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Problem Statement

- Steel construction/ composite steel decking is most efficient
- Maintain large bay size and open floor plan
- Relocation of building site to San Francisco
  - Active seismic zone

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- Structural Depth Study I Redesign composite steel deck
  - Using light weight concrete
- Structural Depth Study I Redesign lateral system
  - Choose type of system
  - Serviceability check
- Construction Management Breadth Study
  - Cost comparison of existing and redesigned lateral system
  - Schedule comparison of existing and redesigned lateral system
- Building Enclosure Breadth Study: Blast Resistant Façade
  - Will not be covered in this presentation

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Structural Depth Study

Existing Building Information

Project Goals

Structural Depth

Construction Management Breadth Topic

Conclusions

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Design Loads

- Dead Loads

light weight concrete	115 pcf
partitions	20 psf
M.E.P.	5 psf
Finishes and misc.	3 psf
Roof Deck	2.6 psf
Rigid insulation	4 psf

- Live loads

corridors, lobbies, & exits	100 psf
labs / offices	100psf
Garage	40 psf
Mech. equip. rooms	150 psf
Roof	30 psf

Design Loads

- ASCE 7-05
  Live load values
  Superimposed load values

- Vulcraft Catalog: composite steel decking
  dead load 43 psf

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Lateral Loads

- Wind load
  North/South Direction Base Shear 1.6(419)= 670 kips
  East/West Direction Base Shear 1.6(305)= 488 kips
- Seismic load
  Base Shear 838 kips
- Governing lateral load
  $V_{seismic}$ = 838 kips > V_{wind} = 670 kips

Lateral Loads

- ASCE 7-05
  For wind loads: Section 6.5: method 2

  For seismic loads: Chapters 11 - 12
  Equivalent Lateral Force Procedure

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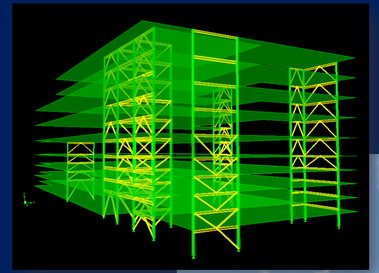
ETABS computer modeling

- Lateral system was modeled and designed
- Diaphragms were assumed to be rigid
- All seismic forces were applied at the center of mass
- Braces were assumed to be pinned at both ends
- Lateral beams were assumed to be fixed at both ends
- Modeling of all beam and column elements took loading deformations into account
- Seismic drift was determined based on ASCE7-05



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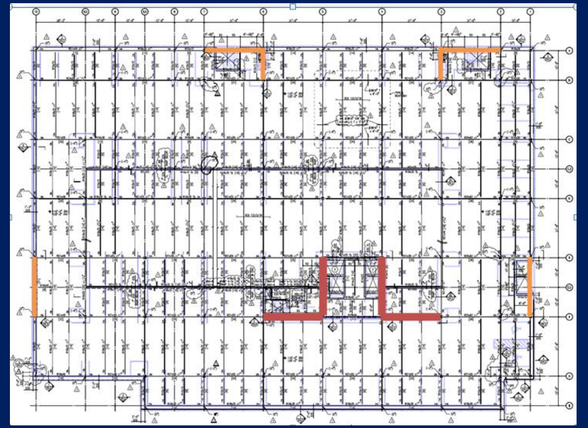

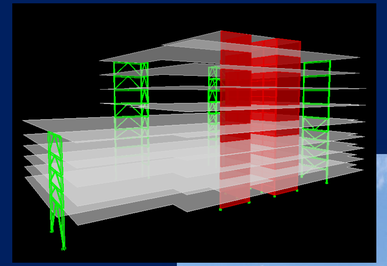

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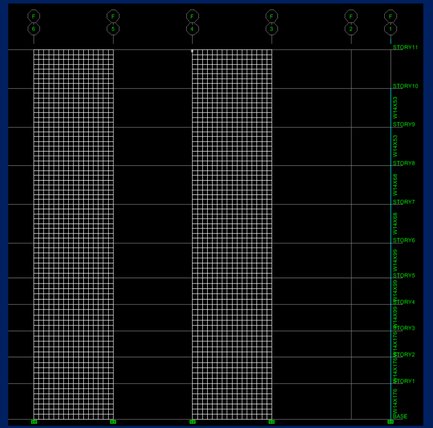
New Lateral System Design



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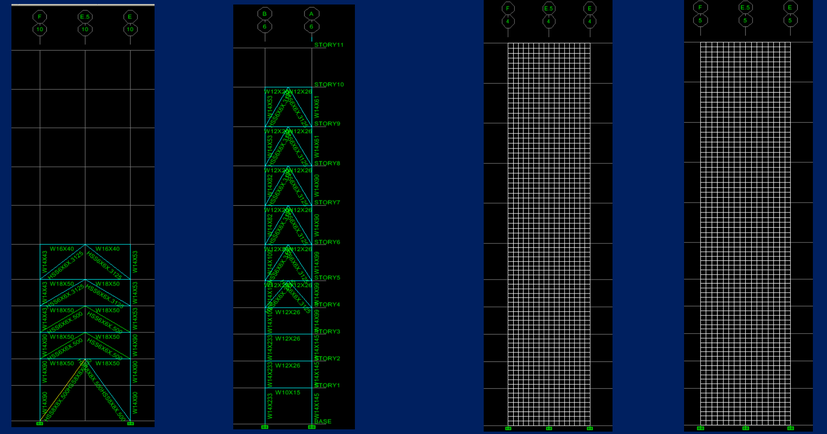

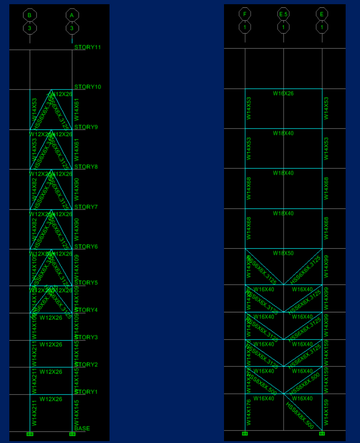

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Drift Checks

Controlling Seismic Drift: North-South Direction							
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift $\Delta_{seismic} = 0.015*h_x$ (in)				Total Drift (in)
11	14.67	0.52000	‹	2.64060	acceptable		2.76010
10	14.67	0.48000	‹	2.64060	acceptable		2.24010
9	14.67	0.42000	‹	2.64060	acceptable		1.76010
8	14.67	0.35000	‹	2.64060	acceptable		1.34010
7	14.67	0.29000	‹	2.64060	acceptable		0.99010
6	13.33	0.24000	‹	2.39940	acceptable		0.70010
5	10	0.18000	‹	1.80000	acceptable		0.46010
4	10	0.13000	‹	1.80000	acceptable		0.28010
3	10	0.09000	‹	1.80000	acceptable		0.15010
2	10	0.06000	‹	1.80000	acceptable		0.06010
1	13.5	0.03000	‹	2.43000	acceptable		0.00010

Controlling Seismic Drift: East-West Direction							
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift $\Delta_{seismic} = 0.015*h_x$ (in)				Total Drift (in)
11	14.67	1.01000	‹	2.64060	acceptable		5.97046
10	14.67	0.98000	‹	2.64060	acceptable		4.96046
9	14.67	0.90000	‹	2.64060	acceptable		3.98046
8	14.67	0.80000	‹	2.64060	acceptable		3.08046
7	14.67	0.64000	‹	2.64060	acceptable		2.28046
6	13.33	0.51000	‹	2.39940	acceptable		1.64046
5	10	0.41000	‹	1.80000	acceptable		1.13046
4	10	0.32000	‹	1.80000	acceptable		0.72046
3	10	0.24000	‹	1.80000	acceptable		0.40046
2	10	0.16000	‹	1.80000	acceptable		0.16046
1	13.5	0.09000	‹	2.43000	acceptable		0.00046

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Construction Management Breadth

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Cost comparison of the existing and new design of the lateral system

Existing Lateral Sytem		New Lateral Sytem	
		Total Steel Cost:	$203,274.76
		Total Concrete Cost:	$114,525.47
Total Structural Steel Cost:	$500,276.86	*Total Lateral System Cost:*	$317,800.23
Total Difference in Cost:	$182,476.63		

- The total costs include location, design contingency, escalation contingency, insurance, bonds and overhead & profits factors

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Schedule comparison of the existing and new design of the lateral system

	Existing (hrs)	Redesign (hrs)
Beams	7.63	3.63
Braces	71.86	24.1
Columns	4.86	2.09
Shear Walls	-	629.61
Total Hours	84.34	659.43
Weeks	2.1	16.5
Duration difference in weeks		14.4
Percent Difference		1278.95%

- The total hours take into consideration the quantity of members, labor hours, finishes, formwork, reinforcement, and curing time.

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Conclusions

Structural
- Design light weight concrete composite steel deck YES
- Redesign lateral system for San Francisco YES
- Maintaining typical bay size and open floor plan YES

Construction Management
- Cost comparison YES
- Schedule comparison YES

Blast Resistant Façade Study
- Curtain wall design YES
- Thermal resistance calculation YES

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Questions and Comments