Justin Kovach

Structural Option
Senior Thesis

UPMC Hamot Women's Hospital

201 State Street
Erie, PA

PRESENTATION OUTLINE

- Introduction
  - Building History & Statistics
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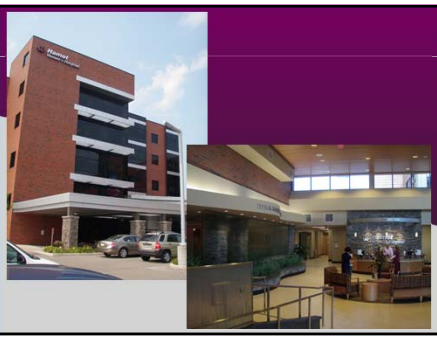
- Structural Depth
  - ASCE Code Comparison
  - Moment Frames
  - Braced Frames
  - Shear Walls
  - MAE Course Related Study
- Architectural Breadth
- Construction Management Breadth
- Conclusion



UPMC Hamot Women's Hospital

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Structural Option

INTRODUCTION

UPMC Hamot Womens Hospital
Erie, PA

Building Statistics

Location:	201 State Street Erie, PA
Occupancy Type:	Hospital/Healthcare
Building Size:	163, 616 ft²
Construction Dates:	January 2007 – January 2011
Construction Costs:	$50,000,000 +/-
Project Delivery Method	Traditional (Design-Bid-Build)
Project Team:	
Owner	UPMC Hamot
Architect	Rechtenwald Architects Inc.
Structural Engineer	Atlantic Engineering Services
MEP Engineer	CJL Engineering
Site/Civil Engineer	Urban Engineers Inc.
General Contractor	Perry Construction Group

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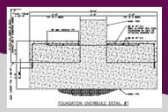

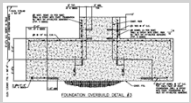

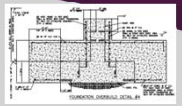

UPMC Hamot Womens Hospital
Erie, PA

Existing Structure

Foundations
- Strip Footings
- Spread Footings

Floor Construction
- 4" concrete on 2" – 20 Gauge Composite Deck

Lateral System
- N-S Direction
  - Braced Frame along Column Line N
  - Moment Frame along Column Line B
- E-W Direction
  - Moment Frames along Column Lines 1 and 17

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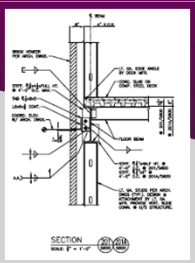

UPMC Hamot Womens Hospital
Erie, PA

Existing Structure

Foundations
- Strip Footings
- Spread Footings

Floor Construction
- 4" concrete on 2" – 20 Gauge Composite Deck

Lateral System
- N-S Direction
  - Braced Frame along Column Line N
  - Moment Frame along Column Line B
- E-W Direction
  - Moment Frames along Column Lines 1 and 17

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INTRODUCTION

UPMC Hamot Womens Hospital
Erie, PA

Existing Structure

Foundations
- Strip Footings
- Spread Footings

Floor Construction
- 4" concrete on 2" – 20 Gauge Composite Deck

Lateral System
- N-S Direction
  - Braced Frame along Column Line N
  - Moment Frame along Column Line B
- E-W Direction
  - Moment Frames along Column Lines 1 and 17

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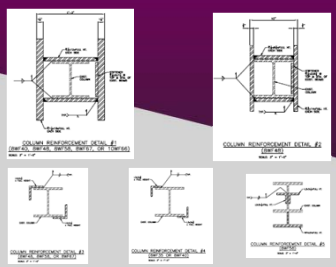

UPMC Hamot Womens Hospital
Erie, PA

Existing Structure

Foundations
- Strip Footings
- Spread Footings

Floor Construction
- 4" concrete on 2" – 20 Gauge Composite Deck

Lateral System
- N-S Direction
  - Braced Frame along Column Line N
  - Moment Frame along Column Line B
- E-W Direction
  - Moment Frames along Column Lines 1 and 17

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Thesis Goals

PENNSTATE Department of Architectural Engineering

UPMC Hamot

UPMC Hamot Womens Hospital
Erie, PA

Thesis Goals

Structural Depth
- ASCE 7-05 vs. ASCE 7-10 Load Comparison
- Comparison of Various Lateral Systems

Architectural Breadth
- Analyze impact of the various lateral systems on the buildings architectural interior

Construction Management Breadth
- Detailed Cost and Schedule Analysis of various lateral systems

MAE Course Related Study
- Develop a deeper understand of RAM Structural System
- Design Connections for Moment Frame and Braced Frame Systems

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Structural Depth

Live Loads

ASCE Code Comparison

Load Type	ASCE 7-05	ASCE 7-10
Live Load	(psf)	(psf)
Lobbies	100	100
Operating Rooms/Labs	60	60
Patient Rooms	40	40
Corridors, above first floor	80	80
First Floor Corridors	100	100
Offices	50	50
Stairs	100	100
Mechanical Space	150	150
Roofs	20	20

Snow Loads

ASCE Code Comparison

Design Parameter	ASCE 7-05	ASCE 7-10
Snow Load		
Ground Snow Load	40 psf	40 psf
Occupancy Category	III	IV
Importance Factor	1.1	1.2
Thermal Factor	1.0	1.0
Exposure Factor	0.8	0.8
Flat Roof Snow Load	24.64	26.88

9% increase in snow load

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Structural Depth

UPMC Hamot Womens Hospital
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ASCE Code Comparison

- ASCE 7-05
  - Occupancy Category III
    - Healthcare Facilities with a capacity of 50 or more resident patients, but not having surgery or emergency treatment facilities
  - Occupancy Category IV
    - Hospitals and other healthcare facilities having surgery or emergency facilities
- ASCE 7-10
  - Occupancy Category III
    - Buildings and other structures, the failure of which could pose a substantial risk to human life
  - Occupancy Category IV
    - Buildings and other structures designated as essential facilities

Snow Loads

ASCE Code Comparison

Design Parameter	ASCE 7-05	ASCE 7-10
Snow Load		
Ground Snow Load	40 psf	40 psf
Occupancy Category	III	IV
Importance Factor	1.1	1.2
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Structural Depth

UPMC Hamot Womens Hospital
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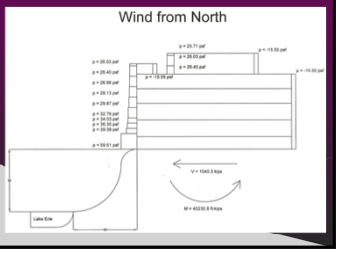
ASCE Code Comparison

Wind Loads

Design Parameter	ASCE 7-05	ASCE 7-10
Wind Load		
Design Wind Speed	90 mph	120 mph
Occupancy Category	III	IV
Importance Factor	1.15	N/A
Exposure Category	D	D
Enclosure Classification	Enclosed	Enclosed
Load Combination Factor	1.6	1.0
Base Shear, N-S	1040.3 k	1688.5 k
Base Shear, E-W	435.9 k	730.9 k

ASCE Code Comparison

2-D Escarpment



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Structural Depth

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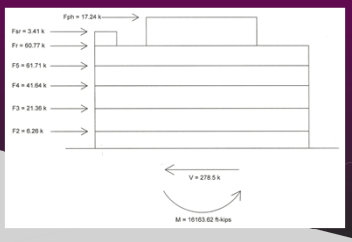
ASCE Code Comparison

Earthquake Loads: Steel Frame – Not Specifically Detailed for Seismic

Design Parameter	ASCE 7-05	ASCE 7-10
Earthquake Load		
R-Value	3	3
Occupancy Category	III	IV
Importance Factor	1.25	1.5
S_{DS}	0.175	0.165
S_{D1}	0.078	0.085
C_S	0.018	0.024
Building Weight	11,606 k	11,606 k
Base Shear	212.4 k	278.5 k

ASCE Code Comparison



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Structural Option

Structural Depth

Moment Frame System

Advantages
- Open Floor Plan

Disadvantages
- Relatively Flexible Lateral System

Typical Sizes

• Beams	W21x48	W24x68	
• Columns	W14x90	W14x132	W14x159

Max Expected Roof Drift	= 2.292"	(Earthquake)
	= 1.904"	(Wind)
Allowable Roof Drift	= 12.96"	(Earthquake)
	= 2.16"	(Wind)

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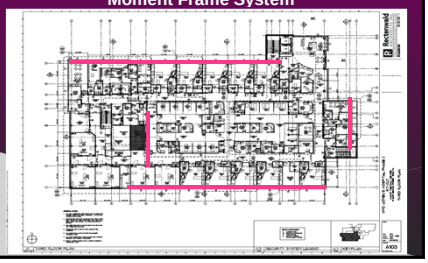
Moment Frame System



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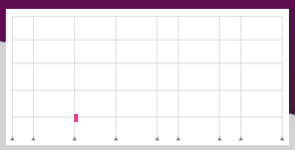
Structural Depth

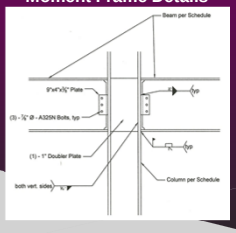
Moment Frame Details



Moment Frame along CL 1

UPMC Hamot Womens Hospital
Erie, PA

Moment Frame Details



Typical Moment Connection Detail

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Structural Depth

Braced Frame System

Advantages
- Increased Stiffness and Decreased Deflection

Disadvantages
- Potentially affects Interior Architecture

Typical Sizes

• Beams	W18x35		
• Columns	W10x49;	W10x60;	W10x88
• Braces	HSS6x6x3/8		

Max Expected Roof Drift	= 1.744"	(Earthquake)
	= 1.449"	(Wind)
Allowable Roof Drift	= 12.96"	(Earthquake)
	= 2.16"	(Wind)

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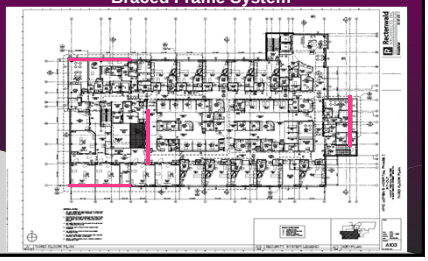
Erie, PA

Braced Frame System



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Structural Depth

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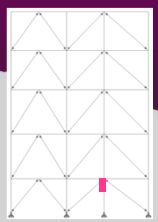
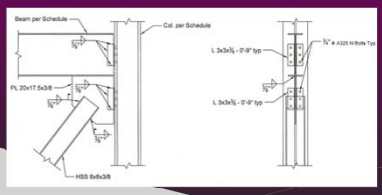
Braced Frame Details



Braced Frame along CL 1

Braced Frame Details



Typical Braced Frame Detail

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Structural Depth

Shear Wall System

Advantages
- Much more rigid than Moment Frames

Disadvantages
- Takes additional time to Form, Reinforce, Pour and allow walls to cure

Typical Sizes
- 8" Thick Reinforced Concrete Shear Walls

Max Expected Roof Drift	= 1.370"	(Earthquake)
	= 1.390"	(Wind)
Allowable Roof Drift	= 12.96"	(Earthquake)
	= 2.16"	(Wind)

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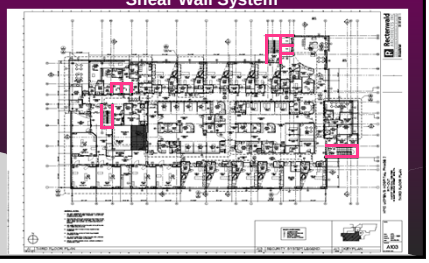
Shear Wall System



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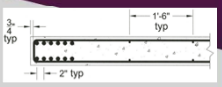
Structural Depth

Shear Wall Details

Base Details



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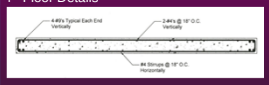
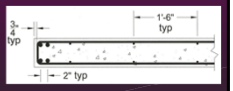
Shear Wall Details

4th Floor Details





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Architectural Breadth

Moment Frame System

2nd Floor

UPMC Hamot Womens Hospital
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Braced Frame System

2nd Floor

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Architectural Breadth

Moment Frame System

5th Floor

UPMC Hamot Womens Hospital
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Braced Frame System

5th Floor

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Construction Management Breadth

Schedule Analysis

	Phase 1 Completion Date
Existing System	November 2008 +/-
Moment Frames	12/28/2007
Braced Frames	1/2/2008
Shear Walls	2/08/2008

Existing System: Data Supplied by Contractor
Moment Frames: Implode and Rebuild with Moment Frames
Braced Frames: Implode and Rebuild with Braced Frames
Shear Walls: Implode and Rebuild with Shear Walls

UPMC Hamot Womens Hospital
Erie, PA

Cost Analysis

	Demolition	Gravity/Lateral System	Floors	Total
Existing System	Unknown	Unknown	Unknown	$9,000,000
Moment Frame	$2,345,293	$6,396,503	$1,963,536	$10,705,332
Braced Frame	$2,345,293	$5,884,627	$1,963,536	$10,193,456
Shear Wall	$2,345,293	$5,018,654	$1,963,536	$9,327,483

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Construction Management Breadth

Cost and Schedule Assumptions

Only analyzing Phase 1 (Structural Shell) of the project
Phase 2 (Fit-Out) is assumed to be unaffected by Phase 1

Phase 1 Critical Path changes will directly move the entire Phase 2 start date

Comparable Cost was completed based on Financial Data that is publically available on the UPMC Hamot Hospital System

UPMC Hamot Womens Hospital
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Cost and Schedule Analysis

	Cost	Schedule Adjustment (Months)	Additional Profit	Comparable Cost
Existing System	$9,000,000	N/A	N/A	$9,000,000
Moment Frames	$10,705,332	10	$2,394,612	$8,310,720
Braced Frames	$10,193,456	10	$2,394,612	$7,798,844
Shear Walls	$9,327,483	9	$2,155,150	$7,172,332

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Lateral Systems

Moment Frame, Braced Frame, and Shear Wall Systems were effectively designed Lateral Systems for the UPMC Hamot Womens Hospital

Architectural Impacts

The Braced Frame System was deemed not desirable due to the loss of the views desired by the architect and the potential health impacts

Construction Management Impacts

It was determined that imploding the building and starting from scratch was the most feasible design for both cost and schedule

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Final Thoughts

Upon final analysis of the UPMC Hamot Womens Hospital my recommendation would have been to use the Concrete Shear Wall system around the vertical circulation of the structure. This becomes efficient when the building is completely demolished from the start of Phase 1 and also allows for the views that the architect and building owner desire,

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Questions and Comments

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Acknowledgements

Atlantic Engineering Services
- Gil Taylor and John Schneider

Penn State AE Faculty
- Dr. Boothby
- Dr. Hanagan
- Professor Parfitt

Family
- For their constant love and support throughout my life!

Friends
- I could not think of a better group of people to spend my time with over these last four years!

My Lord and Savior
- I have been blessed beyond belief in every aspect of my life. I hope to use the talents given to me to glorify God now and in the future

[redacted]

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Code Literature

ASCE 7-05

TABLE 1-1 OCCUPANCY CATEGORY OF BUILDINGS AND OTHER STRUCTURES FOR FLOOD, WIND, SNOW, EARTHQUAKE, AND ICE LOADS

Nature of Occupancy	Occupancy Category
Buildings and other structures that represent a low hazard to human life in the event of failure, including, but not limited to: • Agricultural facilities • Certain temporary facilities • Minor storage facilities	I
All buildings and other structures except those listed in Occupancy Categories I, III, and IV	II
Buildings and other structures that represent a substantial hazard to human life in the event of failure, including, but not limited to: • Buildings and other structures where more than 300 people congregate in one area • Buildings and other structures with day-care facilities with a capacity greater than 150 • Buildings and other structures with elementary school, secondary school, or day-care facilities with a capacity greater than 250 • Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities • Health care facilities with a capacity of 50 or more resident patients, but not having surgery or emergency treatment facilities • Jails and detention facilities Buildings and other structures, not included in Occupancy Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure, including, but not limited to: • Power generating stations* • Water treatment facilities • Wastewater treatment facilities • Telecommunication centers Buildings and other structures not included in Occupancy Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released Buildings and other structures designated as Essential Facilities, including, but not limited to: Structures whose failure could pose a substantial hazard to the community that are not designated as Occupancy Category IV structures and not classified as Occupancy Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the toxic or explosive substances does not pose a threat to the public.	III
Buildings and other structures designated as essential facilities, including, but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue, ambulance, and police stations and garages • Designated earthquake, hurricane, or other emergency shelters • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response • Power generating stations and other public utility facilities required in an emergency • Ancillary structures (including, but not limited to, communication towers, fuel storage tanks, cooling towers, electrical substation structures, fire water storage tanks or other structures housing or supporting water, or other fire-suppression material or equipment) required for the operation of Occupancy Category IV structures during an emergency • Aviation control towers, air traffic control centers, and emergency aircraft hangars • Water storage facilities and pump structures required to maintain water pressure for fire suppression • Buildings and other structures having critical national defense functions Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing highly toxic substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction. Buildings and other structures containing highly toxic substances shall be eligible for classification as Occupancy Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the substances is commensurate with the risk associated with that Occupancy Category or not be permitted if the buildings or other structures also function as essential facilities. *Cogeneration power plants that do not supply power on the national grid shall be designated Occupancy Category II.	IV

ASCE 7-10

Table 1.5-1 Risk Category of Buildings and Other Structures for Flood, Wind, Snow, Earthquake, and Ice Loads

Use or Occupancy of Buildings and Structures	Risk Category
Buildings and other structures that represent a low risk to human life in the event of failure	I
All buildings and other structures except those listed in Risk Categories I, III, and IV	II
Buildings and other structures, the failure of which could pose a substantial risk to human life. Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure. Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where their quantity exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.	III
Buildings and other structures designated as essential facilities. Buildings and other structures, the failure of which could pose a substantial hazard to the community. Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity exceeds a threshold quantity established by the authority having jurisdiction to be dangerous to the public if released and is sufficient to pose a threat to the public if released.* Buildings and other structures required to maintain the functionality of other Risk Category IV structures.	IV

*Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for classification to a lower Risk Category if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the substances is commensurate with the risk associated with that Risk Category.

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Snow Load Calcs

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ASCE 7-05

$p_f = 0.7\ C_e\ C_t\ I\ p_g$

$C_e = 0.8$	Table 7-2, Fully Exposed, Terrain Category D
$C_t = 1.0$	Table 7-3
$I = 1.1$	Table 7-4
$p_g = 40$ psf	Case Study Region., Called Erie Code Office for this info

$p_f = 0.7(0.8)(1.0)(1.1)(40\ psf)$

$p_f = 24.64$ psf

ASCE 7-10

$p_f = 0.7\ C_e\ C_t\ I\ p_g$

$C_e = 0.8$	Table 7-2, Fully Exposed, Terrain Category D
$C_t = 1.0$	Table 7-3
$I = 1.2$	Table 1.5-2
$p_g = 40$ psf	Case Study Region., Called Erie Code Office for this info

$p_f = 0.7(0.8)(1.0)(1.2)(40\ psf)$

$p_f = 26.88$ psf

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Wind Load Calcs

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ASCE 7-05 (Method 2 - Analytical Procedure)

Assume: Enclosed Building
Rigid Building

Wind from North

V = 90 mph	Figure 6-1
$K_d = 0.85$	Table 6-4
I = 1.15	Table 6-1
Occupancy Category = III	Table 1-1
G = 0.85	Section 6.5.8
GC_{pi} = +/- 0.18	Figure 6-5
C_p = 0.8	Figure 6-6 (Windward Wall)
C_p = -0.5	Figure 6-6 (Leeward Wall)
C_p = -0.9	Figure 6-6 (Roof – 0' to 78')
C_p = -0.5	Figure 6-6 (Roof – 78' to 145')

ASCE 7-05 (continued)

p = -15.55 psf (Leeward)

Values that vary with Height

z	K_h & K_z (Table 6-3)	K_{zt} (Figure 6-4)	q_z (Section 6.5.10)	p_z (psf) (Section 6.5.12.4.2) (Windward)
92	1.41	1.046	29.89	25.71
90	1.40	1.070	30.36	26.03
80	1.38	1.105	30.91	26.40
70	1.34	1.162	31.56	26.98
60	1.31	1.252	33.24	28.13
50	1.27	1.391	35.81	29.87
40	1.22	1.620	40.06	32.76
30	1.16	1.783	41.92	34.03
25	1.12	1.997	45.33	36.35
20	1.08	2.275	49.80	39.39
15	1.03	3.803	79.40	59.51

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Wind Load Calcs

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ASCE 7-10 (Directional Procedure)

Assume: Enclosed Building — Section 26.10
Rigid Building

Wind from North

Risk Category = IV	Table 1.5-1
V = 120 mph	Figure 26.5-1B
K_d = 0.85	Table 26.6-1
G = 0.85	Section 26.9.4
GC_{pi} = +/- 0.18	Table 26.11-1
C_p = 0.8	Figure 27.4-1 (Windward Wall)
C_p = -0.5	Figure 27.4-1 (Leeward Wall)
C_p = -0.9	Figure 27.4-1 (Roof – 0' to 78')
C_p = -0.5	Figure 27.4-1 (Roof – 78' to 145')

ASCE 7-10 (continued)

p = -27.96 psf (Leeward)

Values that vary with Height

z	K_h & K_z (Table 27.3-1)	K_{zt} (Figure 26.8-1)	q_z (Section 27.3.2)	p_z (psf) (Section 27.4.1) (Windward)
92	1.41	1.046	46.21	39.74
90	1.40	1.070	46.94	40.24
80	1.38	1.105	47.78	40.81
70	1.34	1.162	48.79	41.72
60	1.31	1.252	51.39	43.48
50	1.27	1.391	55.35	46.18
40	1.22	1.620	61.93	50.65
30	1.16	1.783	64.81	52.61
25	1.12	1.997	70.08	56.19
20	1.08	2.275	76.99	60.89
15	1.03	3.803	122.74	93.00

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Earthquake Load Calcs

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ASCE 7-05

- Moment Frames

R = 3	Table 12.2-1
I = 1.25	Table 11.5-1
T_L = 12	Figure 12.2-1
$T = C_uT_a$ = 1.7(1.043) = 1.773	
Cu = 1.7	Table 12.8-1
$Ta = C_th_n^x$ = 0.028(92')^0.8 = 1.043	
S_{DS} = 0.175	From USGS
S_{D1} = 0.078	From USGS
C_s = 0.0183	
W = 11,606 kips	
V = C.W = 0.0183(11,606 k) = 212.39 k	

ASCE 7-05 (continued)

Level	Weight (k)	Height (ft)	C_v	F_v
Penthouse	315.4	92	0.08118	17.24
Stair Roof	74.3	82	0.01604	3.41
Roof	1616.0	72	0.28611	60.77
5th Floor	2282.7	58	0.29053	61.71
4th Floor	2348.6	44	0.19607	41.64
3rd Floor	2401.9	28	0.10058	21.36
2nd Floor	2567.1	12	0.02949	6.26

$$C_{vi} = w_i h_i^k$$
$$F_{pi} = C_{vi} V$$

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Earthquake Load Calcs

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- Moment Frames

R = 3	Table 12.2-1
I = 1.5	Table 11.5-1
T_L = 12	Figure 12.2-1

$T = C_u T_a = 1.7(1.043) = 1.773$

Cu = 1.7	Table 12.8-1

$T_a = C_t h_n^x = 0.028(92')^{0.8} = 1.043$

S_{DS} = 0.165	From USGS
S_{D1} = 0.085	From USGS

$C_s = 0.024$

W = 11,606 kips

$V = C_s W = 0.024(11{,}606\ k) = 278.54\ k$

ASCE 7-10 (continued)

Level	Weight (k)	Height (ft)	C_v	F_v
Penthouse	315.4	92	0.08118	22.61
Stair Roof	74.3	82	0.01604	4.47
Roof	1616.0	72	0.28611	79.69
5th Floor	2282.7	58	0.29053	80.92
4th Floor	2348.6	44	0.19607	54.61
3rd Floor	2401.9	28	0.10058	28.02
2nd Floor	2567.1	12	0.02949	8.21

$$C_{vi} = w_i h_i^k$$
$$F_{pi} = C_{vi} V$$

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Earthquake Load Calcs

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ASCE 7-05

- Braced Frames

R = 3	Table 12.2-1
I = 1.25	Table 11.5-1
T_L = 12	Figure 12.2-1

$T = C_u T_a = 1.7(1.043) = 1.773$

Cu = 1.7	Table 12.8-1

$T_a = C_t h_n^x = 0.028(92')^{0.8} = 1.043$

S_{DS} = 0.175	From USGS
S_{D1} = 0.078	From USGS

$C_s = 0.0183$

W = 11,501 kips

$V = C_s W = 0.0183(11{,}501\ k) = 210.47\ k$

ASCE 7-05 (continued)

Level	Weight (k)	Height (ft)	C_v	F_v
Penthouse	309.2	92	0.05187	10.92
Stair Roof	68.1	82	0.01042	2.19
Roof	1597.4	72	0.22026	46.36
5th Floor	2264.1	58	0.26260	55.27
4th Floor	2330.0	44	0.21666	45.60
3rd Floor	2383.3	28	0.15437	32.49
2nd Floor	2548.5	12	0.08381	17.64

$$C_{vi} = w_i h_i^k$$
$$F_{pi} = C_{vi} V$$

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Earthquake Load Calcs

ASCE 7-10

- Braced Frames

R = 3	Table 12.2-1
I = 1.5	Table 11.5-1
T_L = 12	Figure 12.2-1
$T = C_t T_a$ = 1.7(1.043) = 1.773	
Cu = 1.7	Table 12.8-1
Ta = $C_t h_n^x$ = 0.028(92')^0.8 = 1.043	
S_{DS} = 0.165	From USGS
S_{D1} = 0.085	From USGS
C_s = 0.024	
W = 11,501 kips	
V = C$_s$W = 0.024(11,501 k) = 276.02 k	

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ASCE 7-10 (continued)

Level	Weight (k)	Height (ft)	C_v	F_v
Penthouse	309.2	92	0.05187	14.32
Stair Roof	68.1	82	0.01042	2.88
Roof	1597.4	72	0.22026	60.80
5th Floor	2264.1	58	0.26260	72.48
4th Floor	2330.0	44	0.21666	59.80
3rd Floor	2383.3	28	0.15437	42.61
2nd Floor	2548.5	12	0.08381	23.13

$$C_{vi} = w_i h_i^k$$
$$F_{pi} = C_{vi} V$$

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Earthquake Load Calcs

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- Concrete Shear Walls

R = 4	Table 12.2-1
I = 1.25	Table 11.5-1
T_L = 12	Figure 12.2-1
$T = C_t T_a$ = 1.7(1.043) = 1.773	
Cu = 1.7	Table 12.8-1
Ta = $C_t h_n^x$ = 0.028(92')^0.8 = 1.043	
S_{DS} = 0.175	From USGS
S_{D1} = 0.078	From USGS
C_s = 0.0137	
W = 13,579 kips	
V = C$_s$W = 0.0137(13,579 k) = 186.03 k	

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ASCE 7-05 (continued)

Level	Weight (k)	Height (ft)	C_{vi}	F_v
Penthouse	606.1	92	0.08285	15.41
Stair Roof	365.0	82	0.04551	8.47
Roof	1894.3	72	0.21284	39.59
5th Floor	2561.0	58	0.24204	45.03
4th Floor	2626.9	44	0.19904	37.03
3rd Floor	2680.2	28	0.14146	26.32
2nd Floor	2845.4	12	0.07625	14.18

$$C_{vi} = w_i h_i^k$$
$$F_{pi} = C_{vi} V$$

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Earthquake Load Calcs

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ASCE 7-10

- Concrete Shear Walls

R = 4	Table 12.2-1
I_e = 1.5	Table 11.5-1
T_L = 12	Figure 12.2-1
$T = C_u T_a = 1.7(1.043) = 1.773$	
Cu = 1.7	Table 12.8-1
$Ta = C h_n^x = 0.028(92')^{0.8} = 1.043$	
S_{DS} = 0.165	From USGS
S_{D1} = 0.085	From USGS
C_s = 0.0180	
W = 13,579 kips	
$V = C_s W = 0.0180(13{,}579\ k) = 244.42\ k$	

ASCE 7-10 (continued)

Level	Weight (k)	Height (ft)	C_v	F_v
Penthouse	606.1	92	0.08285	20.25
Stair Roof	365.0	82	0.04551	11.12
Roof	1894.3	72	0.21284	52.02
5th Floor	2561.0	58	0.24204	59.16
4th Floor	2626.9	44	0.19904	48.65
3rd Floor	2680.2	28	0.14146	34.58
2nd Floor	2845.4	12	0.07625	18.64

$$C_{vi} = w_i h_i^k$$
$$F_{vi} = C_{vi} V$$

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MAE Course Material

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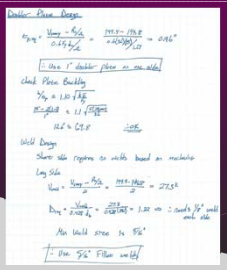
Moment Connection Details



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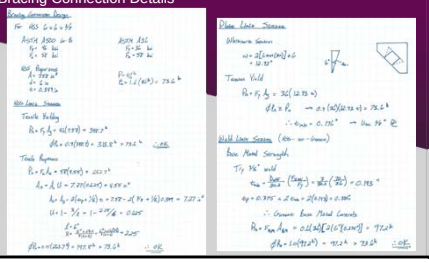
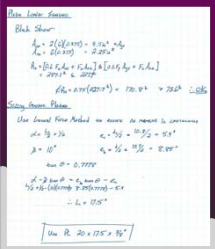
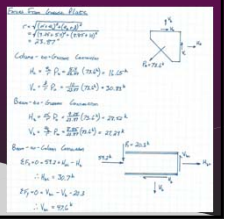
Bracing Connection Details







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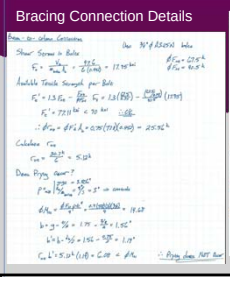

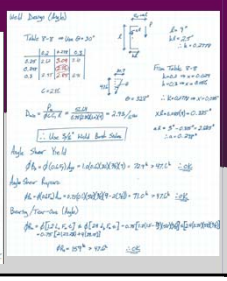

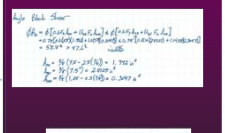

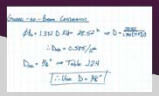

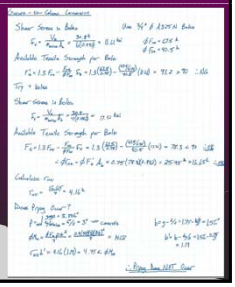

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- Wind Load Calcs
- Earthquake Load Calcs
  - Moment Frames
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  - Concrete Shear Walls
- MAE Course Material
- CM Breadth Calcs

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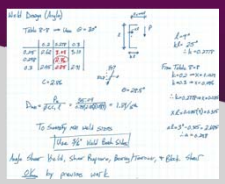
Structural Option

MAE Course Material

Bracing Connection Details



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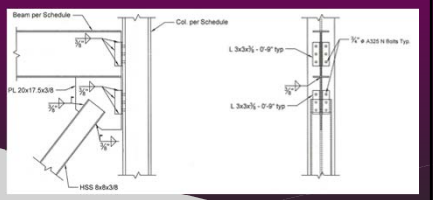

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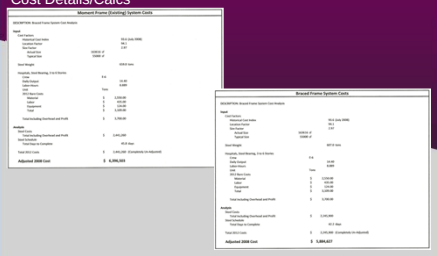
Cost Details/Calcs



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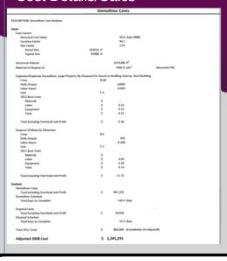

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