JUDICIAL CENTER ANNEX

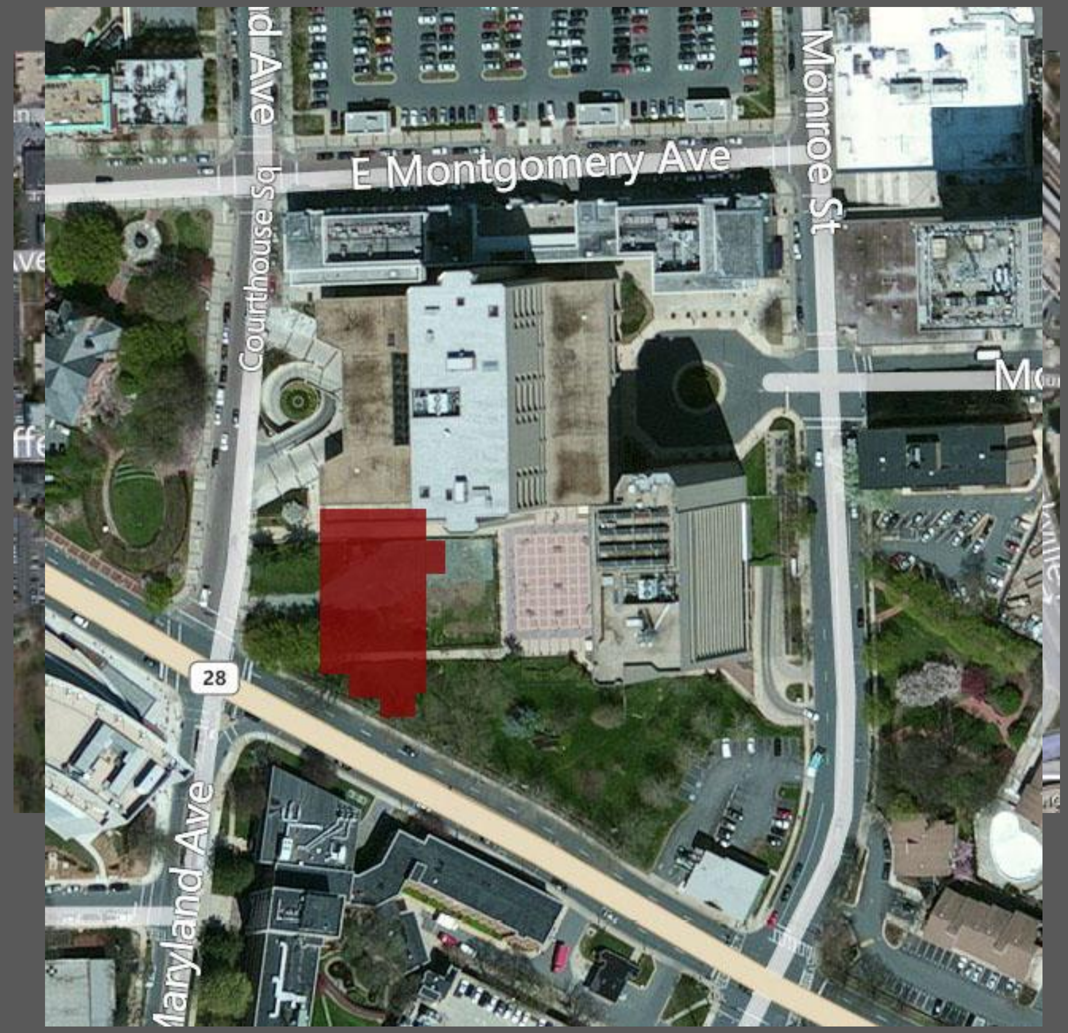
Judicial Center Annex

- **Building Overview**
- Existing Structural System
- Proposal
- Structural Depth Phase 1
- CM Breadth
- Structural Depth Phase 2
- Sustainability Breadth
- Questions/Comments

Building Overview

- Annex to existing Judicial Center
- Located in Rockville, MD
- 210,000 sq ft
- Timeline: April 2011 to April 2013
- Total Project Cost $88 Million
  - $67 Million on Annex
- Max Height: 114’
- LEED Gold
- Design-Bid-Build

Site Map



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Project Team

- Owner: Montgomery County Circuit Court
- AECOM
  - Architecture
  - Structural
  - MEP/FP
- Contractor: Tompkins Builders, Inc.
- Civil Engineer: Adtek Engineers

Site Map

Judicial Center Annex

Architecture

Building Elevations

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- Building Envelope
  - Precast
  - Aluminum Panels
  - Glazing
- Lanterns

Judicial Center Annex

Existing Structure

Typical Framing

- Building Overview
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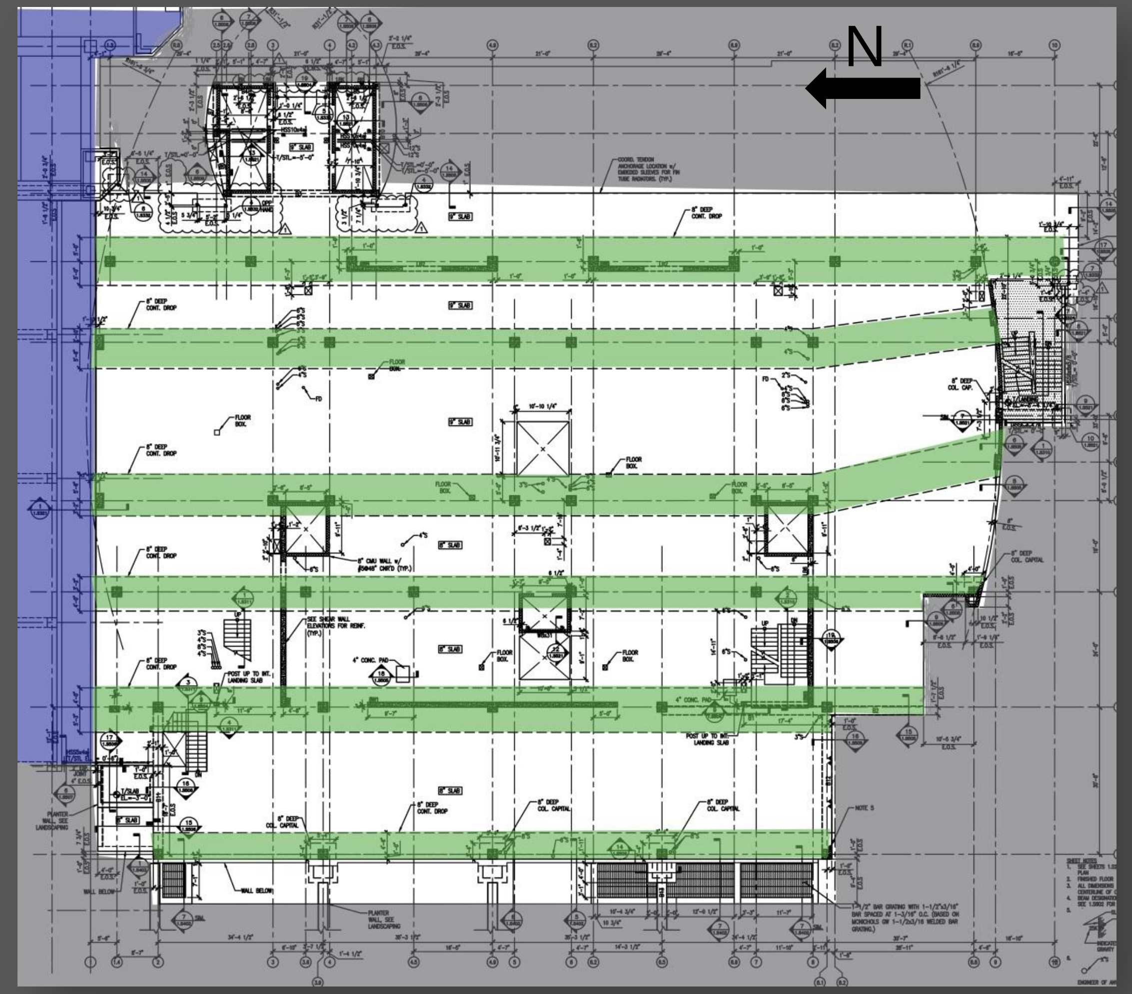
- Foundations
  - Cast – In – Place Drilled Piers
- Framing
  - Post-tensioned Slab with Wide-Shallow Beams



Judicial Center Annex   Existing Structure   Shear Walls

- Building Overview
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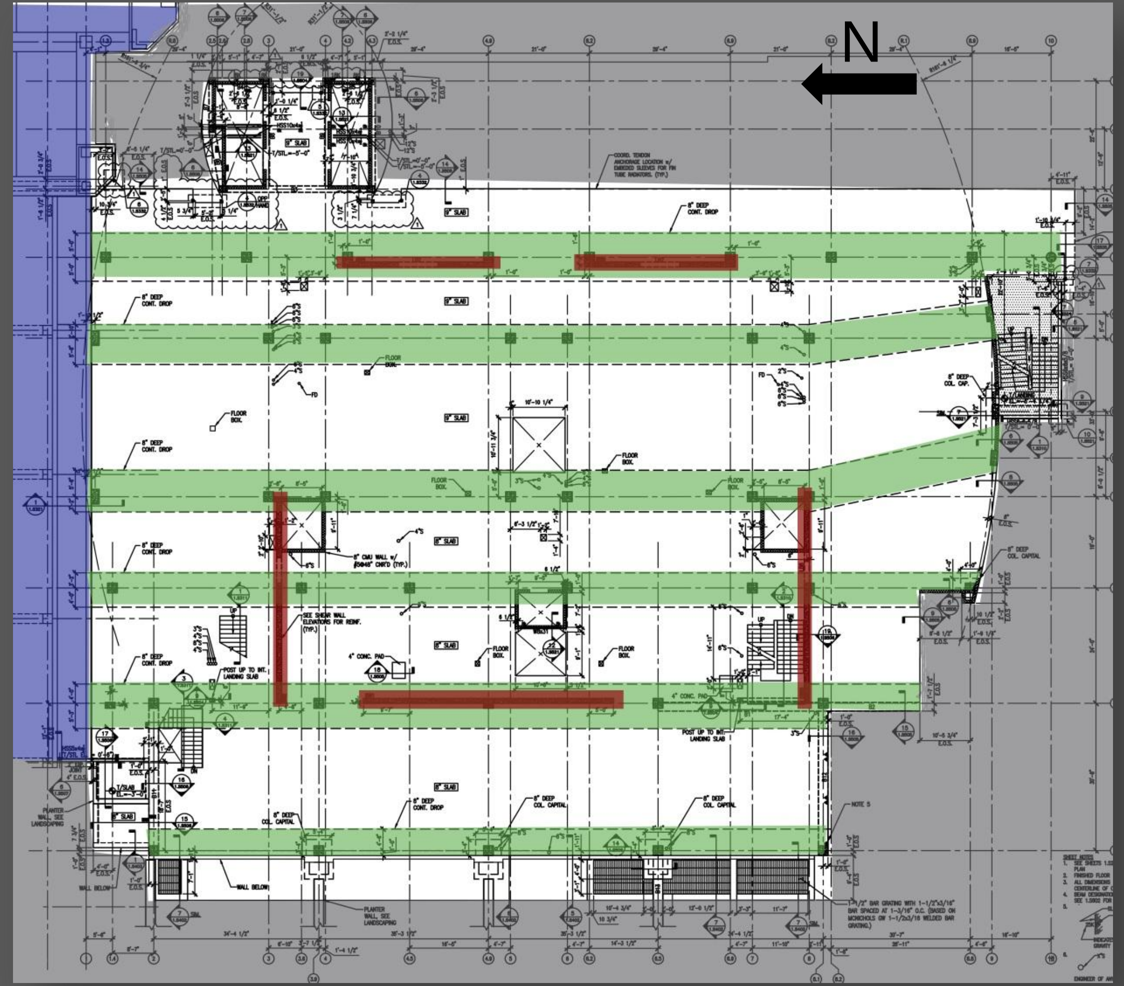
- Foundations
  - Cast – In – Place Drilled Piers
- Framing
  - Post-tensioned Slab with Wide-Shallow Beams
- Lateral
  - Five Cast-In-Place Shear Walls



Existing Structure

Lantern Framing

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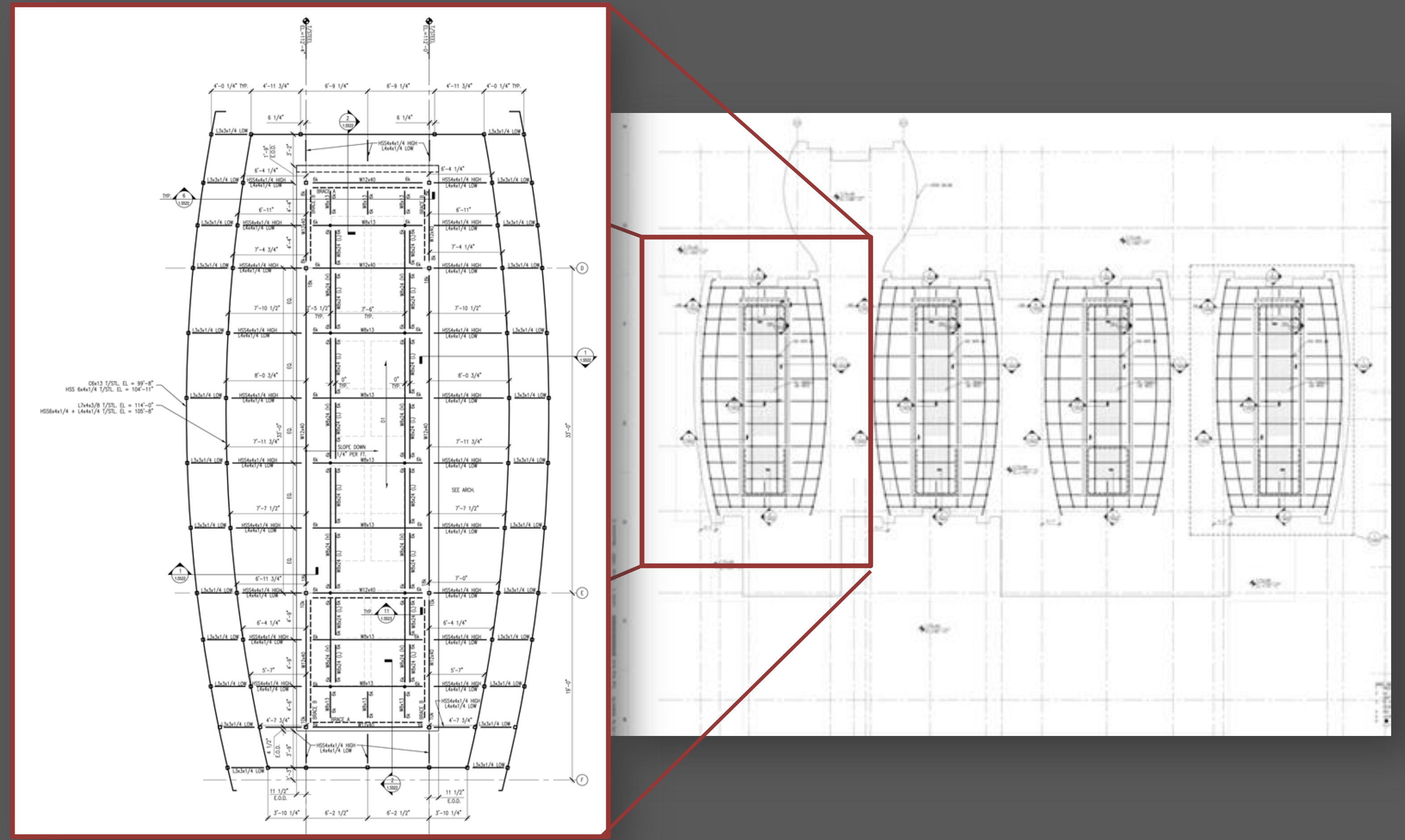
  - Cast – In – Place Drilled Piers
- Framing
  - Post-tensioned Slab with Wide-Shallow Beams
- Lateral
  - Five Cast-In-Place Shear Walls
- Lanterns
  - Steel



Proposal

Problem Statement

- Phase 1
  - Steel redesign has good chance of being competitive
- Phase 2
  - Move building to San Francisco and design steel for new seismic region

- Phase 1
  - No height restriction and large floor to floor heights
- Phase 2
  - Interest in seismic design

Proposal

Goals

- Phase 1
  - Redesign gravity system for LW concrete on metal deck on composite beams
  - Use braced frames for lateral system
  - Change two frames in redundant design to EBF

- Phase 2 (Purely Lateral System)
  - Redesign Phase 1 layout for increased seismic loads using SCBF
  - Design a more redundant lateral system using SCBF
  - Reevaluate foundations with new loads

Goals

- Phase 1
  - Compare cost and schedule of original design in MD to steel design in MD

- Phase 2
  - Compare lateral system cost of three layouts

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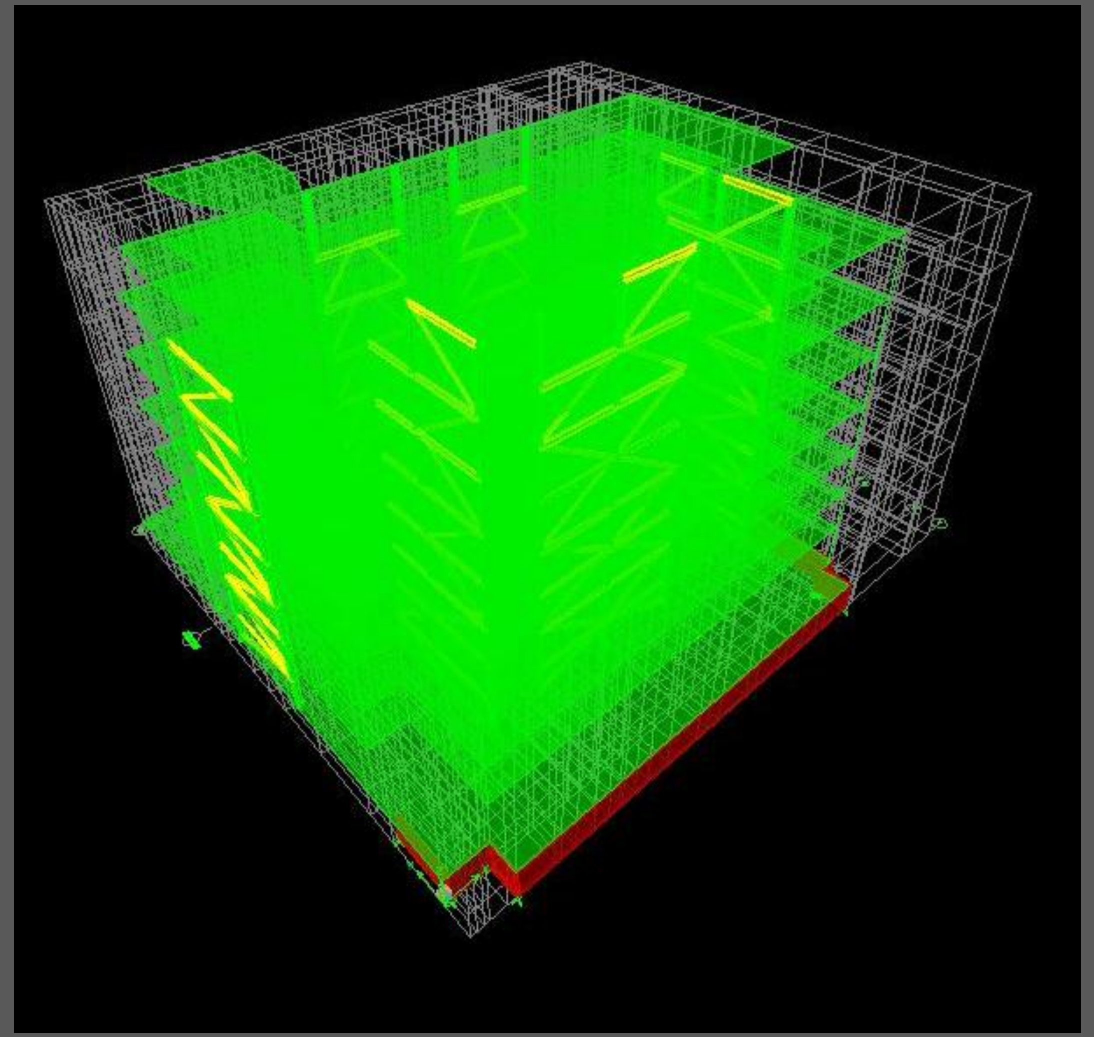
MAE Requirements

- AE 597A – Computer Modeling
- AE 534 – Steel Connections
- AE 538 – Earthquake Engineering

ETABS Model



Judicial Center Annex

Structural Depth

Wall Sections

- Building Overview
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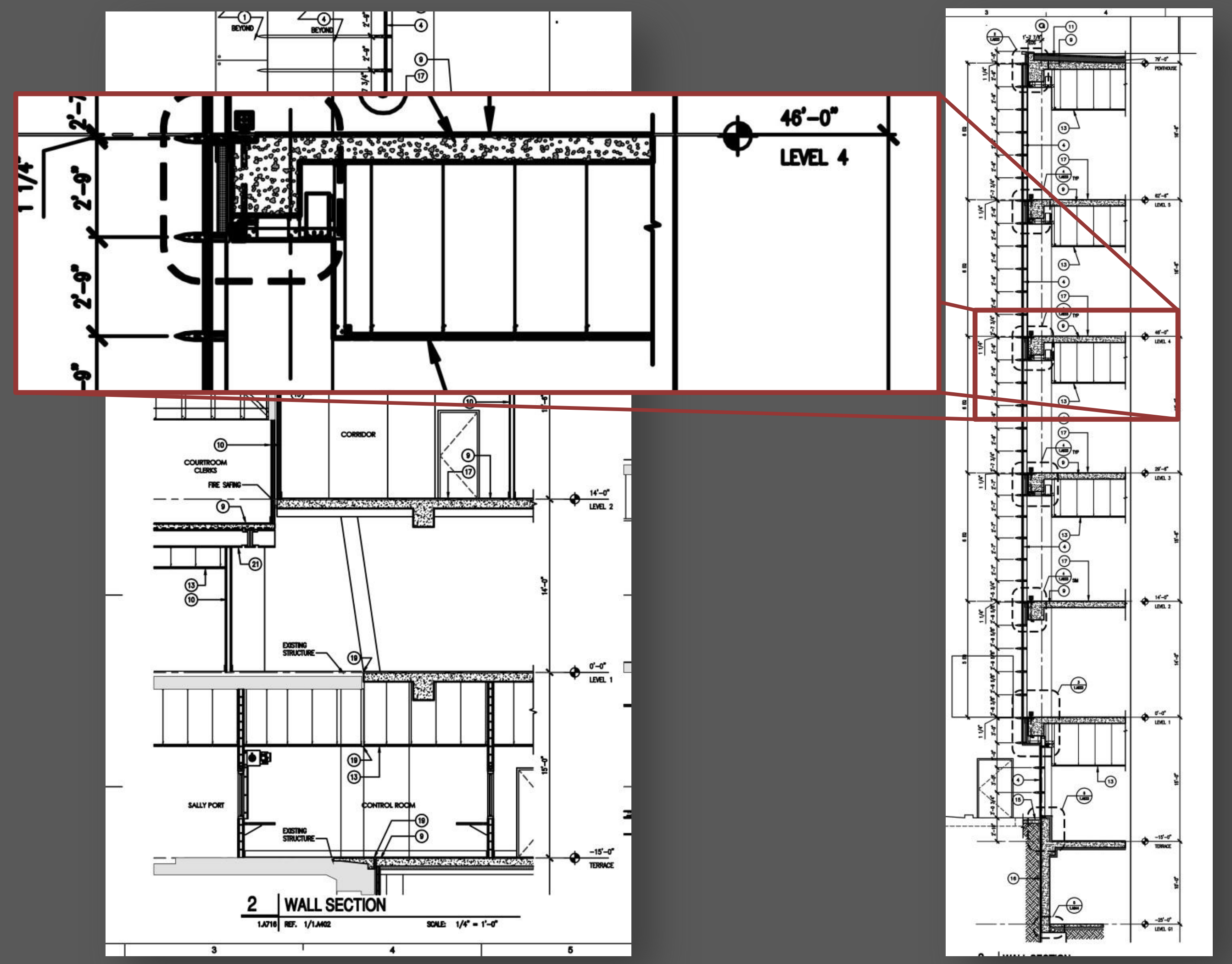
- Use existing grid lines to reduce structural impact
- Place Ordinary Concentric Braced Frames in location of shear walls
    - R = 3
- Minimize adjustment to height



Gravity System

Typical Framing

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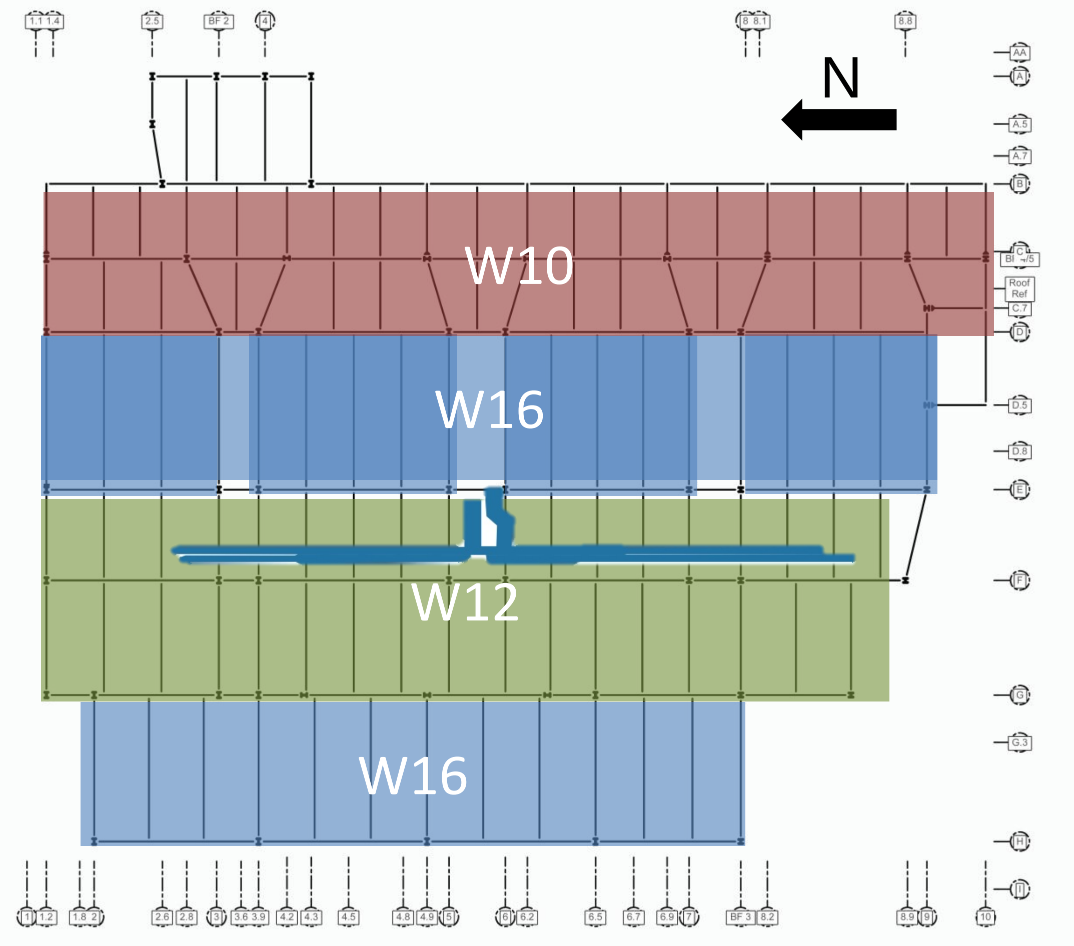

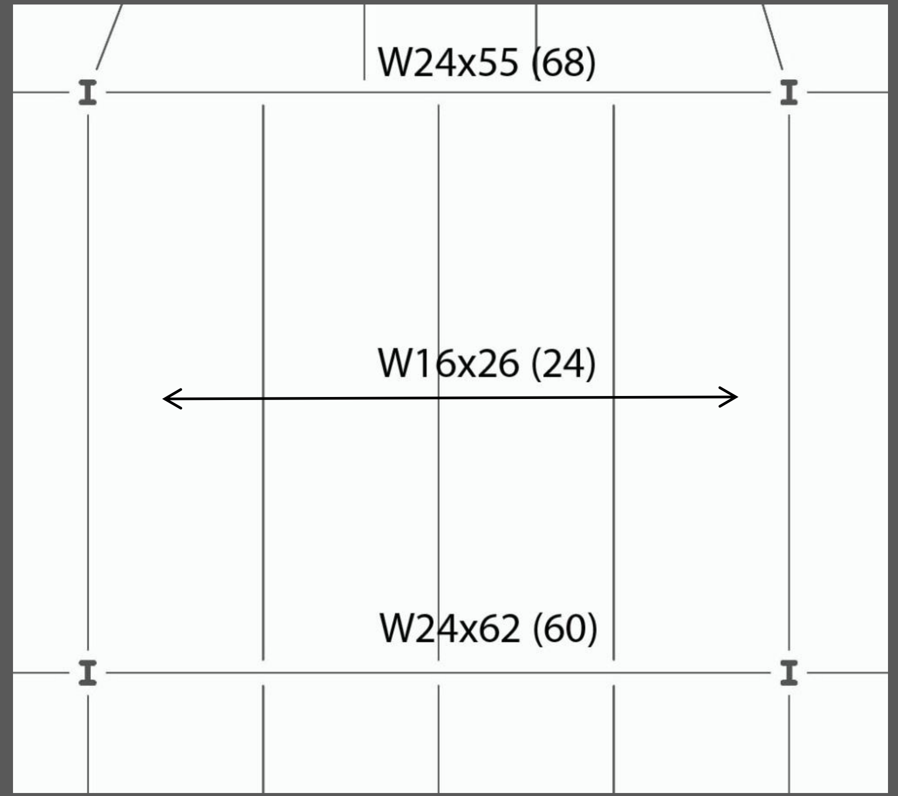

- Typical: 2VLI18 w/ 3” LW Topping
- Penthouse: 3VLI16 w/ 3 ¼ ” LW Topping

Typical Bay Design

	Hand	RAM	ETABS
Beams	W16x31 (26)	W16x26 (24)	W16x26(22)
Girder D	W21x68(40)	W24x55(68)	W24x55(48)
Girder E	-	W24x62(60)	W24x62(44)

Judicial Center Annex — Lateral System — Brace Frame Layout

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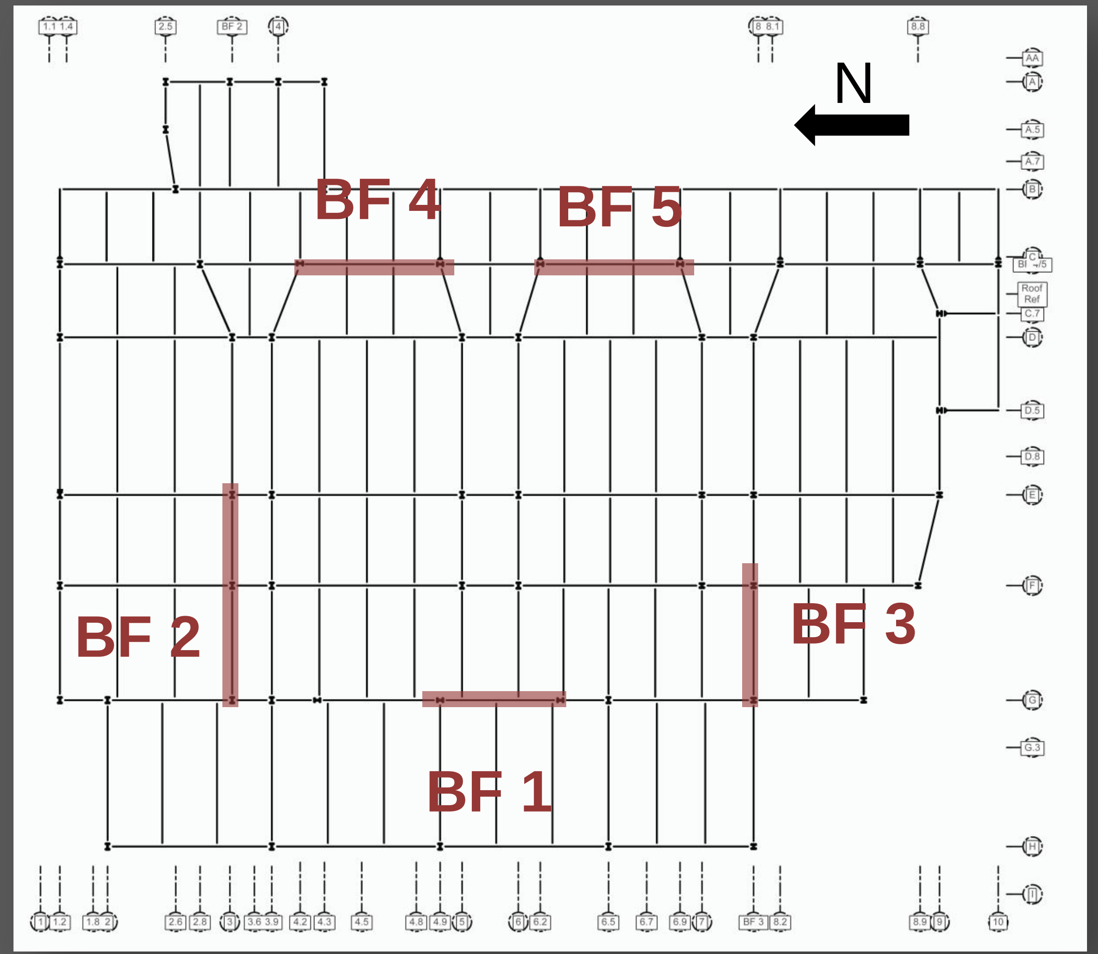
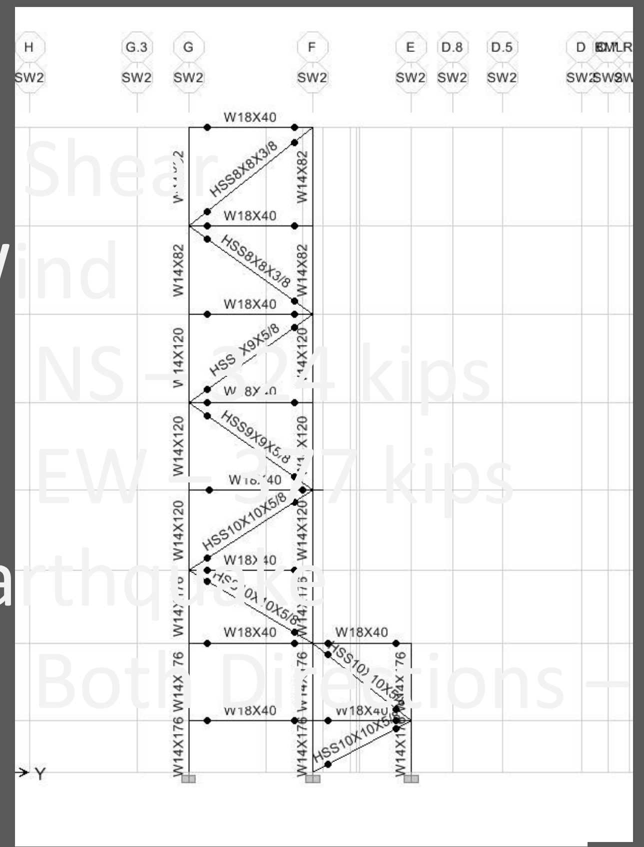
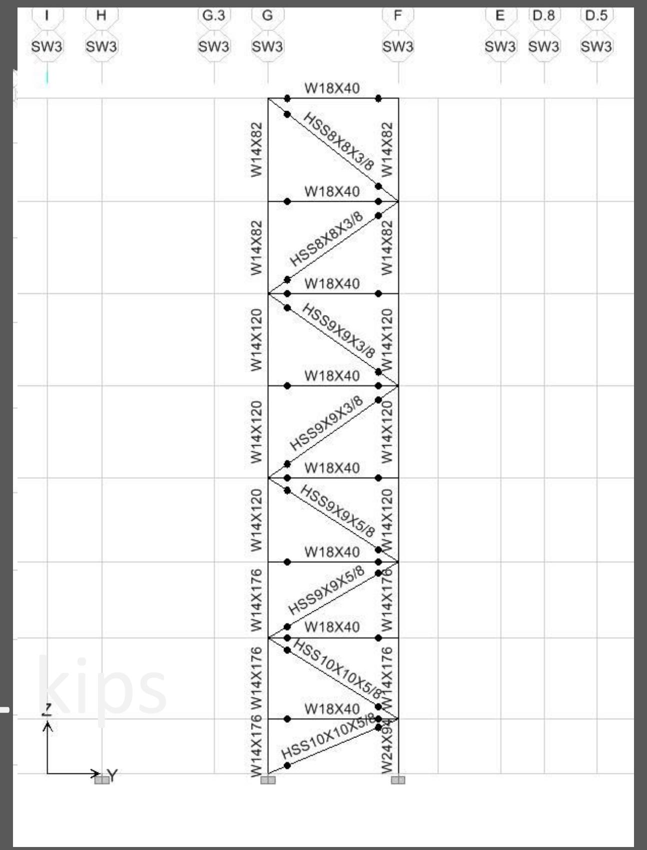


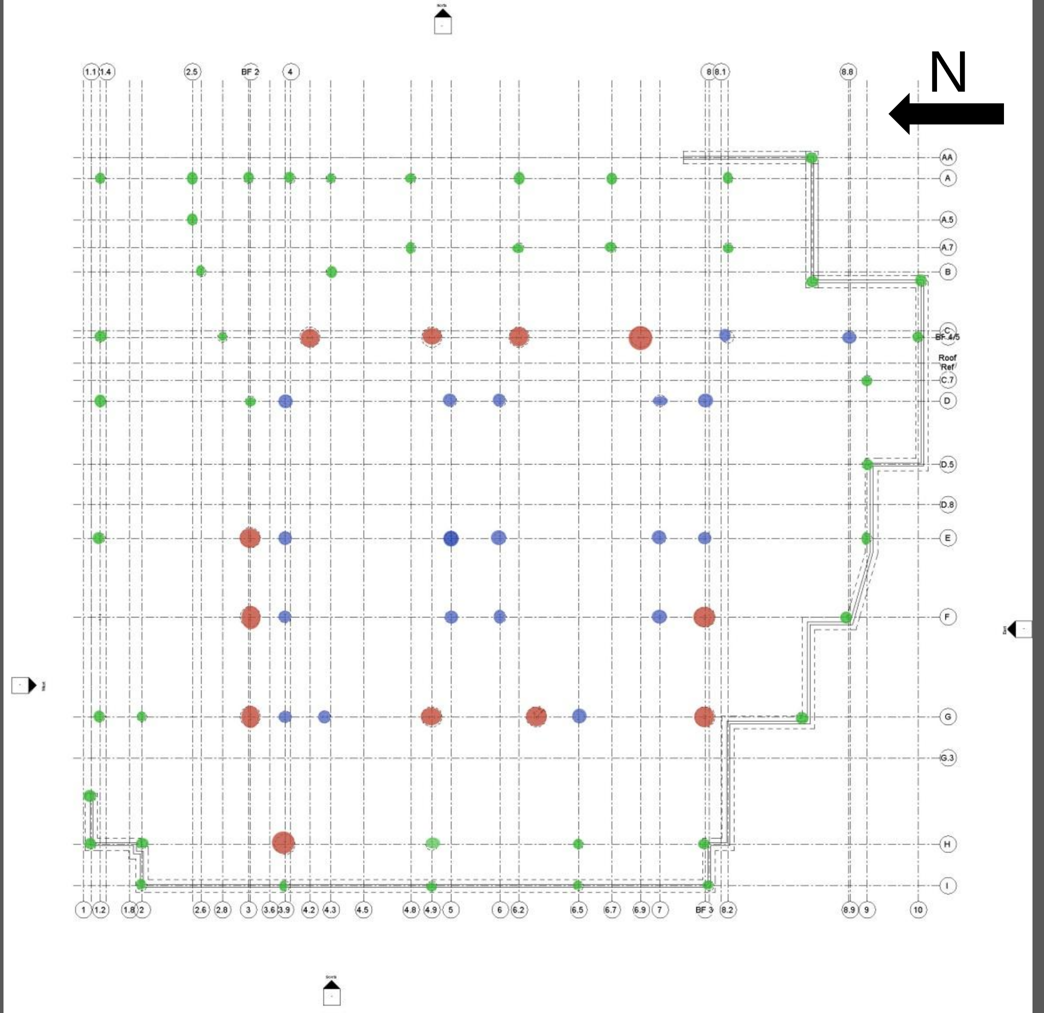
Base Shear
- Wind
  - NS
  - EW
- Earthquake
  - Both Directions – 441 kips



Braced Frame 2



Braced Frame 4 & 5



Foundations		
	Original	Redesign
CY Concrete	1506	798
Tons of Stl	61.7	29.3

Construction Management

Summary

- Building Overview
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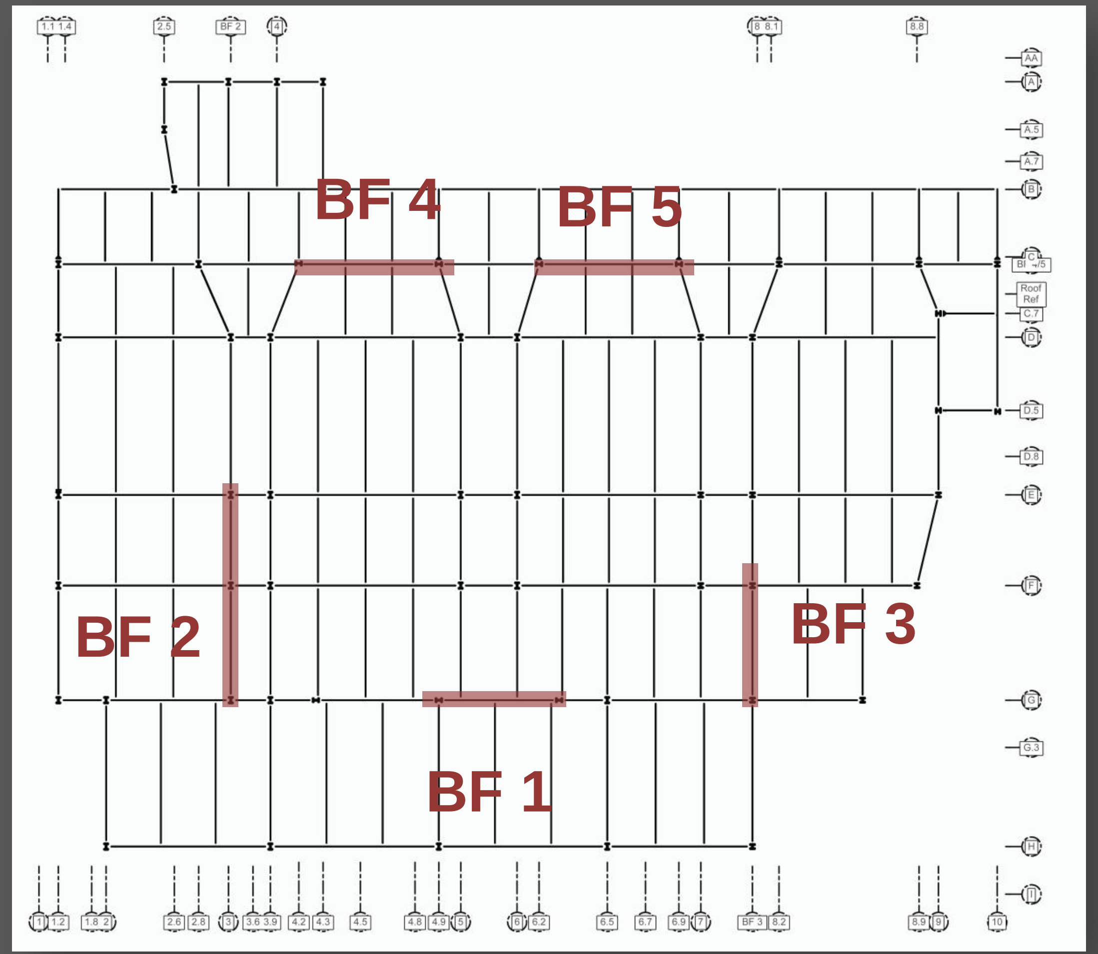
Cost Comparison			
	As Designed		**ReDesign**
Super Structure	Value		Value Adj for O&P
Cast-In-Place Concrete	$ 6,281,783.00		$ 1,839,890.40
Structural Steel	$ 1,784,892.00		$ 5,726,574.58
Substructure			
Drilled Piers	$ 953,320.00		$ 557,951.45
Exterior Enclosure			
Arch. Precast	$ 598,000.00		$ 609,960.00
Metal Wall Panels	$ 2,125,533.00		$ 2,168,043.66
Curtain Wall	$ 6,456,000.00		$ 6,585,120.00
Interior Glass (CW)	$ 683,223.00		$ 696,887.46
Louvers & Vents	$ 38,167.00		$ 38,930.34
Interior			
Masonry	$ 1,801,768.00		$ 1,837,803.36
Gypsum Board	$ 3,559,255.00		$ 3,630,440.10
Comparison	$ 24,281,941.00		$ 23,691,601.35
		Savings	$ 590,339.65

Cost/Schedule Summary		
	Original	Redesign
Schedule	9 months	8 months
Cost	$ 24,281,941	$ 23,691,601

Judicial Center Annex

Structural Depth Phase 2



Base Shear

- Wind
  - NS – 304 kips
  - EW – 346 kips
- Earthquake
  - Both Directions – 1384 kips

    *MRSA

- SDC = D
- SCBF, R=6

Chevron Connection

Seismic Provisions

- Building Overview
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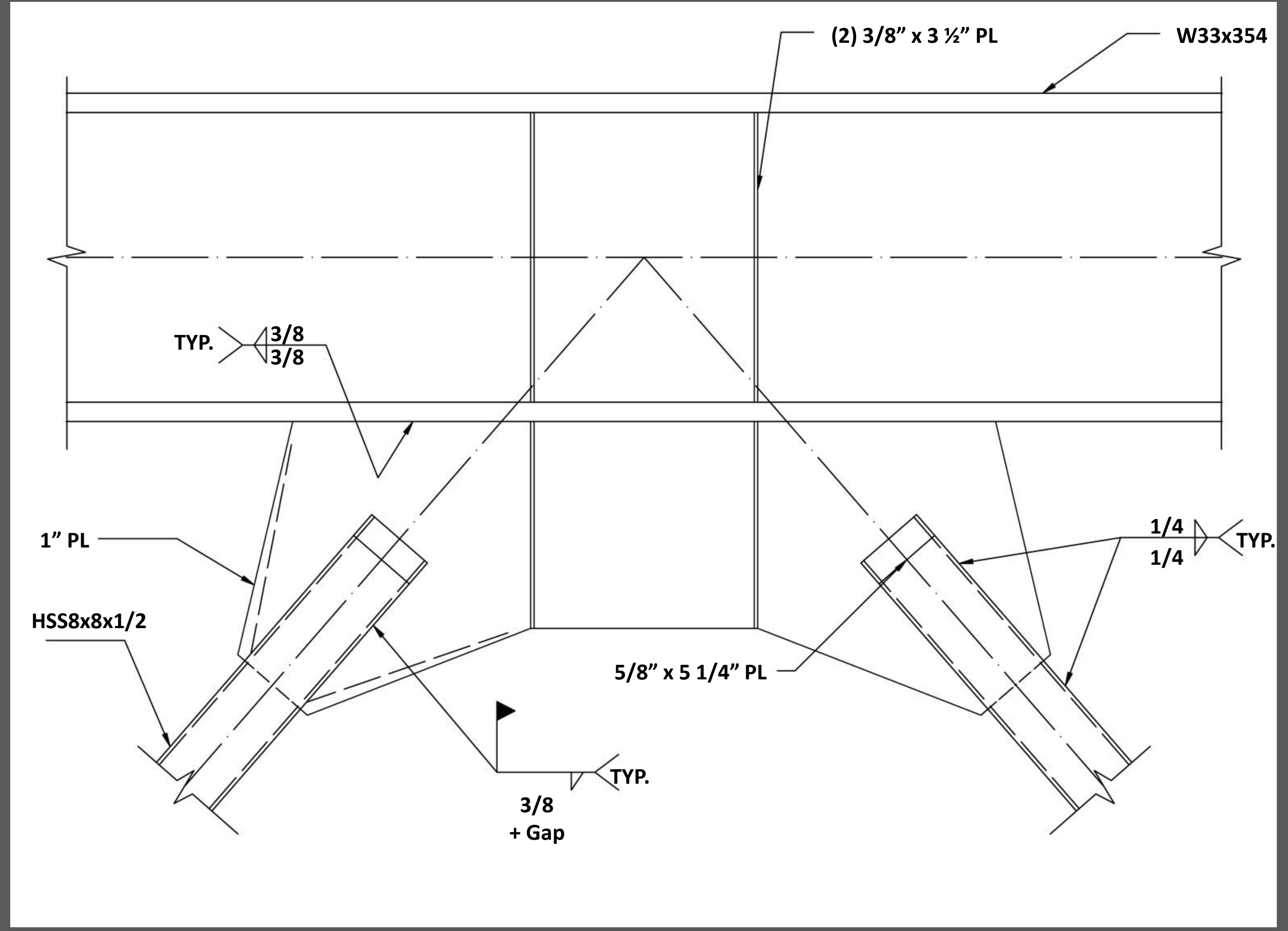

AISC 341 - 05

- 13.2a Slenderness – Bracing members shall have : $Kl/r \leq 4\sqrt{E/F_y}$
- 13.3 Required Strength of Bracing Connections

$$Tensile\ Str = R_y F_y A_g \quad Compr\ Str = 1.1 R_y P_n \quad Flexural\ Str = 1.1 R_y M_p$$

- 13.4a Inverted V-Type Bracing – For loading acting on the member

$$Brace\ Tensile\ Str = R_y F_y A_g\ ,\ Compr\ Str = 0.3 P_n$$

- 13.4a(2) – Top and Bottom Flanges must be braced

$$P_{br} = 0.02 M_{rx} \frac{C_d}{h_o}$$

Judicial Center Annex

CA Layout 2

- Building Overview
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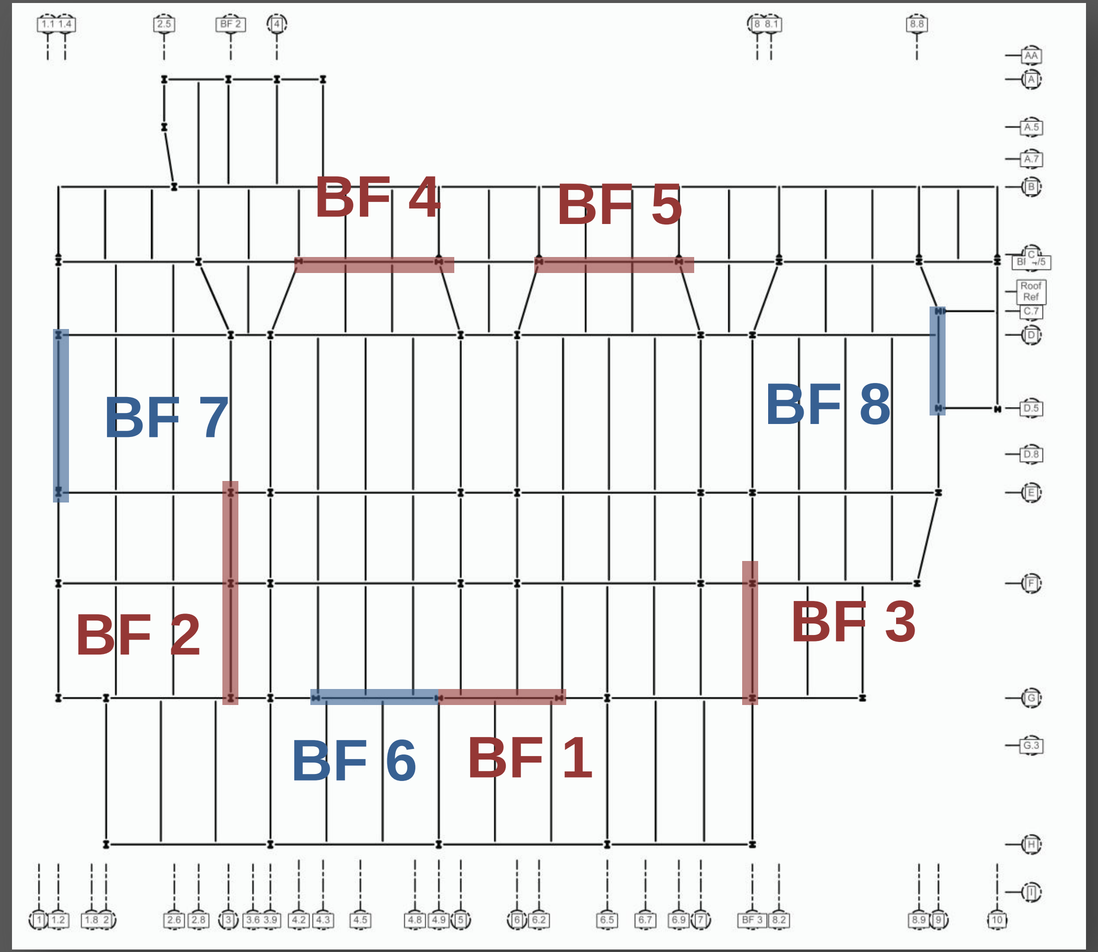

12.3.4.2 Redundancy Factor, ρ, for Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E, or F, ρ shall equal 1.3 unless one of the following two conditions is met, whereby ρ is permitted to be taken as 1.0:

Lateral Force-Resisting Element	Requirement
Braced Frames	Removal of an individual brace, or connection thereto, would not result in more than a 33% reduction in story strength, nor does the resulting system have an extreme torsional irregularity (horizontal structural irregularity Type 1b).

number of bays for a shear wall shall be calculated as the length of shear wall divided by the story height or two times the length of shear wall divided by the story height for light-framed construction.

Additional Frames

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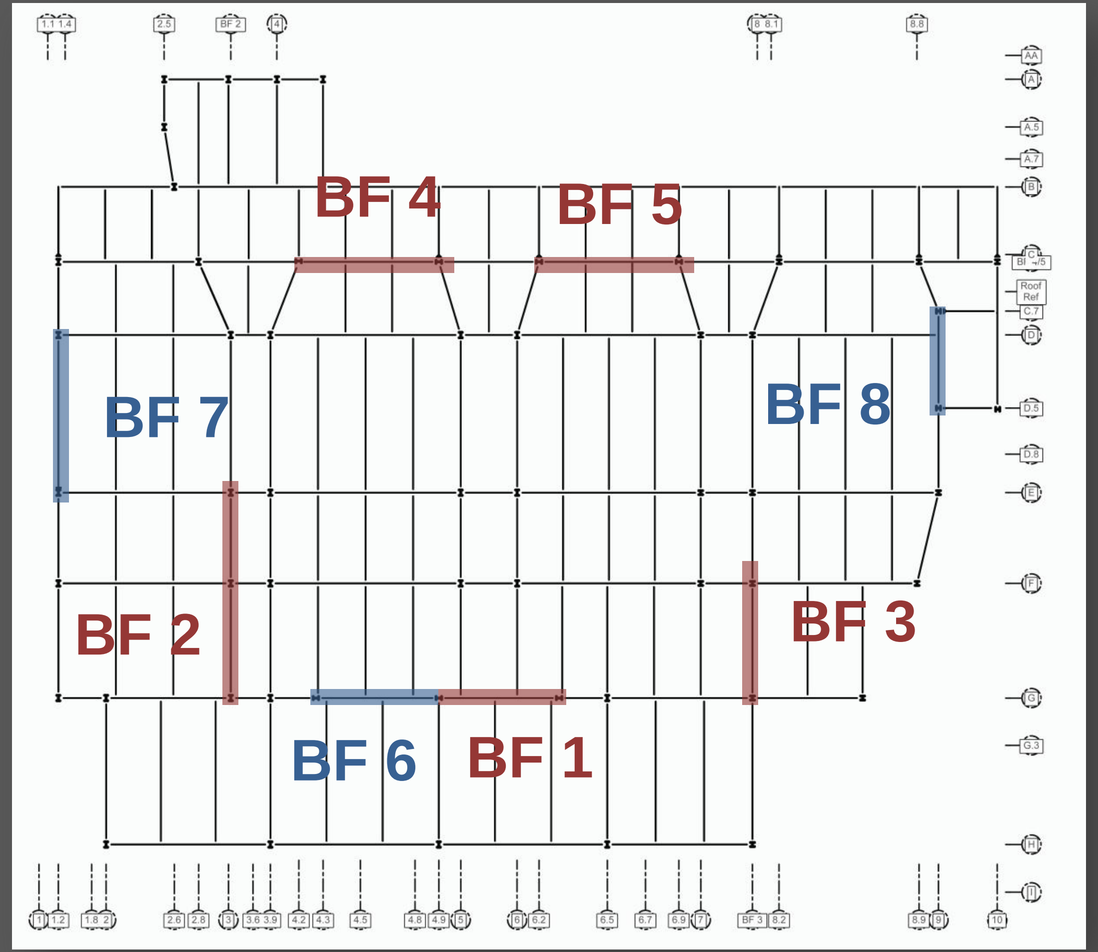
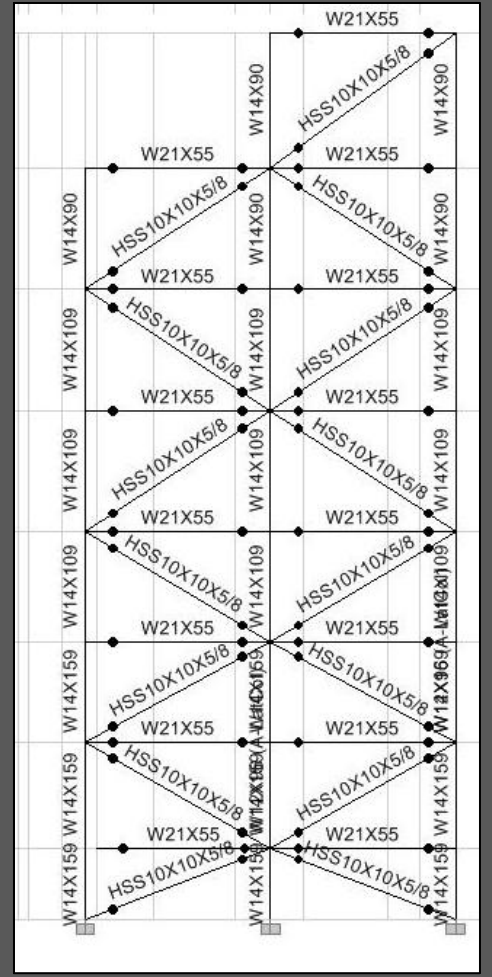
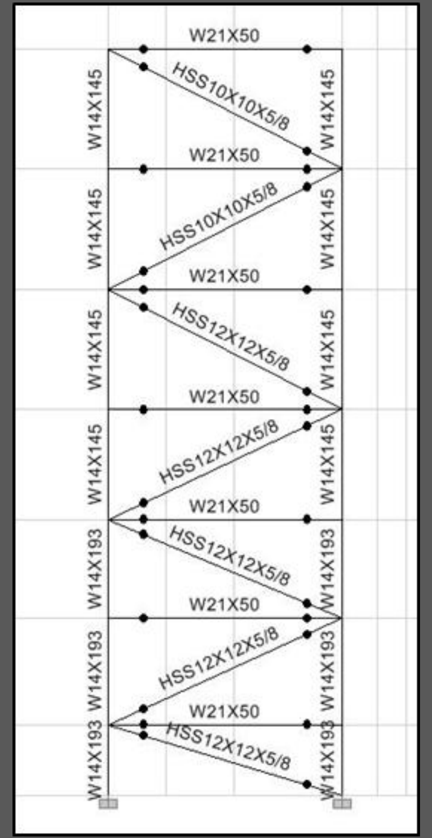
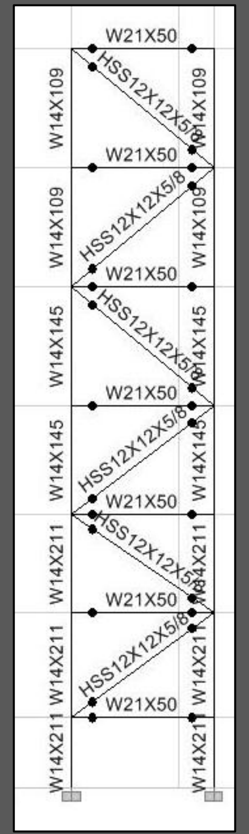




Braced Frame 1 & 6



Braced Frame 7



Braced Frame 8

Judicial Center Annex — CA Layout 3 — EBF Elevations

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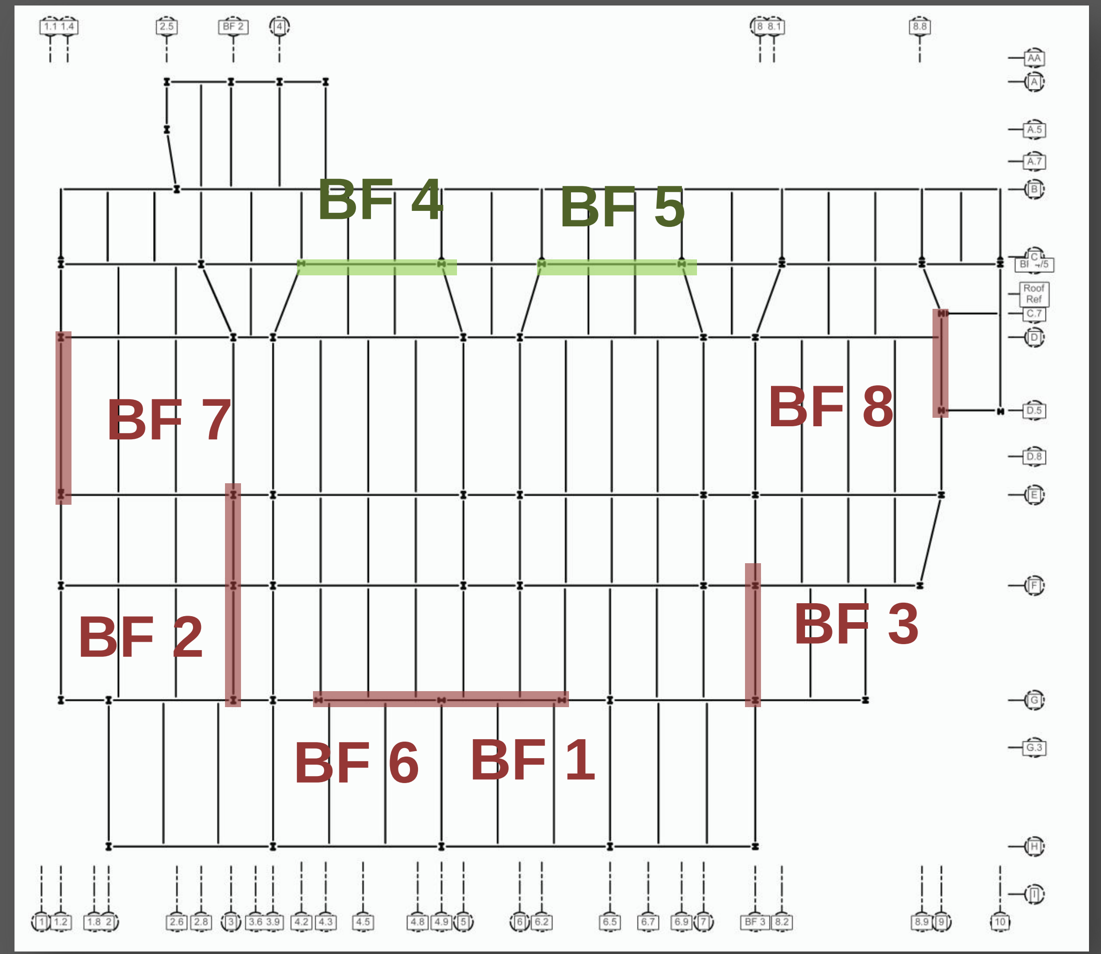

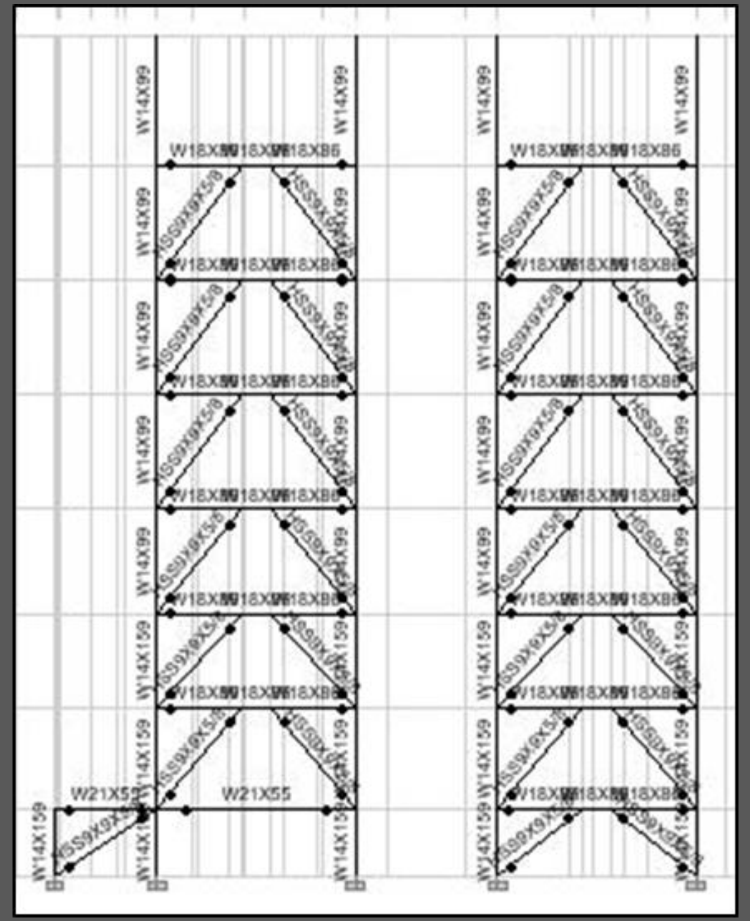

Braced Frame 4&5

EBF Beam Design

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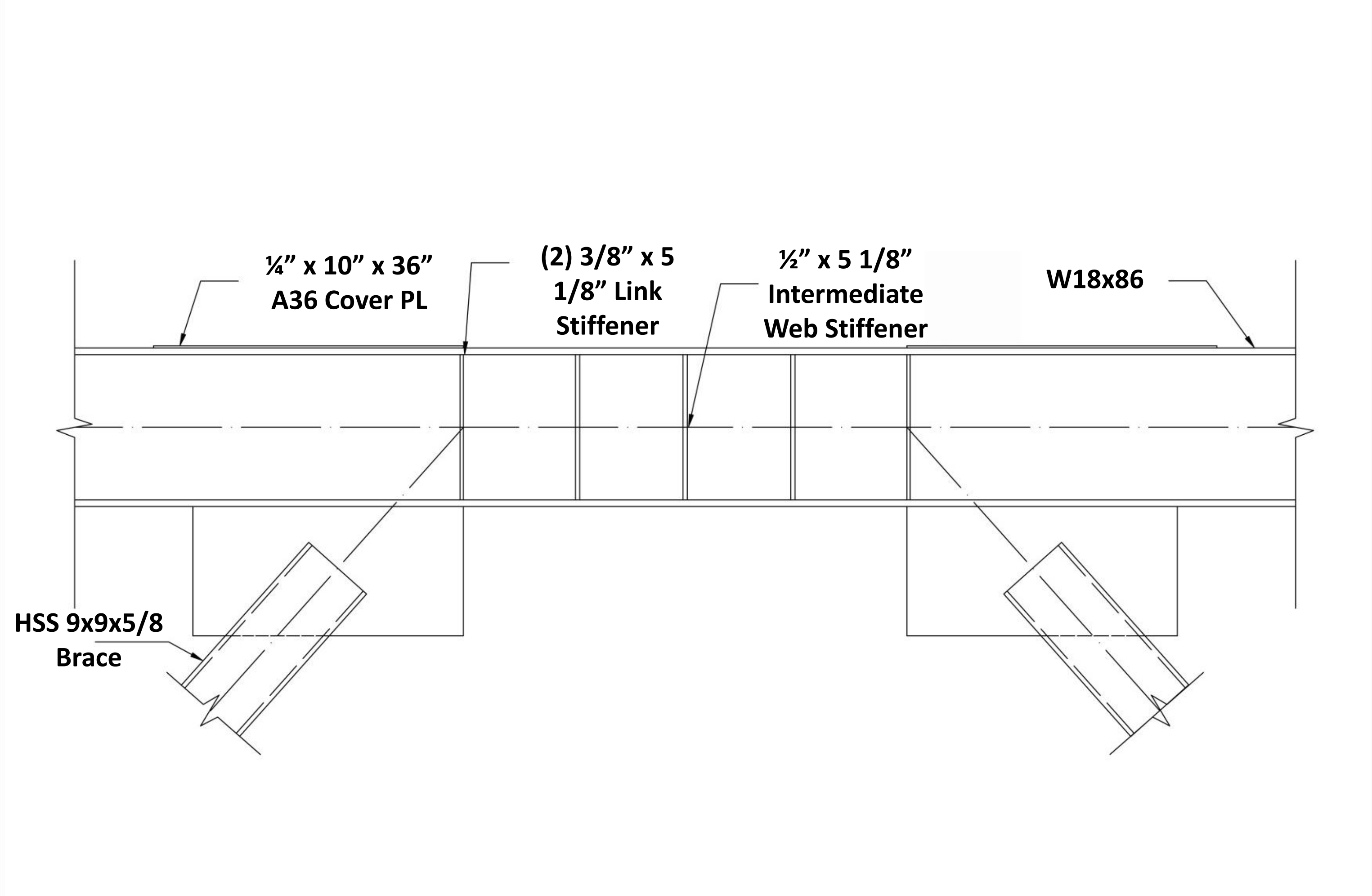

AISC 341 - 05

- 15.2a Limitations – Web of a link shall be a single thickness
- 15.2c Link Rotation Angle – The link rotation shall not exceed 0.08 radians for links of length $1.6M_p/V_p$ or less
- 15.3 – Link Stiffeners

Judicial Center Annex

Depth Summary

- Building Overview
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Steel Designs				
	MD	CA 1	CA 2	CA 3
Steel Tonnage	154	339	331	261
Est. Cost	$ 511,808.30	$ 1,085,139.94	$ 1,072,457.85	$ 851,582.56
Stl lbs/sq ft	9.9	11.7	11.6	10.9

Judicial Center Annex

Sustainability Breadth

Current Roof Plan

- Building Overview
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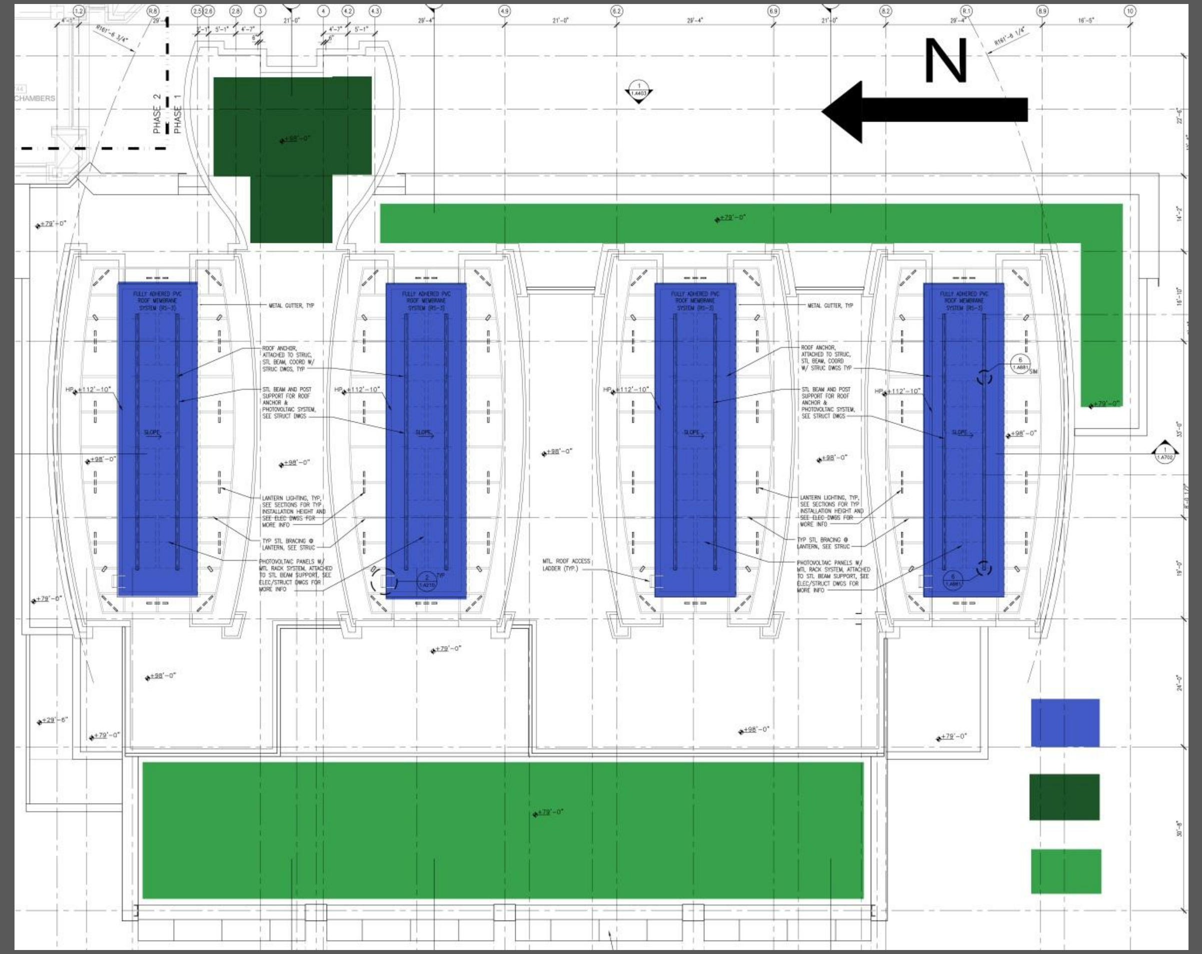
- LEED Gold Building
- PV Panels on Lanterns
- Green roof covers large portion of remaining roof



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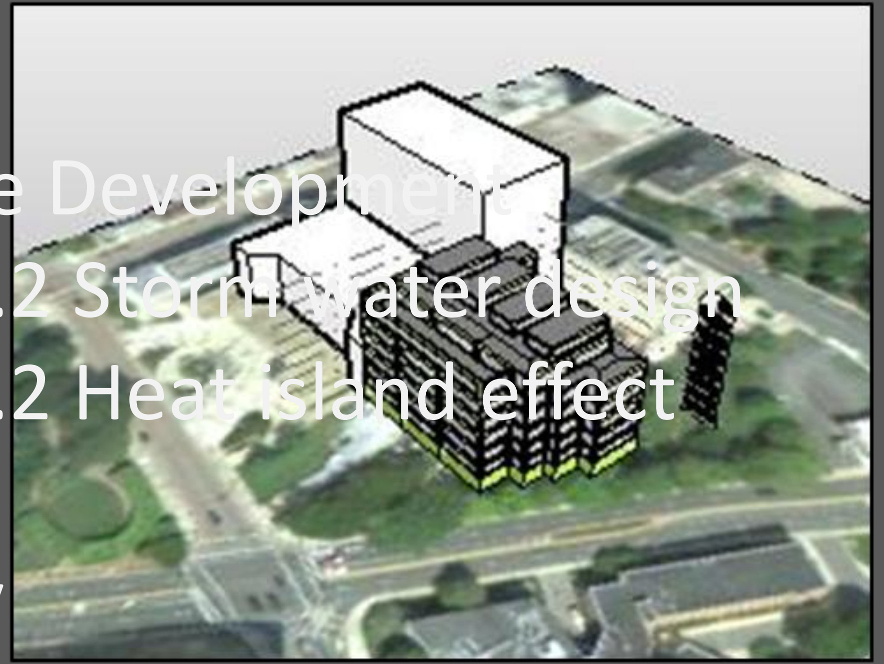
Green Roof

- LEED Impact
  - Sustainable Site
    - Credit 5.2 Site Development
    - Credits 6.1/6.2 Storm water design
    - Credits 7.1/7.2 Heat island effect roof
  - Water Efficiency
    - Credits 3.1/3.2



Lifecycle Cost

Extensive Green Roof			
Annual Energy Use Estimate	Estimated Reduction	Cost of Electricity	Annual Savings
kWh	kWh	$/kWh	
3183686	31836.86	$ 0.13	$4,138.79
Carbon Reductions	Run-off Saved (kgal)	Storm Water Cost	Annual Savings
lbs CO_2	kgal	$/kgal	
47755.29	80.4	2.27	$ 182.51
Total Annual Savings		$	4,321.30
Pay Back Period		21.06 Years	

	l Cost
Initial Cos	-94050.00
Maintena	-2857.20
Replacem	-5765.27
	-7091.37
Savings o	14430.00
Salvage	4345.11
	0,988.73)

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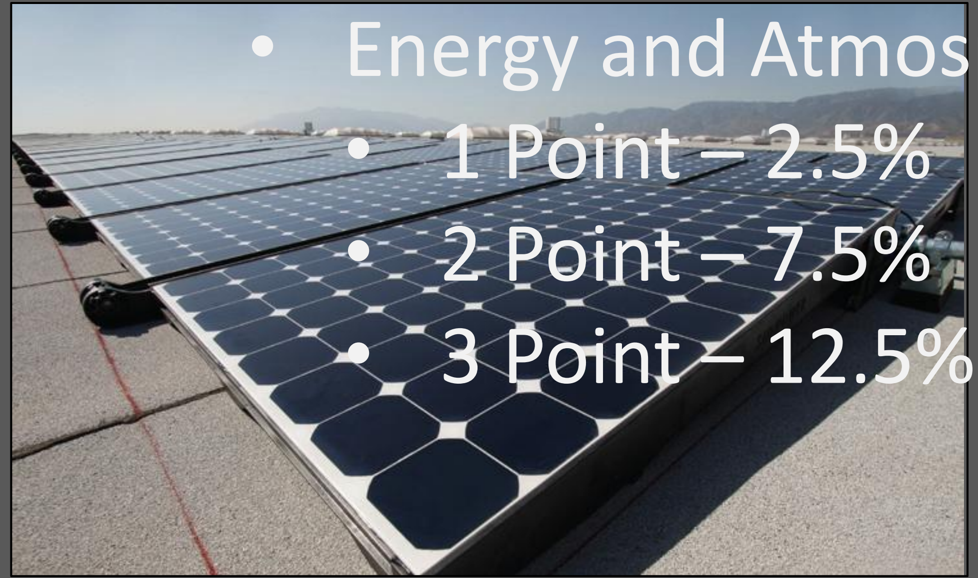
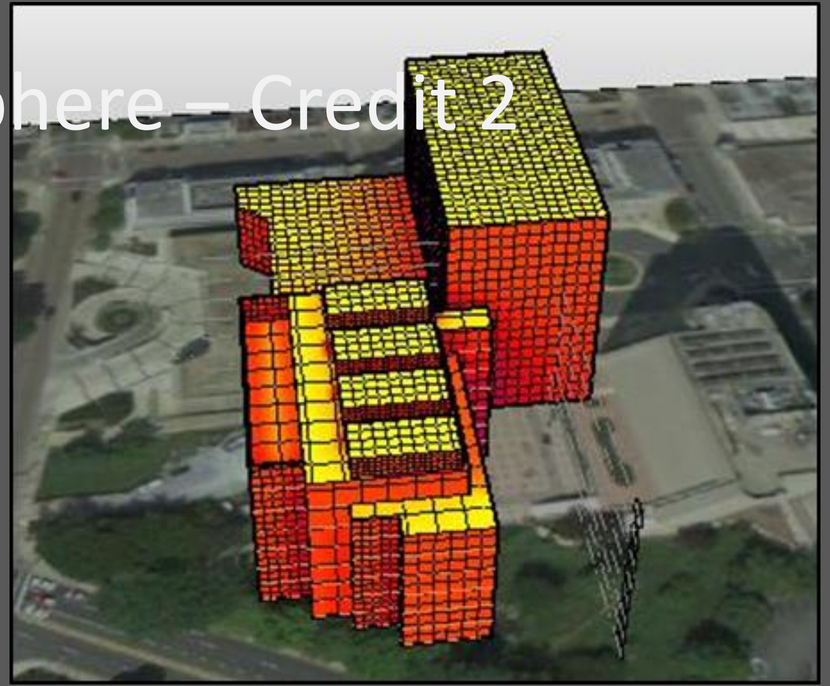
PV Panels

- LEED Impact
  - Energy and Atmosphere – Credit 2
    - 1 Point – 2.5%
    - 2 Point – 7.5%
    - 3 Point – 12.5%





SAM Output

SAM Study	
Metric	Base
Net Annual Energy	55,522 kWh
LCOE Nominal	16.66 ¢/kWh
LCOE Real	12.78 ¢/kWh
First Year Revenue without System	($250,655.16)
First Year Revenue with System	($240,903.48)
First Year Net Revenue	$9,751.68
After-tax NPV	($10,323.20)
Payback Period (Yrs)	27.0
DC-to-AC Capacity Factor	12.00%
First year kWhac/kWdc	1,048
System Performance Factor	0.81
Total Land Area	0.19 acres

System Summaries

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Sustainability Summary		
	Photovoltaics	Green Roof
System Cost	$215,769	$90,989
Carbon Footprint (tons CO_2)	106.3	-505.0
Stormwater Mitigation (kgal)	-	80.4
Payback Period (yr)	27.0	21.1
Weight (psf)	3	20
Structural Impact	NA	Moderate
LEED Credits (gained[possible])	2[3]	4[7]

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Acknowledgements

- AECOM
  - Phil Antis
  - Jeannie Gasper
  - Lee Ressler
  - Carl Hubben
- AE Faculty and Staff
  - Andrés Lepage
  - Kevin Parfitt
  - Robert Holland
- Entire AE student body
- Friends and Family

Acknowledgements

Questions/Comments?

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	Brace	Column	Brace	Column	Brace	Column	Brace	Column
BF 1	MD		CA 1		CA 2		CA 3	
	HSS8x8x3/8	W14x82	W14x193	W14x159	HSS10x10x5/8	W14x90	HSS10x10x5/8	W14x90
	HSS8x8x3/8	W14x82	W14x193	W14x159	HSS10x10x5/8	W14x90	HSS10x10x5/8	W14x90
	HSS9x9x1/2	W14x120	W14x193	W14x257	HSS10x10x5/8	W14x109	HSS10x10x5/8	W14x09
	HSS9x9x1/2	W14x120	W14x193	W14x257	HSS10x10x5/8	W14x109	HSS12x12x5/8	W14x09
	HSS9x9x5/8	W14x120	W14x193	W14x257	HSS10x10x5/8	W14x109	HSS12x12x5/8	W14x09
	HSS9x9x5/8	W14x176	W14x193	W14x455	HSS10x10x5/8	W14x159	HSS12x12x5/8	W14x159
	HSS10x10x5/8	W14x176	W14x193	W14x455	HSS10x10x5/8	W14x159	HSS12x12x5/8	W14x159
	HSS10x10x5/8	W14x176	W14x193	W14x455	HSS10x10x5/8	W14x159	HSS12x12x5/8	W14x159
BF 2	MD		CA 1		CA 2		CA 3	
	HSS8x8x3/8	W14x82	W14x176	W14x145	HSS9x9x5/8	W14x120	HSS9x9x5/8	W14x120
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	HSS9x9x5/8	W14x120	W14x176	W14x233	HSS9x9x5/8	W14x176	HSS9x9x5/8	W14x176
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	HSS10x10x5/8	W14x176	W14x132	W14x342	HSS12x12x5/8	W14x211	HSS10x10x5/8	W14x211
	MD		CA 1		CA 2		CA 3	
BF3	HSS8x8x3/8	W14x82	W14x176	W14x145	HSS12x12x5/8	W14x120	HSS12x12x5/8	W14x120
	HSS8x8x3/8	W14x82	W14x176	W14x145	HSS12x12x5/8	W14x120	HSS12x12x5/8	W14x120
	HSS9x9x3/8	W14x120	W14x176	W14x233	HSS12x12x5/8	W14x176	HSS12x12x5/8	W14x176
	HSS9x9x3/8	W14x120	W14x176	W14x233	HSS12x12x5/8	W14x176	HSS12x12x5/8	W14x176
	HSS9x9x5/8	W14x120	W14x193	W14x233	HSS12x12x5/8	W14x176	HSS12x12x5/8	W14x176
	HSS9x9x5/8	W14x176	W14x193	W14x342	HSS12x12x5/8	W14x211	HSS12x12x5/8	W14x211
	HSS10x10x5/8	W14x176	W14x193	W14x342	HSS12x12x5/8	W14x211	HSS12x12x5/8	W14x211
	HSS10x10x5/8	W14x176	W14x159	W14x342	HSS12x12x5/8	W14x211	HSS12x12x5/8	W14x211
	MD		CA 1		CA 2		CA 3	
BF 4		W14x53		W14x109		W14x74		W14x99
	HSS5x5x3/8	W14x53	HSS8x8x1/2	W14x109	HSS8x8x1/2	W14x74	HSS9x9x5/8	W14x99
	HSS6x6x3/8	W14x68	HSS8x8x1/2	W14x132	HSS8x8x1/2	W14x99	HSS9x9x5/8	W14x99
	HSS6x6x3/8	W14x68	HSS8x8x1/2	W14x132	HSS8x8x1/2	W14x99	HSS9x9x5/8	W14x99
	HSS6x6x3/8	W14x68	HSS8x8x1/2	W14x132	HSS8x8x1/2	W14x99	HSS9x9x5/8	W14x99
	HSS6x6x3/8	W14x99	HSS8x8x1/2	W14x193	HSS8x8x1/2	W14x159	HSS9x9x5/8	W14x159
	HSS6x6x3/8	W14x99	HSS9x9x5/8	W14x193	HSS8x8x1/2	W14x159	HSS9x9x5/8	W14x159
	HSS6x6x3/8	W14x99	HSS9x9x5/8	W14x193	HSS8x8x1/2	W14x159	HSS9x9x5/8	W14x159
	MD		CA 1		CA 2		CA 3	
BF 5		W14x53		W14x109		W14x74		W14x99
	HSS5x5x3/8	W14x53	HSS8x8x1/2	W14x109	HSS8x8x1/2	W14x74	HSS9x9x5/8	W14x99
	HSS6x6x3/8	W14x68	HSS8x8x1/2	W14x132	HSS8x8x1/2	W14x99	HSS9x9x5/8	W14x99
	HSS6x6x3/8	W14x68	HSS8x8x1/2	W14x132	HSS8x8x1/2	W14x99	HSS9x9x5/8	W14x99
	HSS6x6x3/8	W14x68	HSS8x8x1/2	W14x132	HSS8x8x1/2	W14x99	HSS9x9x5/8	W14x99
	HSS6x6x3/8	W14x99	HSS8x8x1/2	W14x193	HSS8x8x1/2	W14x159	HSS9x9x5/8	W14x159
	HSS6x6x3/8	W14x99	HSS9x9x5/8	W14x193	HSS8x8x1/2	W14x159	HSS9x9x5/8	W14x159
	HSS8x8x3/8	W14x99	HSS10x10x5/8	W14x193	HSS9x9x5/8	W14x159	HSS9x9x5/8	W14x159

	CA 2		CA 3	
BF 6		W14x90		W14x90
	HSS10x10x5/8	W14x90	HSS10x10x5/8	W14x90
	HSS10x10x5/8	W14x109	HSS10x10x5/8	W14x09
	HSS10x10x5/8	W14x109	HSS12x12x5/8	W14x09
	HSS10x10x5/8	W14x109	HSS12x12x5/8	W14x09
	HSS10x10x5/8	W14x159	HSS12x12x5/8	W14x159
	HSS10x10x5/8	W14x159	HSS12x12x5/8	W14x159
	HSS10x10x5/8	W14x159	HSS12x12x5/8	W14x159
	CA 2		CA 3	
BF 7		W14x109		W14x176
	HSS10x10x5/8	W14x109	HSS10x10x5/8	W14x176
	HSS10x10x5/8	W14x145	HSS10x10x5/8	W14x176
	HSS12x12x5/8	W14x145	HSS12x12x5/8	W14x176
	HSS12x12x5/8	W14x145	HSS12x12x5/8	W14x176
	HSS12x12x5/8	W14x193	HSS12x12x5/8	W14x193
	HSS12x12x5/8	W14x193	HSS12x12x5/8	W14x193
	HSS12x12x5/8	W14x193	HSS12x12x5/8	W14x193
	CA 2		CA 3	
BF 8		W14x109		W14x145
	HSS12x12x5/8	W14x109	HSS12x12x5/8	W14x145
	HSS12x12x5/8	W14x109	HSS12x12x5/8	W14x145
	HSS12x12x5/8	W14x145	HSS12x12x5/8	W14x176
	HSS12x12x5/8	W14x145	HSS12x12x5/8	W14x176
	HSS12x12x5/8	W14x211	HSS12x12x5/8	W14x193
	HSS12x12x5/8	W14x211	HSS12x12x5/8	W14x193
	HSS12x12x5/8	W14x211	HSS12x12x5/8	W14x193