Dormitory

Northeast USA

Cadell G. Calkins

Structural Option

Faculty Advisor: Dr. Richard A. Behr

April 9, 2012

Dormitory

- **Introduction**
- Existing Structural System
- Problem Statement
- Proposed Solution
- Oriented Strand Board Shear Walls
- Steel Braced Frame Shear Walls
- Comparison of Lateral Systems
- Electrical Breadth
- Façade Breadth
- Conclusion

Building Introduction

- New Dormitory Building A
- Located in Northeast USA
- 92,389 SF
- Height: 57.75’
- Construction Cost: $26 Million
  - Buildings A & B and sitework
- October 2010 to January 2012
- Delivery: Public/private partnership using a development team to deliver the project by guaranteed maximum price

Site Map

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Project Team

- Owner: Nonprofit Corporation
- Architect: WTW Architects
- Construction Manager: Massaro Corporation
- MEP, Telecom, and Security Engineer: H. F. Lenz Company
- Structural Engineer: Taylor Structural Engineers, Inc.
- Landscape Architect: LaQuatra Bonci Associates
- Developer: Allen & O’Hara Development Co. LLC

South Wing

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Architecture

- Wings
  - Suite Style Rooms
  - Brick and Ground Face CMU
  - Hip Roof with Asphalt Shingles
  - Sweeping Dormer Accents
- Core
  - Student Gathering Spaces
  - Large, Storefront Windows
  - Flat Roof
  - Sun Shades

Central Core

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Existing Structural System

- Foundation
  - Rammed Aggregate Piers
    - 2 foot hole
    - 30 feet deep
    - 2 foot lifts of well graded crushed rock
    - Strengthened soil around hole for slab on grade
  - Strip and Spread Footings
  - Concrete Masonry Units (CMU)
- Floor
  - 1st Floor
    - 8 inch concrete planks resting on CMUs
  - 2nd-4th Floors
    - 18 inch deep wood floor trusses on load bearing walls
    - 9.25 inch deep laminated veneer lumber wood joists on wide flange beams and girders

Rammed Aggregate Pier

Wood Floor Trusses

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Existing Structural System

- Lateral System
  - Wings North-South Direction
    - Shear walls located in corridor and exterior walls
    - ½ inch oriented strand board for exterior walls
    - ¾ inch oriented strand board for corridor walls
  - Wings East-West Direction
    - Shear walls located between each suite and exterior walls
    - ½ inch oriented strand board for exterior walls
    - 2 layers of 5/8 inch gypsum wall board (GWB) for suite walls
  - Core
    - Shear walls around the stairs, elevator, and where the core meets the wings.
    - 8 inch reinforced CMU

Corridor Shear Wall

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Problem Statement

- Global Warming might soon be a design consideration for a structural engineer.
- According to the National Wildlife Federation, the maximum hurricane wind speeds are expected to increase 2 to 13 percent within this century.
- In regards to the Dormitory,
  - Original Design 90 mph (ASCE 7-05) or 115 mph (ASCE 7-10)
  - Increase to 102 mph or 130 mph, respectively

- To understand this new loading, the following situation has been created.
  - State College of Florida, Manatee-Sarasota (SCF) would like to build the Dormitory. In this area, the design wind speed is 150 mph.
  - SCF has required that the Dormitory be capable of withstanding:
    - wind pressures due to hurricanes and tornadoes
    - debris impacts on the façade
    - foundation for the sandy soil

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Proposed Solution

- Lateral System in Wings:
  - Oriented strand board (OSB) shear walls
  - Steel braced frame shear walls
- Lateral System in Core
  - Steel braced frame shear walls
- Gravity System
  - Steel deck and joist floors
  - Steel wide flange beams and columns
- Foundation
  - Strip and spread footings

Problem Statement

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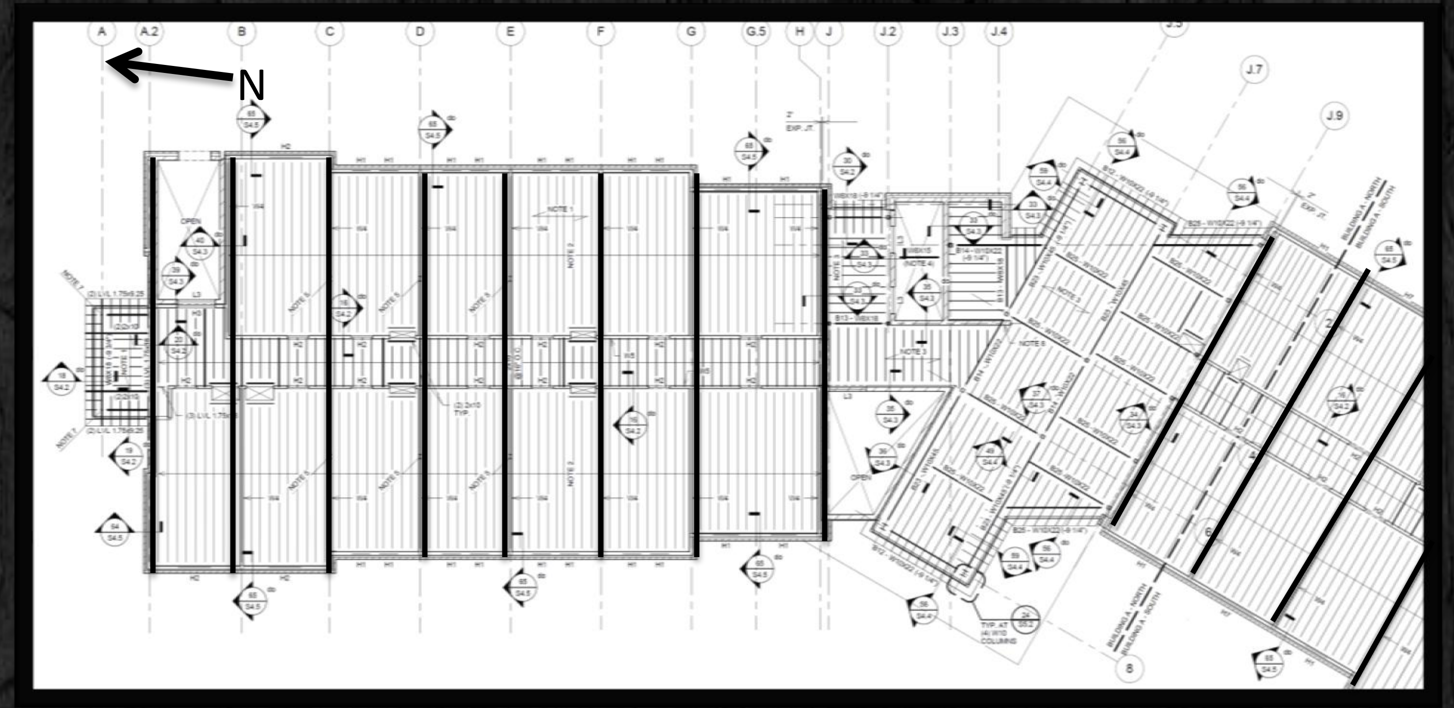
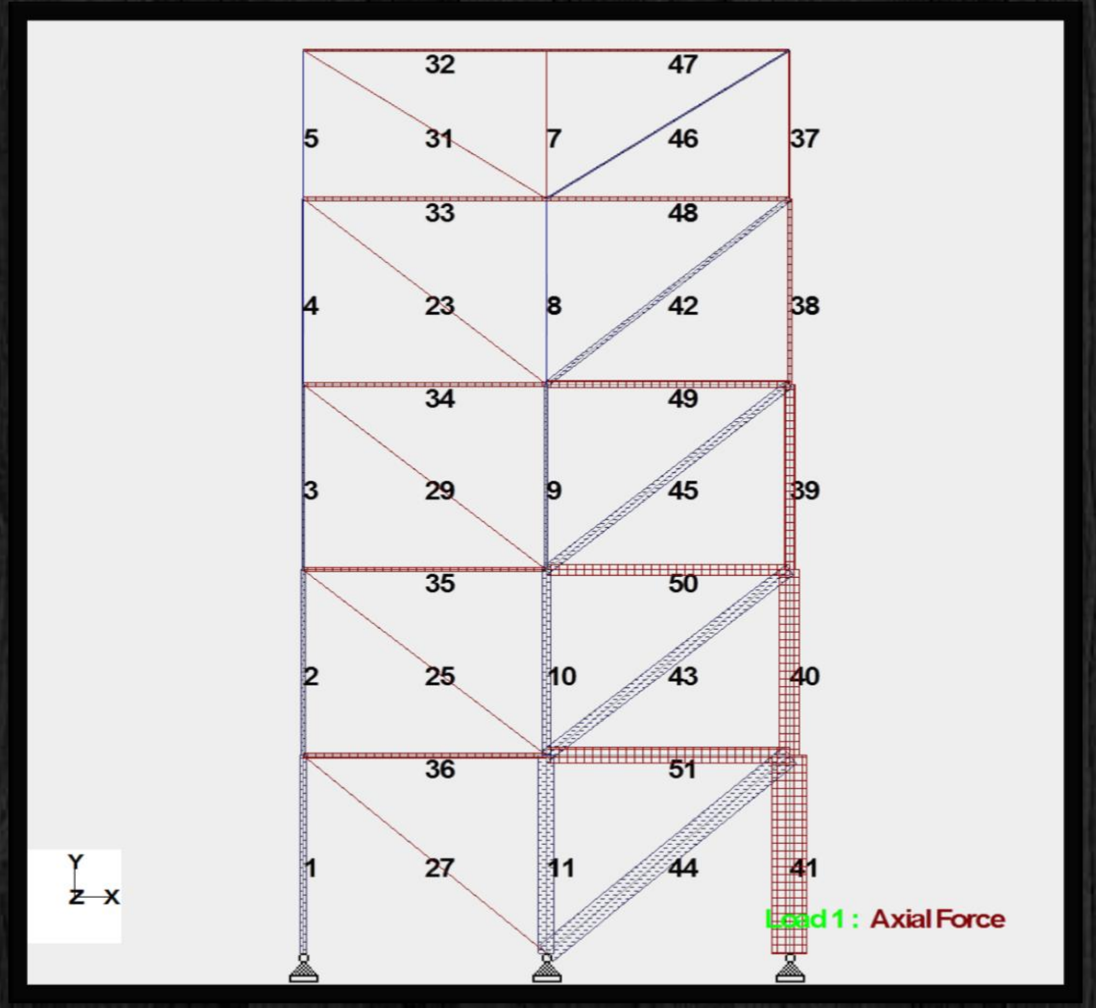
Shear Wall Design

- 1^{st} Floor Shear Wall Design
- North – South Winds
  - Original Design Satisfactory
    - ¾ inch OSB corridor walls
    - ½ inch OSB exterior walls
  - Maximum Deflection = 0.17 in < L/360 = 0.3 in
- East – West Winds
  - GWB Insufficient
  - Use 5/16 in OSB with 3 in edge fastener spacing
  - Maximum Deflection = 0.26 in < L/360 = 0.3 in

Oriented Strand Board



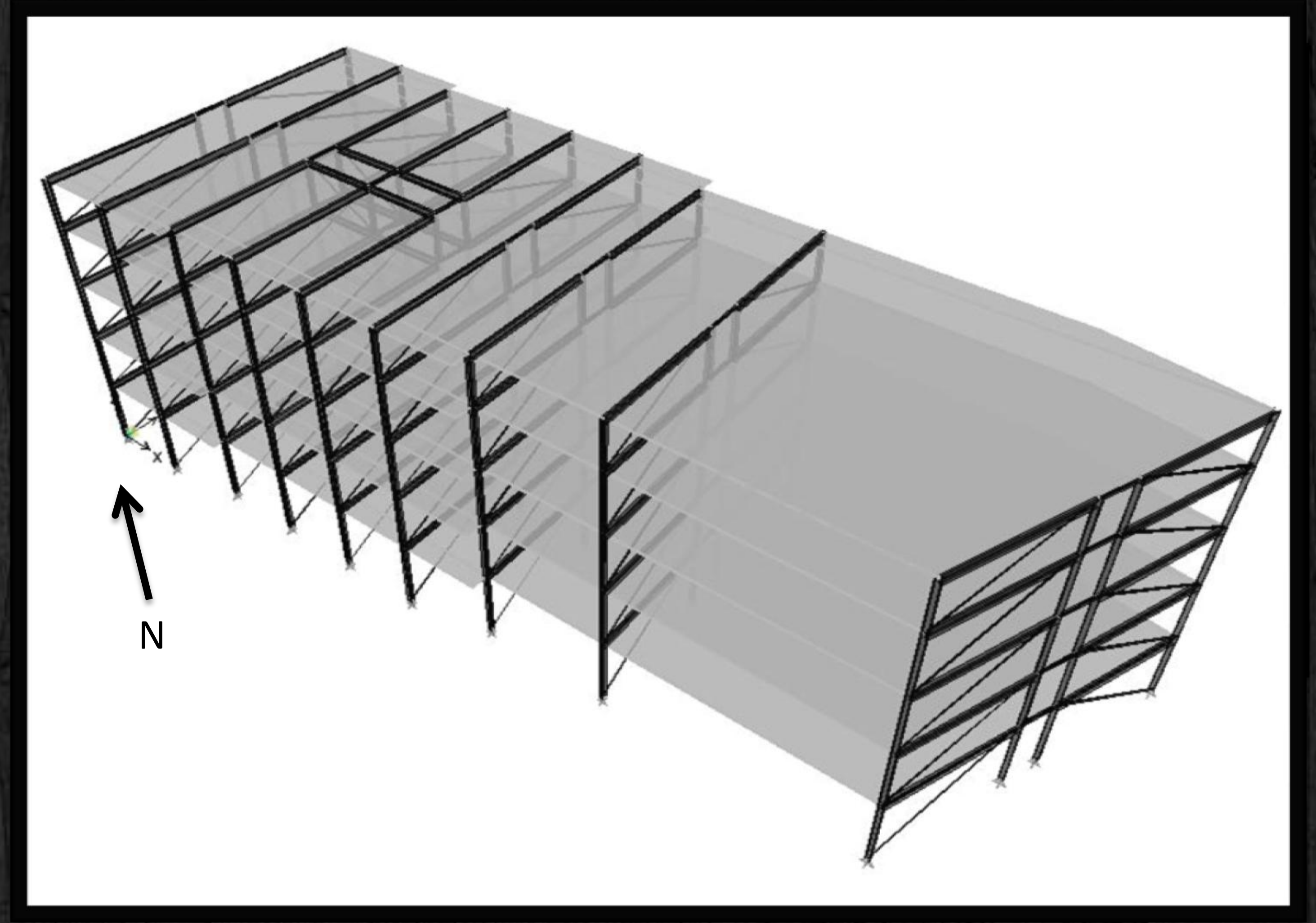
Dormitory



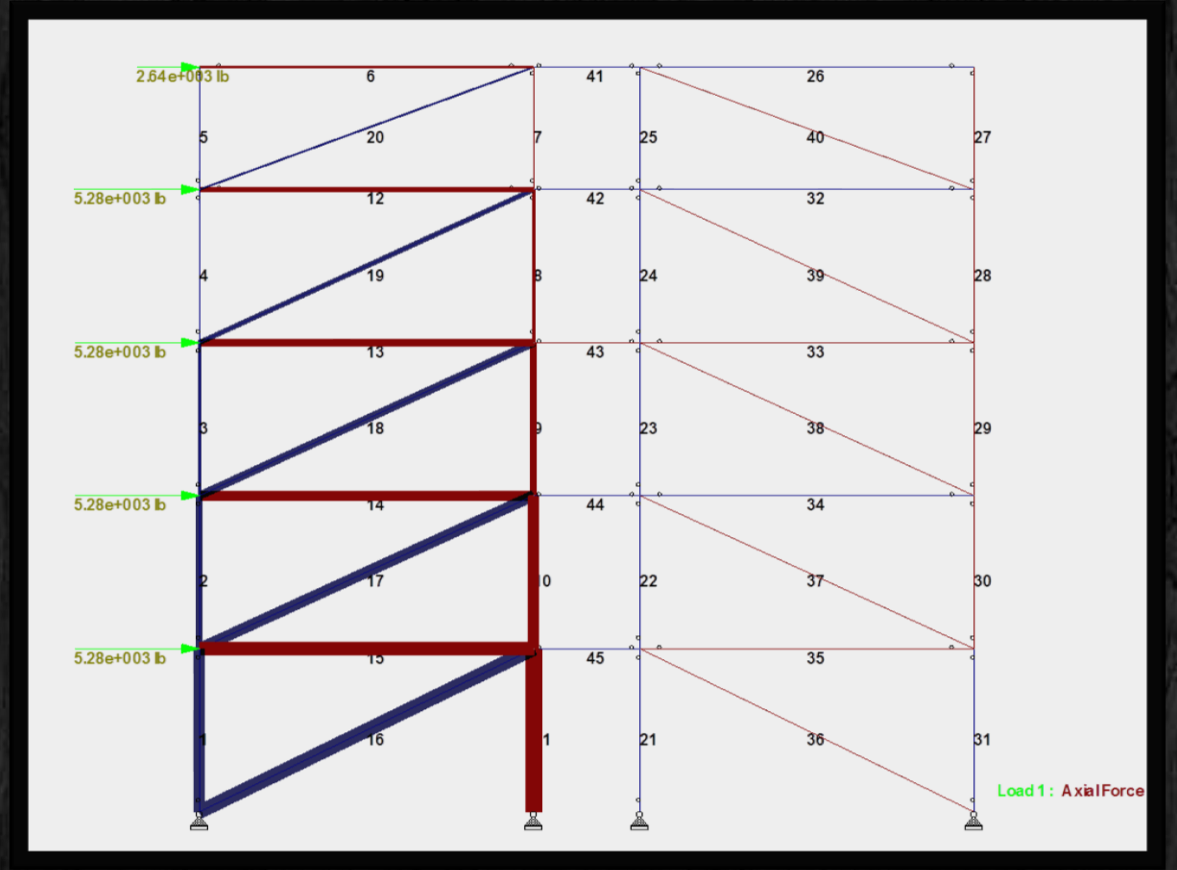
Shear Wall Design

- North – South Winds
  - Maximum Deflection
    - 0.19 in < L/360 = 0.30 in
- Columns – W8x31
- Braces – L2x2x1/8 – L2x2x5/16
- Beams – W12x35

Steel Braced Frames



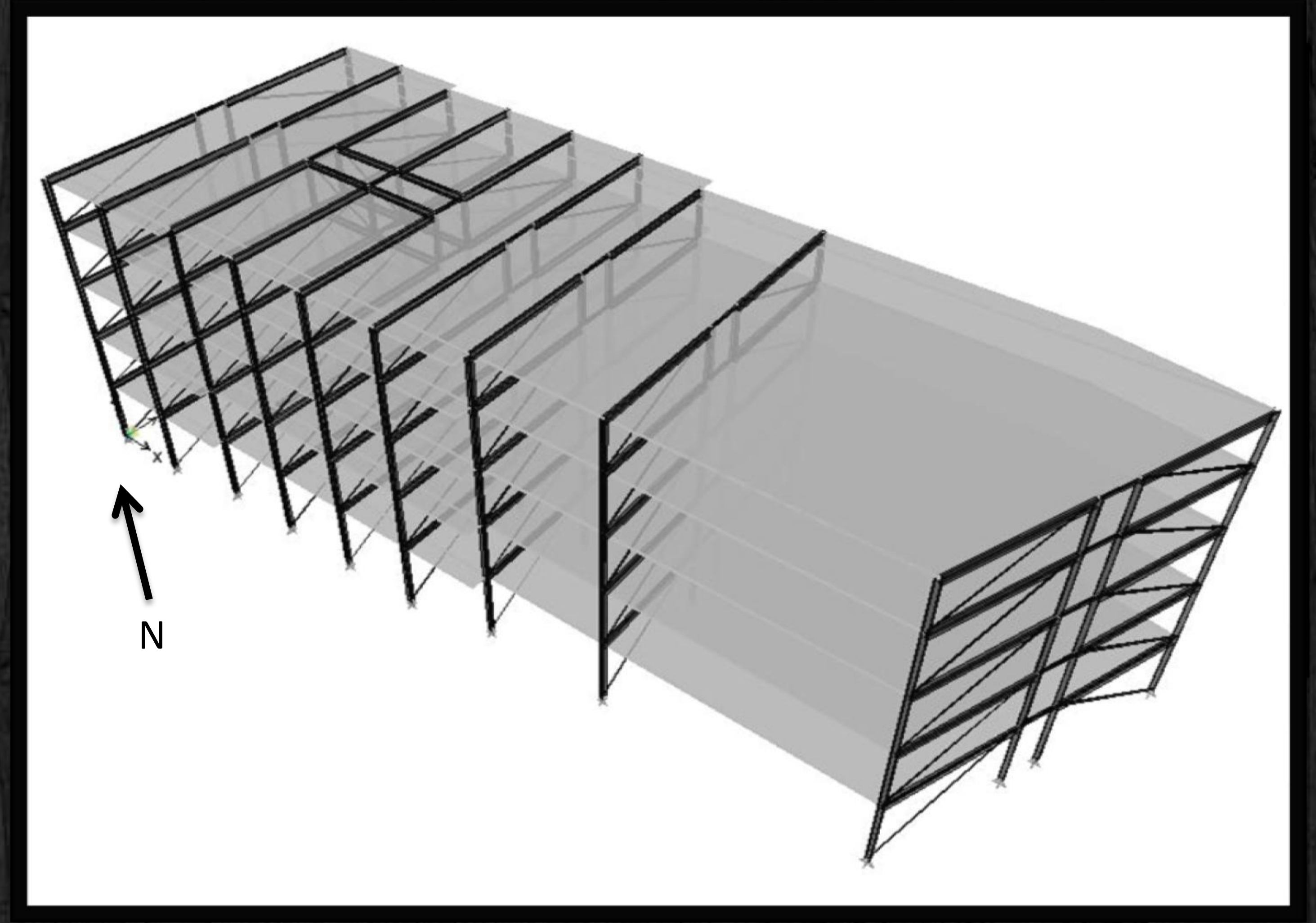
Dormitory



Shear Wall Design

- East – West Winds
  - Maximum Deflection
    - 0.08 in < L/360 = 0.30 in
- Columns – W8x31
- Braces – L2x2x1/8 – L2x2x1/4
- Beams – W12x30 – W12x35

Steel Braced Frames



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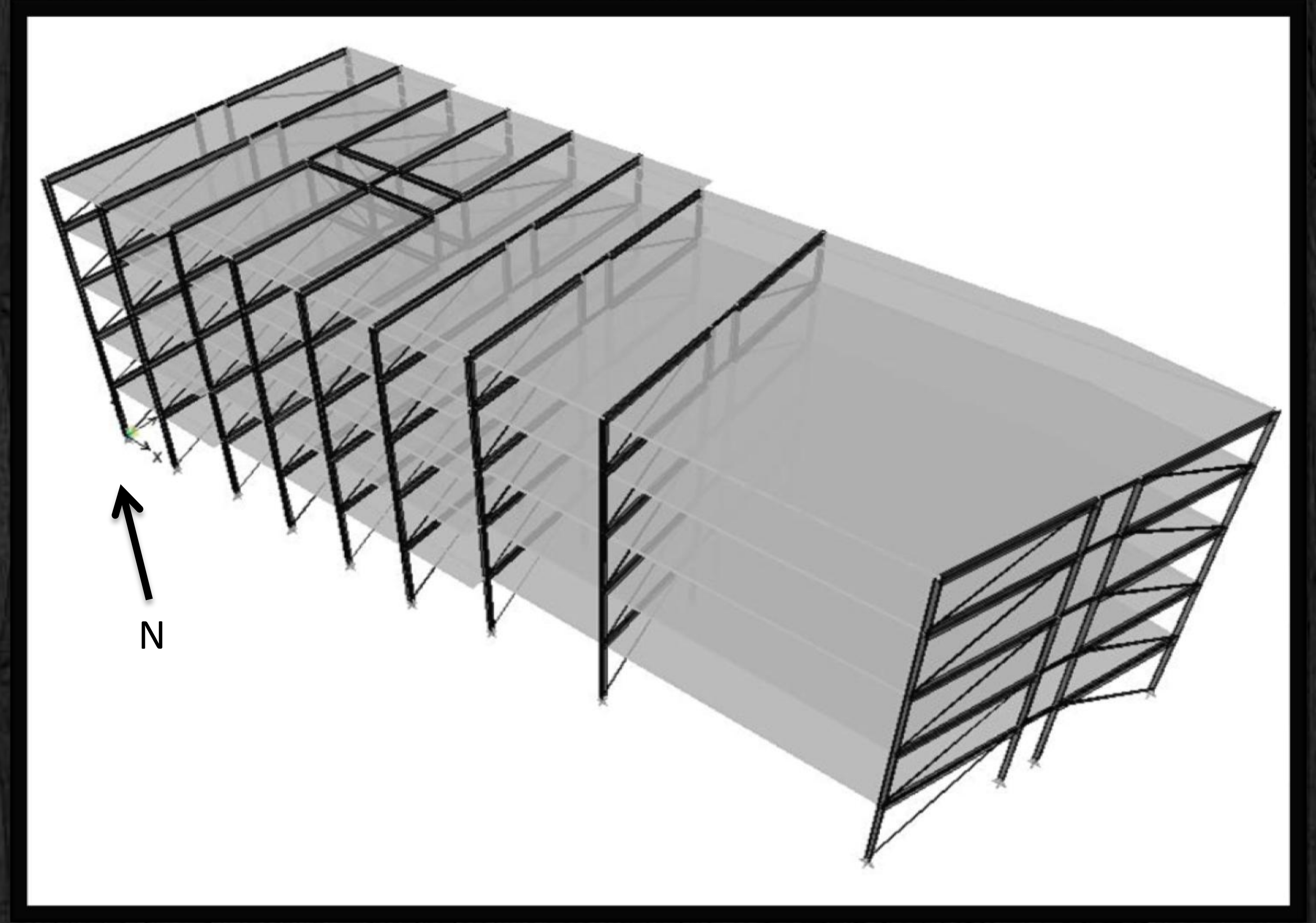
Shear Wall Design

- ETABS Model
  - AE 597A – Computer Modeling
  - Deflections

MAE Requirement



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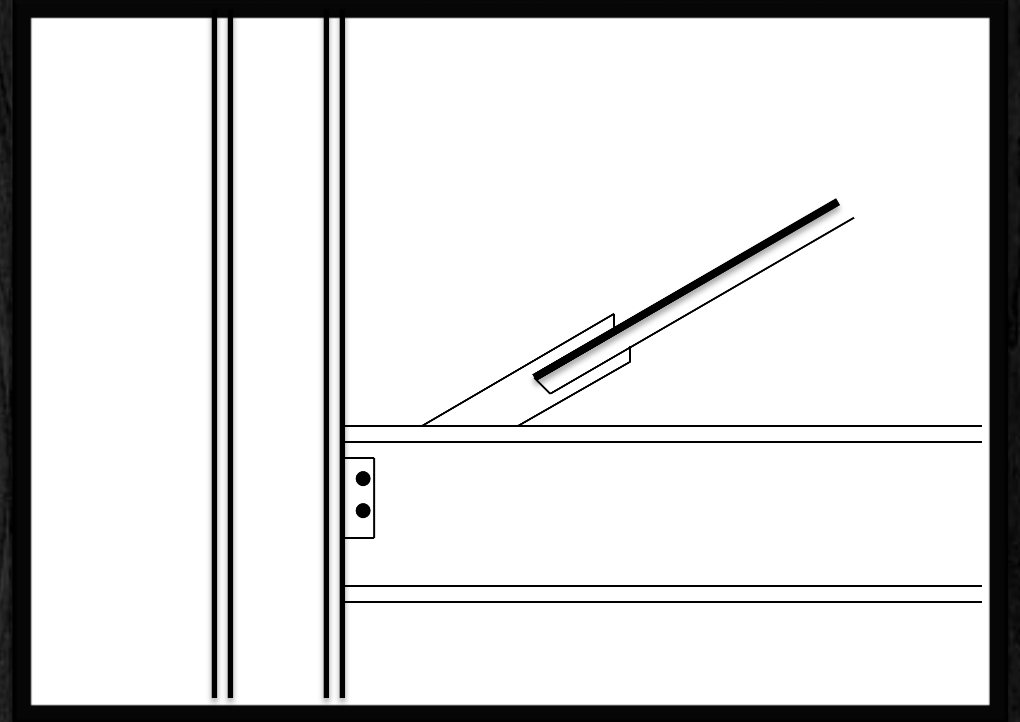
Shear Wall Design

- Braced Frame Connection
  - AE 534 – Steel Connections
  - 4 inch wide, ¼ inch A36 plate
  - (2) 1/8 inch welds, 5 inches long
  - (2) 1/16 inch welds, 9 inches long

MAE Requirement



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Lateral System Comparison

System	Drift at Roof (inches)	h/400 (inches)
OSB Shear Wall E-W	1.30	1.47
Steel Braced Frame E-W	0.32	1.47
OSB Shear Wall N-S	0.86	1.47
Steel Braced Frame N-S	0.75	1.47

Steel Braced Frames

System	Gravity	Walls	Total
OSB Shear Wall	$1,228,000	$288,000	$1.516 million
Steel Braced Frame	$1,072,000	$261,000	$1.333 million

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Electrical Breadth

- Results:
  - DOW POWERHOUSE Solar Shingle
  - Payback Period of 10 Years
  - Install like Asphalt Shingles
  - Battery Backup

Photovoltaic System

http://www.dowsolar.com/about/business.htm

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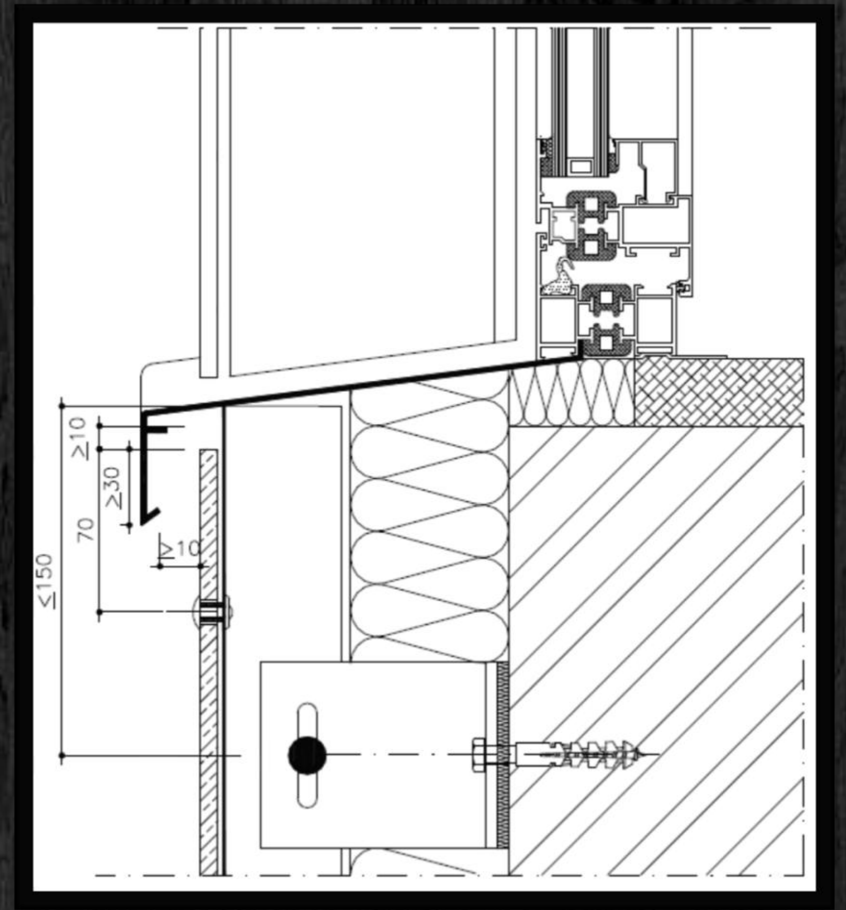
Façade Breadth

- Rain Screen Wall Cladding System
  - American Fiber Cement Corporation’s Textura
  - R-value and condensation analysis using H.A.M.
  - Impact Resistant
    - “This product has been designed and tested to comply with the Requirements of the Florida Building Code 2010 edition including High Velocity Hurricane Zone (HVHZ), TAS 202 and TAS 203”

Rain Screen



http://www.americanfibercement.com/textura

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Conclusion

- Lateral System Comparison
  - Oriented strand board
  - Steel braced frame
- Solar Shingles
- Rain Screen Cladding

Recommendation

- Steel braced frame system
- Steel floor and gravity system

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  - Dr. Behr
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  - David Sciullo
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- Family and Friends

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Questions and Comments