



**St. Elizabeth Boardman Hospital
Inpatient Facility**
Boardman, Ohio

Josh Behun - Structural

Faculty Advisor: Dr. Linda Hanagan

Existing Conditions

St. Elizabeth Boardman Hospital Renovation

Thesis Outline / Goals

- ❖ Analyze and design concrete structure
- ❖ Expand knowledge and skills of concrete design methods
 - Initial analysis did not provide building flaws worthy of thesis investigation
 - Base goals on educational growth, rather than solutions to improve deficiencies in structure
- ❖ Analyze steel vs. concrete comparison
- ❖ Improve understanding of construction management

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Existing Conditions

Owner:
- Humility of Mary Health Partners



Structural Engineer:
- Atlantic Engineering Services



Mechanical / Electrical Engineer:
- Scheeser, Buckley, Mayfield, LLC



Architects:
- Moody-Nolan, Inc



- Strollo Architects



General Contractors:
- The Albert M. Higley Co



- Alex Downie & Sons Co.



Project Background

Location:
- Boardman, Ohio

Project Size:
- 7 stories – 220,000 sqft
- 14'-8" typical story heights

Total Cost:
- \$64 Million

Construction Dates:
- July 2005 – August 2007

Design-Bid-Build



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Existing Conditions

St. Elizabeth Boardman Hospital Renovation

Expansion Plan



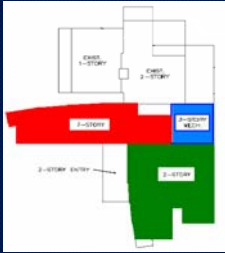
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- Renovation footprint shown in red

Existing Conditions

St. Elizabeth Boardman Hospital Renovation

Expansion Plan



- 7 Story Patient Tower
- 3 Story Mechanical Area
- 2 Story O.R. / Offices / Kitchen - Cafeteria
- All else Pre-Existing, Non-structural, or Future

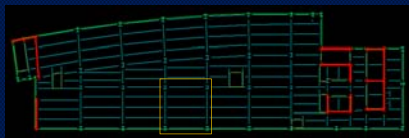


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Existing Conditions

St. Elizabeth Boardman Hospital Renovation

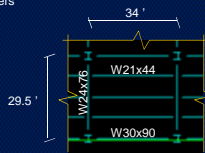
Typical Floor Framing for Patient Tower



- Lateral bracing shown in red

Typical bay supported by:

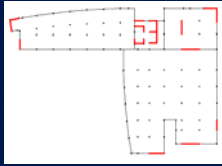
- 4" composite, light weight concrete slab.
- 2" composite metal deck with ¼ inch shear studs.
- Wide flange steel beams and girders of various sizes



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Existing Conditions

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- Lateral bracing shown in red

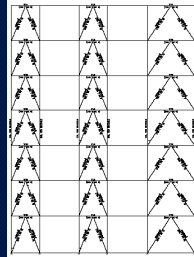
Lateral steel "chevron" bracing

- HSS members
- Elevator Core
- West Stairwell Patient Tower
- Significant locations of mechanical room area and OR wing



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Lateral Resisting System



Existing Conditions

St. Elizabeth Boardman Hospital Renovation

Architecture / Exterior Wall System

Patient Tower Southern Elevation



- Primarily brick façade

Patient Tower Northern Elevation



- Curvilinear aluminum panel curtain wall

Patient Tower Eastern Elevation

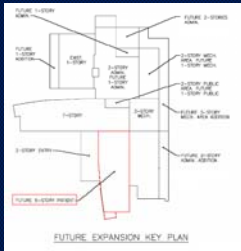


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Future Expansions

St. Elizabeth Boardman Hospital Renovation

Phase II Renovation



- ❖ Second tower to be added with next expansion project
 - Mirrors original tower renovation
 - Directly off elevator core
 - with additional elevators to be added to service new tower demands



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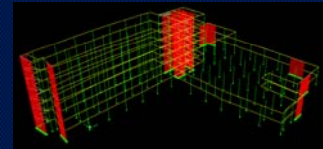
Structural Depth Study

St. Elizabeth Boardman Hospital Renovation

Structural Depth Study



- ❖ Redesign hospital's structural framing system using reinforced structural concrete
 - Slabs
 - Columns
 - Lateral Bracing System (Shear walls)
- ❖ Evaluate effectiveness of concrete structure against structural steel system
- ❖ Further develop knowledge and understanding of concrete system design and relative tools

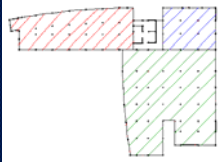


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Structural Depth Study

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Two-Way Flat Plate Slab with Drop Panels and Perimeter Beams



- 19,000 sqft Patient Tower
- 9,000 sqft Mechanical Room area
- 36,000 sqft OR / Kitchen-Cafeteria

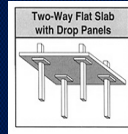
Redesign Patient Tower and Typical Slabs

- 4000 psi concrete
- 9.5 inch slab depth
- 7.5 inch deep drop panels
- 16 x 22.5 inch perimeter beams
- Typical #8 rebar at 12" spacing spanning both directions

Long girder spans

Maintain open architectural plan

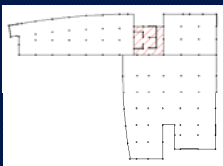
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Structural Depth Study

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One-Way Slab with Beams



- 5,000 sqft Elevator Core

Redesign Elevator Core Slabs

- 4000 psi concrete
- 8 inch slab
- 16 x 22.5 inch edge and T-beams
- Typical #8 rebar at 12" spacing spanning only one direction

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Structural Depth Study

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Beam Design

- ❖ One-way slab
 - T-beams
 - 16" width x 13" depth
 - (6) #6 rebars
- ❖ Two-way slab
 - Spandrel beams
 - 16" width x 13" depth
 - (6) #6 rebars



Overall floor depth of 22.5 inches

* A difference of 13.5 inches ! *

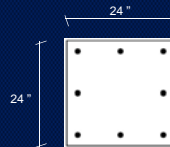
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Column Design

- ❖ Redesign Columns with Concrete
 - 14'- 8" story height, with 15'- 3" ground floor
 - 24"x 24" square columns
 - Typically (8) #8 bars used throughout (except ground floor columns)
 - # 3 confinement ties
- ❖ Original Column Encasement Size
- ❖ Resist Punching Shear in Slabs

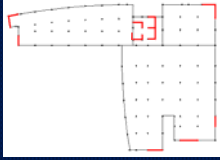


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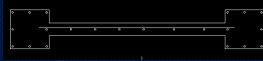
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Shear Wall Design



- Shear walls shown in red

- ❖ Replace Braced Frames with Concrete Shear Walls
 - 8 inch "special reinforced concrete shear walls"
 - Boundary elements
 - Monolithically constructed with columns
 - One curtain of # 5 rebar spaced at 15" o.c.
- ❖ Rigid Structure
 - Period of 0.4 seconds



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Structural Depth Study

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Concrete Redesign Weight

- ❖ Recalculated Building Loads

	Steel Framing	Concrete Framing
Estimated Building Weight	36,000 Kips	52,300 Kips
Floor Dead Load	105 psf	145 psf
Period	1.7 seconds	0.4 seconds

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Breadth Studies

St. Elizabeth Boardman Hospital Renovation

Construction Management



- ❖ Determine effects redesign places upon construction process
- ❖ Evaluate managerial aspects of alternative concrete framing system through:
 - Scheduling Process
 - Construction Sequence
 - Cost Breakdown
- ❖ Determine which system provides more effective construction process



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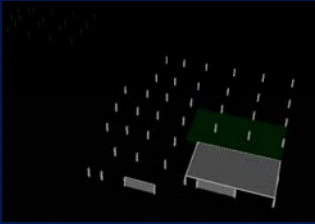
Construction Management

- ❖ Schedule Update
 - Original Steel Framing Structure
 - 4 months
 - Other trades working continuously
 - Alternative Concrete Framing Structure
 - 7 months
 - Other trades start after several weeks

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❖ Construction Sequence

- Formwork
- Rebar
- Concrete
- Shoring / Reshoring
- Columns
- Shear Walls
- Slabs

Construction Management

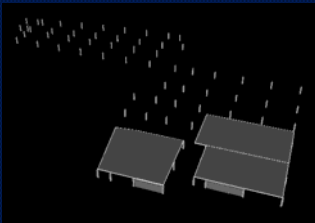
❖ Operating Room / Kitchen Wing

- More intricate work
- Less repetitive tasks
- Lobby
- Kitchen
- Offices
- Beneficial to begin work earlier in project

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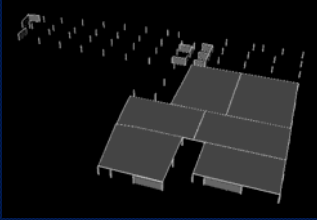
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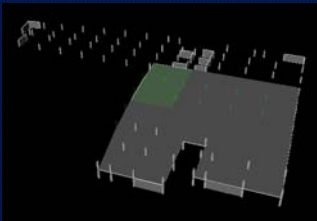
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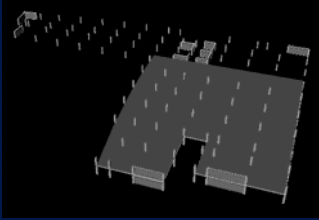
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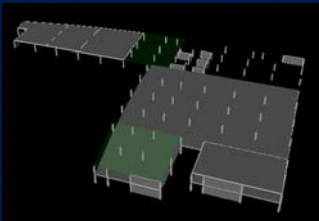
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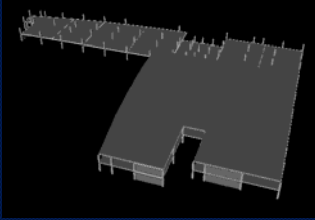
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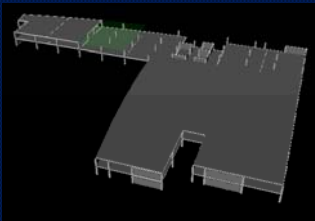
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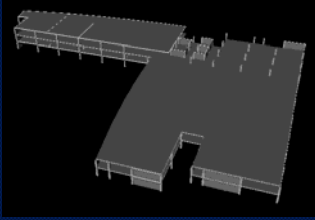
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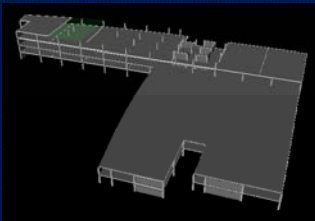
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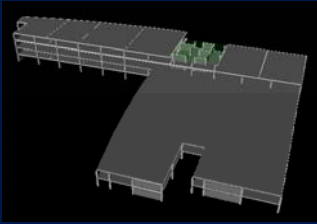
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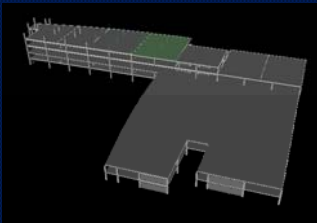
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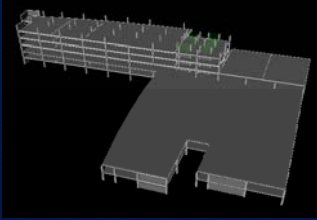
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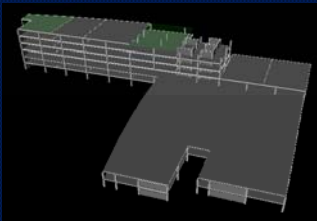
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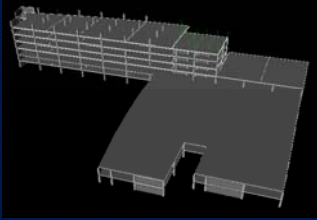
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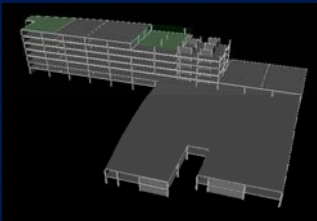
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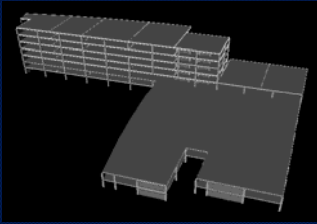
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Construction Management

❖ Cost Comparison

	Steel Framing	Concrete Framing
Material And Labor	\$ 3,572,400	\$ 2,665,825
Schedule Effects	Shorter	Longer

- Concrete framing system actually less expensive
- Though, only accounts for structural framing costs
- Extended schedule would drive project costs

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Final Recommendations

St. Elizabeth Boardman Hospital Renovation

- ❖ Concrete Structure Vs. Original Steel Structure
- ❖ Benefits of Concrete Structure
- ❖ Recommendations

Concrete System

- Shallower floor system
- Less expensive framing system
- Stiffer structural frame

Steel System

- More open floor plans
- Faster construction schedule

- ❖ Advantages not enough to suggest concrete system's superiority



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Final Recommendations

St. Elizabeth Boardman Hospital Renovation

- ❖ Concrete Structure Vs. Original Steel Structure
- ❖ Benefits of Concrete Structure
- ❖ Recommendations

Benefits

- 13.5 inch floor system reduction
- Stiffer structural frame - lower period
- Less expensive system (Based on material installation alone)
- Additional fire-proofing unnecessary

Disadvantages

- Extended construction schedule
- Likely larger foundations
- More material usage



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Final Recommendations

St. Elizabeth Boardman Hospital Renovation

- ❖ Concrete Structure Vs. Original Steel Structure
- ❖ Benefits of Concrete Structure
- ❖ Recommendations
- ❖ Steel system more effective with specific project
- ❖ Having designed for concrete from conception stages would produce better results



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Breadth Studies

Vegetated Green Roof System

- ❖ Extensive System
 - 4 inch substrate depth
 - 41 psf wet
 - 60% water retention
- ❖ Cools Roof Surface
 - Evaporation
 - Absorbs Sunlight
- ❖ Full, direct southern exposure
 - Offset summertime HVAC cooling demands



St. Elizabeth Boardman Hospital Renovation Sustainability



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EPDM Roofing Membrane System

- Applications
 - Excellent weather resistance
 - Resists freeze-thaw cycle
 - Reflects Sunlight - lowers surface temperature
- Problems
 - Reflects light toward adjacent buildings
 - Heating surface temperatures of exterior walls



? ? Questions ? ?

St. Elizabeth Boardman Hospital Renovation



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Existing Conditions

St. Elizabeth Boardman Hospital Renovation

Expansion Joints

❖ Teflon slide bearings

- Two 3/32" pads of 100% virgin polytetrafluoroethylene polymer resin
- Reinforcing aggregates of ground glass fibers bonded to stainless steel plate
- Withstand temperatures of up to 400 degrees Fahrenheit
- Working load capacity of 2000 psi



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