HEIFER INTERNATIONAL CENTER
LITTLE ROCK, ARKANSAS

TECHNICAL REPORT III
SIKANDAR PORTER-GILL
ADVISOR: DR. THOMAS BOOTHBY

Image Courtesy: Timothy Hursley
SITE AND LOCATION

Image Courtesy: Google Earth
HEIFER INTERNATIONAL CENTER

Height: 65’-0”
Stories: 4
Square Footage: 98,000 GSF
Approximate Cost: $18 million
Project Delivery: Construction Management at Risk
USGBC Rating: LEED Platinum
Unique Architecture

Inverted Roof

Rainwater Storage
TYPICAL FLOOR PLAN

N

64’-0”

491’-0”
TYPICAL FLOOR PLAN

PUBLIC AREAS

MECHANICAL SPACE

OFFICES
EXISTING STRUCTURAL SYSTEM

• FOUNDATION
  • Geopier™ Rammed Aggregate Pier® System
    • Increase soil capacity to 5 to 7 ksf
  • Grade Beams
  • Slab On Grade

Image Courtesy: Tensar Geopier™ Foundations
EXISTING STRUCTURAL SYSTEM

• **GRAVITY SYSTEM**
  - Composite Deck, Beam and Girder System
    - 3VLI Decking with 2 ½” NWC Topping
    - Beams and Girders Cambered
  - HSS COLUMNS

• **LATERAL SYSTEM**
  - Steel plate shear wall system

Image Courtesy: Meredith Parks
“Typical” Bay
“Typical” Bay

Radial Bay

Rectangular Bay

Deck

30’-0”

22’-0”
**Gravity Spot Checks | Deck**

3VLI 20 Gauge, 2 ½” NWC

- **Clear Span Check**
  - 11'-0” span > 2 and 3 span condition **Pass!**
  - Failed 1 span condition **No Good!**

- **Strength Check**
  - $w_{LL} + w_{misc,DL} \leq$ Superimposed Live Load
  - 92 PSF $\leq$ 106 PSF **Pass!**

Image Courtesy: nexus.globalquakemodel.org
Gravity Spot Checks | Beam

W14x22 (26) [1”]

- **Strength Check**
  - \( \phi M_n = 265.4 kN < M_u = 273 kN \)
  - **Pass!**

- **Unshored Strength Check**
  - \( \phi M = 125 kN > M_u = 118.3 kN \)
  - No Shoring Required
  - **Pass!**

- **Wet Concrete Check**
  - \( \Delta_{wc,max} = 1.5" < \Delta_{wc} = 1.84" \)
  - Beam Requires Camber
  - **Camber!**

- **Live Load Deflection Check**
  - \( \Delta_{LL,max} = \frac{l}{360} = 1" > \Delta_{LL} = 0.850" \)
  - **Pass!**

Strength check passes with modified dead loads (not used in analysis)
**Gravity Spot Checks | Girder**

**W16x26 (18)**

- **Strength Check**
  - $\varphi M_n = 336'k < M_u = 401'k$
  - **Pass!**

- **Unshored Strength Check**
  - $\varphi M = 166'k > M_u = 466'k$
  - Shoring Required
  - **Shoring!**

- **Wet Concrete Check**
  - $\Delta_{wc,max} = 1.1'' > \Delta_{wc} = 0.784''$
  - **Pass!**

- **Live Load Deflection Check**
  - $\Delta_{LL,max} = \frac{l}{360} = 0.733'' > \Delta_{LL} = 0.330''$
  - **Pass!**

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Strength check passes with modified dead loads (not used in analysis)
**Gravity Spot Checks | Girder**

W14x22 (10)

- **Strength Check**
  - $\varphi M_n = 229^{\prime}k < M_u = 234^{\prime}k$
  - **Pass!**

- **Unshored Strength Check**
  - $\varphi M = 125^{\prime}k < M_u = 233^{\prime}k$
  - Shoring Required
  - **Shoring!**

- **Wet Concrete Check**
  - $\Delta_{wc,max} = 1.1'' > \Delta_{wc} = 0.6''$
  - **Pass!**

- **Live Load Deflection Check**
  - $\Delta_{LL,max} = \frac{l}{360} = 0.733'' > \Delta_{LL} = 0.614''$
  - **Pass!**

Strength check passes with modified dead loads (not used in analysis)
Gravity Spot Checks | Columns

HSS24x0.5*

- **Interior Column**
  - $\phi P_n = 1080^k > P_u = 511^k$
    
    Pass!

- **Exterior Column**
  - $\phi P_n = 1080^k > P_u = 262^k$
    
    Pass!

*Axial compression values used for an HSS20x0.5, Steel Construction Manual (14th Edition) does not have HSS24x0.5
ALTERNATIVE SYSTEMS

• Glulam
• Hollow Core Plank
• Post Tension Slab

Image Courtesy: ArchiEXPO.com
SEPSA Precast Solutions Corp.
Kansas Department of Transportation
ALT. #1 - GLULAM

Heifer International Visitor and Education Center

Image Courtesy: Meredith Parks and Timothy Hursley
ALT. #1 - GLULAM

**Design**
- (5) 8 3/4” x 22 1/2” 24F-V4
  - @ 5’-6” spacing
- (1) 10 3/4” x 33” 24F-V4
- (1) 8 3/4” x 27” 24F-V4

**Durability**
- Common material for construction, currently in use Heifer International’s Visitor Center
## Alt. #1 - Glulam

<table>
<thead>
<tr>
<th>System Depth</th>
<th>System Fire Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>37” &gt; 21.2”</td>
<td>1 HR Char of 1.5” / HR</td>
</tr>
</tbody>
</table>

### RS Means Cost

$20.43 / SF

### System Weight

18 psf

### Lateral System

- Steel Plate Shear Walls
  - Setup in existing building at mechanical and lobby space at both ends and middle core
- Prefabricated System
  - SIMPSON Strong-Tie®
    - Steel or Wood Shear Walls
    - Moment Frames

Image Courtesy: Boise Cascade
ALT. #2 – HOLLOW CORE PLANKS

Image Courtesy:
Spiroll Precast Services, Ltd.
Mabetón España, S.A.
**Alt. #2 – Hollow Core Planks**

**Design**
- (8) 6” x 4’-0” Planks
  - 7 – ½” Ø Strands @ 2” Concrete Topping
- W24x84 Beam

**Durability**
- Strong concrete system that allows more open space in a building
ALT. #2 – HOLLOW CORE PLANKS

**System Depth**

32.7” > 21.2”

- **Planks**
- **Existing**

**System Fire Rating**

1 HR

**RS Means Cost**

$11.04 / SF

**System Weight**

57 psf

**Lateral System**

- Concrete Masonry Walls
  - Could be integrated into existing mechanical, elevator and stair towers
- Steel Plate Shear Walls
  - System not as compatible with existing lateral system

Image Courtesy: Nitterhouse Concrete Products, Inc.
Alt. #3 – Post Tension Slab

Image Courtesy:
Metzger Testing & Inspection
Architectoid, Learning Architecture for Life
Alt. #3 – Post Tension Slab

Design

- 8” Slab Concrete Slab
  - 270 kips @ 90% Jacking
  - 2 Strands @ 10” O.C. (N-S)
- (1) 18” x 27” NWC Beam
  - (7) #5 Longitudinal
  - (16) #3 Stirrup @ 7” (2” from ends)
- (1) 15” x 25” NWC Beam
  - (5) #8 Longitudinal
  - (10) #3 Stirrup @ 11” (2” from ends)

Durability

- Post tension is extremely durable and is a established system for use in offices and garages
**ALT. #3 – POST TENSION SLAB**

**SYSTEM DEPTH**

35” > 21.2”

- **POST TENSION**
- **EXISTING**

**SYSTEM FIRE RATING**

2 HR

**ACHIEVED**

**RS MEANS COST**

$18.92 / SF

**SYSTEM WEIGHT**

132 psf

**LATERAL SYSTEM**

- **Moment Frame**
  - Redesign of office layout will be required, may complicate this system

- **Concrete Shear Wall**
  - Could be integrated into existing mechanical, elevator and stair towers

Image Courtesy: SPX
<table>
<thead>
<tr>
<th>Considerations</th>
<th>Composite Deck and Beam</th>
<th>Gravity Systems</th>
<th>Prefabricated Hollow Plank</th>
<th>Post Tension Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alterations</td>
<td>Composite deck and composite beams</td>
<td>Engineered glulam beams and girders, supporting 4&quot; T&amp;G floor decking</td>
<td>Prefabricated 4' hollow core planks supported by steel beams</td>
<td>Post tensioned 8&quot; slab, supported by interior and exterior concrete girders</td>
</tr>
<tr>
<td>Gravity System</td>
<td>Steel plate shear wall (SPSW)</td>
<td>SPSW or Prefabricated Wood Shear Wall</td>
<td>Concrete or masonry shear walls, SPSW not viable</td>
<td>Moment Frame or Concrete Shear Wall</td>
</tr>
<tr>
<td>Lateral System</td>
<td>-</td>
<td>Minor adjustments</td>
<td>Minor adjustments to bay sizes</td>
<td>Increased weight will impact existing foundation system</td>
</tr>
<tr>
<td>Impact</td>
<td>-</td>
<td>Minor adjustments</td>
<td>Minor adjustments to bay sizes</td>
<td>Increased weight will impact existing foundation system</td>
</tr>
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</table>

**Potential Future Investigation**

- Yes, Hybrid Steel and Wood System
- Yes, Hybrid Steel and Wood System
- No, semicircular building not viable in prefabricated rectangular sections
- Yes, research viability on semi-circular building
## Architectural Considerations

<table>
<thead>
<tr>
<th>Considerations</th>
<th>Composite Deck and Beam</th>
<th>Glulam</th>
<th>Prefabricated Hollow Plank</th>
<th>Post Tension Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size of Bay</strong></td>
<td>22’ x 30'</td>
<td>22' x 30'</td>
<td>22’ x 32'</td>
<td>22’ x 30'</td>
</tr>
<tr>
<td><strong>Fire Protection</strong></td>
<td>None*</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Fire Rating</strong></td>
<td>1 HR</td>
<td>1 HR @ Char of 1.5” / HR</td>
<td>1 HR</td>
<td>2 HR ACHIEVED</td>
</tr>
<tr>
<td><strong>MEP Coordination</strong></td>
<td>Underfloor Air Distribution (UFAD) System</td>
<td>No concealed spaces allowed, UFAD not possible</td>
<td>No impact</td>
<td>No impact</td>
</tr>
<tr>
<td><strong>Impact</strong></td>
<td>Framing members not protected from fire</td>
<td>Decrease in floor to floor height</td>
<td>Decrease in floor to floor height</td>
<td>Decrease in floor to floor height</td>
</tr>
</tbody>
</table>
# System Statistics

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<tr>
<th>Considerations</th>
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<th>Glulam</th>
<th>Prefabricated Hollow Plank</th>
<th>Post Tension Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Weight</td>
<td>57 psf</td>
<td>18 psf</td>
<td>57 psf</td>
<td>132 psf</td>
</tr>
<tr>
<td>Slab Depth</td>
<td>5.5&quot;</td>
<td>4&quot;</td>
<td>8&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>System Depth</td>
<td>21.2&quot;</td>
<td>37&quot;</td>
<td>32.7&quot;</td>
<td>35&quot;</td>
</tr>
<tr>
<td>Constructability</td>
<td>Easy</td>
<td>Easy</td>
<td>Easy</td>
<td>Challenge</td>
</tr>
<tr>
<td>Durability</td>
<td>Acceptable</td>
<td>Acceptable</td>
<td>Acceptable</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Cost</td>
<td>$17.93 / SF</td>
<td>$20.43 / SF</td>
<td>$11.04 / SF</td>
<td>$18.92 / SF</td>
</tr>
</tbody>
</table>
THANK YOU