Heifer International Center

Little Rock, Arkansas

Technical Report III

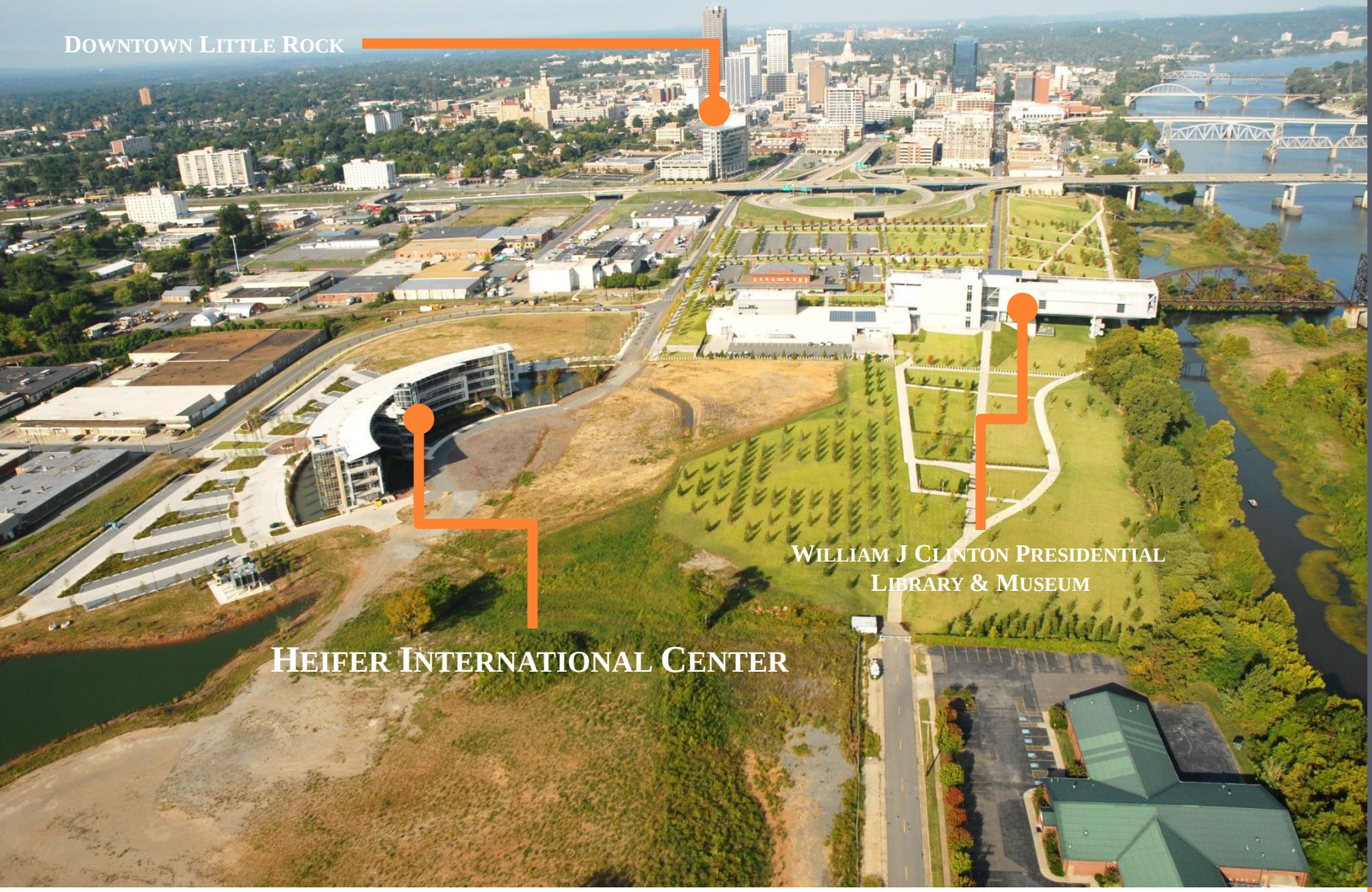
Sikandar Porter-Gill

Advisor: Dr. Thomas Boothby

Image Courtesy: Timothy Hursley

SITE AND LOCATION

Image Courtesy: Google Earth



LITTLE ROCK, ARKANSAS

Image Courtesy: Heifer International and Meredith Parks

Heifer International Center

Height	65’-0”
Stories	4
Square Footage	98,000 GSF
Construction Dates	February 2004 – January 2006
Approximate Cost	$18 million
Project Delivery	Construction Management at Risk
USGBC Rating	LEED Platinum

PASS ON THE GIFT
HEIFER®
INTERNATIONAL

POLK
STANLEY
WILCOX
ARCHITECTS

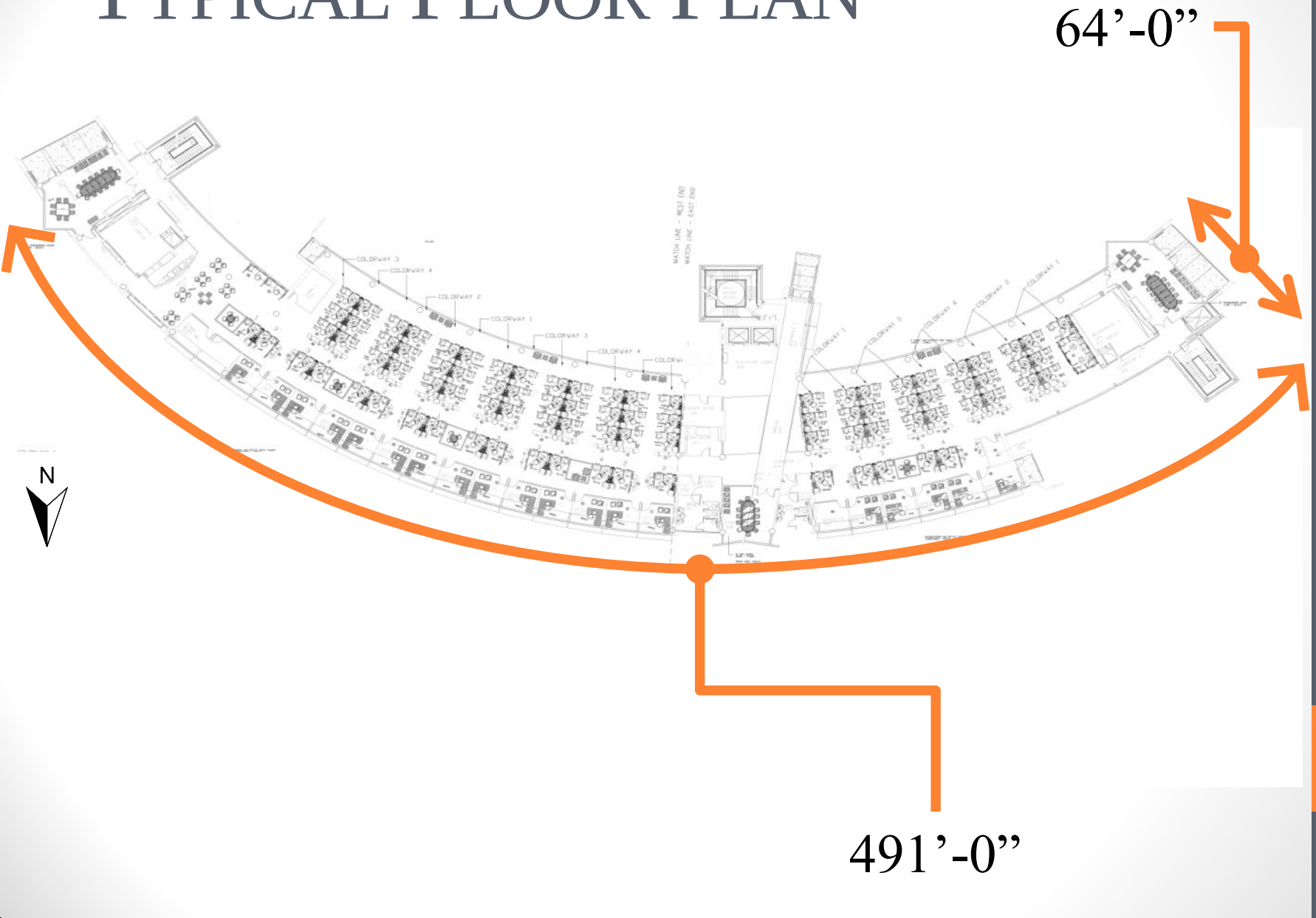
CROMWELL

Unique Architecture

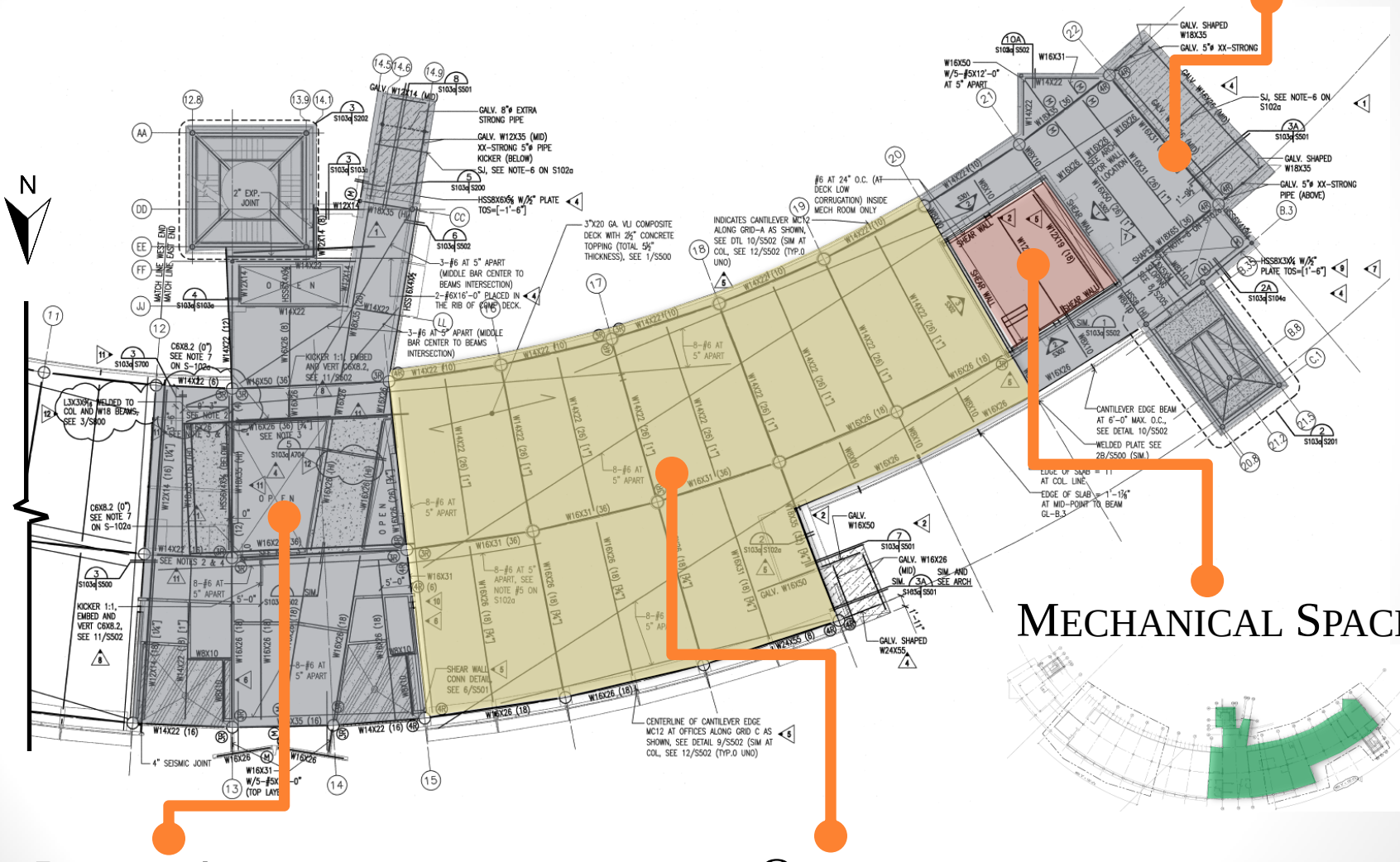
Inverted Roof

Rainwater Storage

Typical Floor Plan



Typical Floor Plan



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

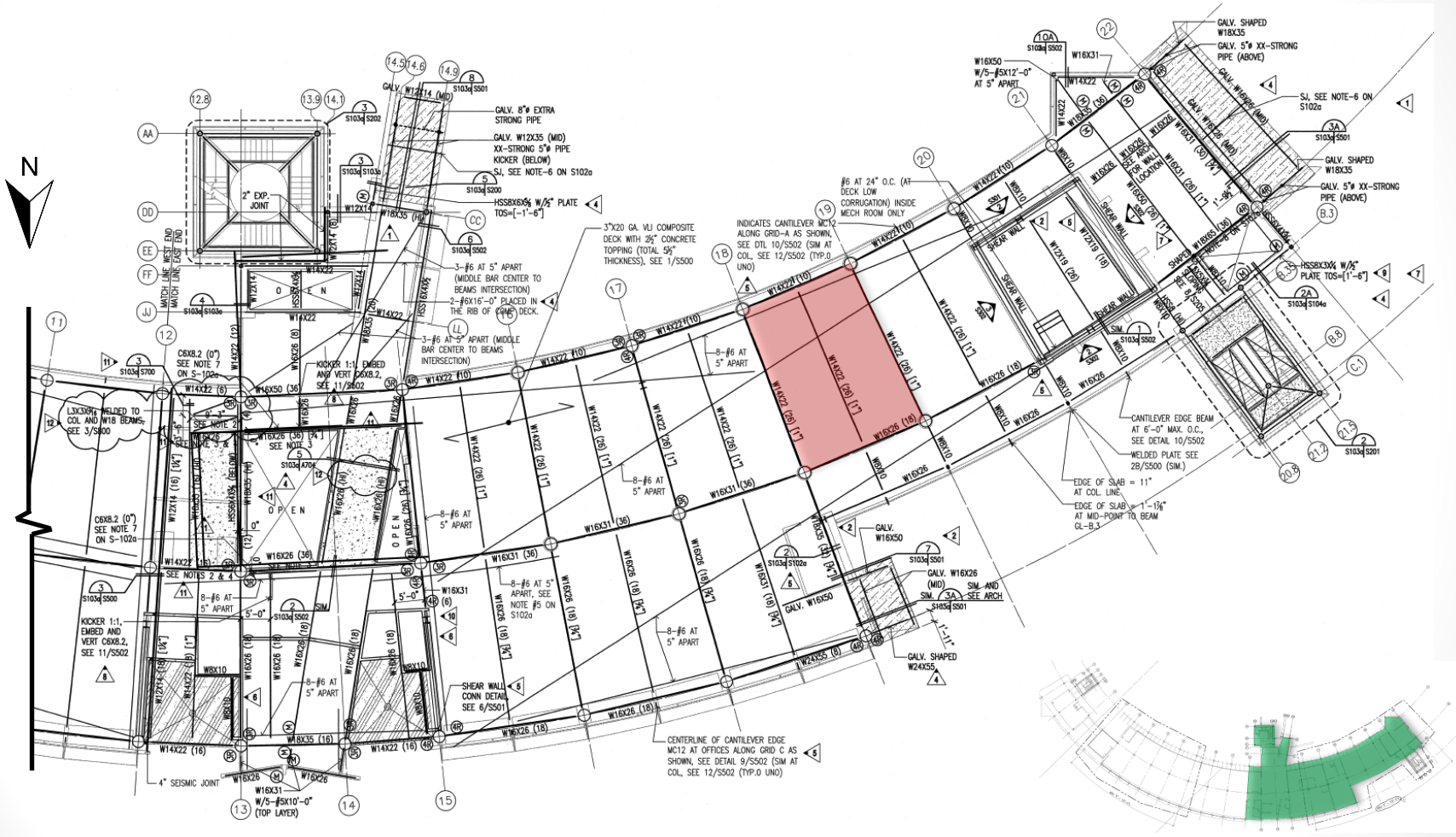
Existing Structural System

- 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

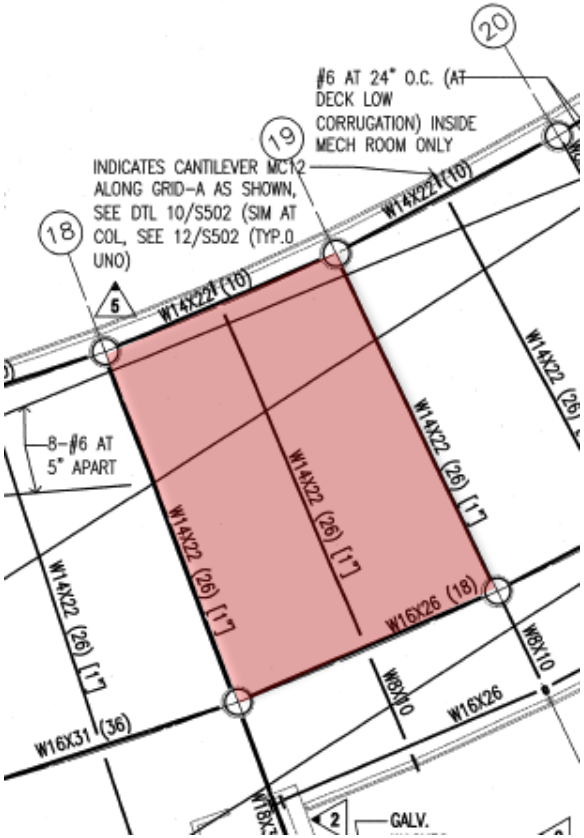
Image Courtesy: Meredith Parks

"TYPICAL" BAY

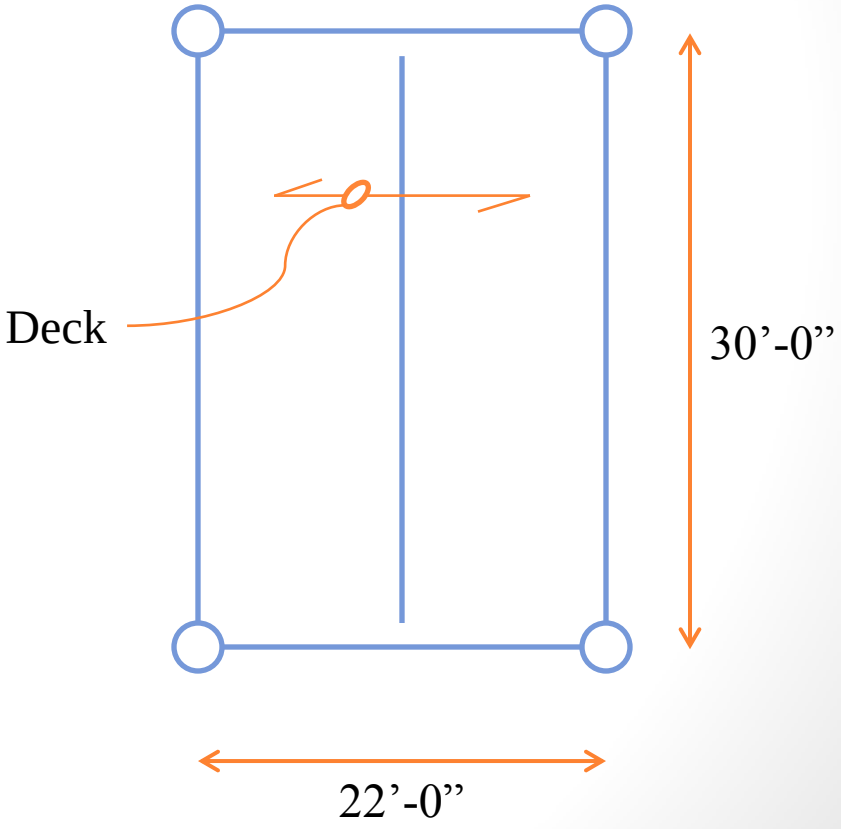

N
GALV. SHAPED W18X35
GALV. 5"ø XX-STRONG PIPE (ABOVE)
GALV. 8"ø EXTRA STRONG PIPE
GALV. W12X35 (MID) XX-STRONG 5"ø PIPE KICKER (BELOW)
SJ, SEE NOTE-6 ON S102a
HSS8X6X5/16 W/5/8" PLATE TOS=[-1'-6"]
3"X20 GA. VLI COMPOSITE DECK WITH 2 5/8" CONCRETE TOPPING (TOTAL 5 1/2" THICKNESS), SEE 1/S500
INDICATES CANTILEVER MC12 ALONG GRID-A AS SHOWN, SEE DTL 10/S502 (SIM AT COL, SEE 12/S502 (TYP.0 UNO)
#6 AT 24" O.C. (AT DECK LOW CORRUGATION) INSIDE MECH ROOM ONLY
3-#6 AT 5" APART (MIDDLE BAR CENTER TO BEAMS INTERSECTION)
2-#6X16'-0" PLACED IN THE RIB OF PANEL DECK.
3-#6 AT 5" APART (MIDDLE BAR CENTER TO BEAMS INTERSECTION)
KICKER 1:1, EMBED AND VERT C6X8.2, SEE 11/S502
C6X8.2 (0") SEE NOTE 7 ON S-102a
L3X3X5/16 WELDED TO COL AND W18 BEAMS, SEE 3/S600
8-#6 AT 5" APART
8-#6 AT 5" APART, SEE NOTE #5 ON S102a
SHEAR WALL CONN DETAIL SEE 6/S501
CENTERLINE OF CANTILEVER EDGE MC12 AT OFFICES ALONG GRID C AS SHOWN, SEE DETAIL 9/S502 (SIM AT COL, SEE 12/S502 (TYP.0 UNO)
CANTILEVER EDGE BEAM AT 6'-0" MAX. O.C., SEE DETAIL 10/S502
WELDED PLATE SEE 2B/S500 (SIM.)
EDGE OF SLAB = 11" AT COL. LINE
EDGE OF SLAB = 1'-1 7/8" AT MID-POINT TO BEAM GL-B.3
GALV. W16X50
GALV. W16X26 (MID) SIM. AND SEE ARCH
GALV. SHAPED W24X55
4" SEISMIC JOINT
W16X31 W/5-#5X10'-0" (TOP LAYER)
W16X50 W/5-#5X12'-0" AT 5" APART
HSS8X6X5/16 W/5/8" PLATE TOS=[1'-6"]
SHEAR WALL
OPEN

"Typical" Bay

Radial Bay

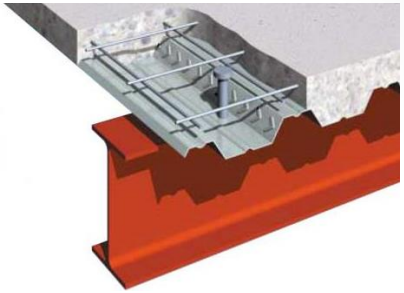


Rectangular Bay



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 ≤ 106 PSF

    Pass!

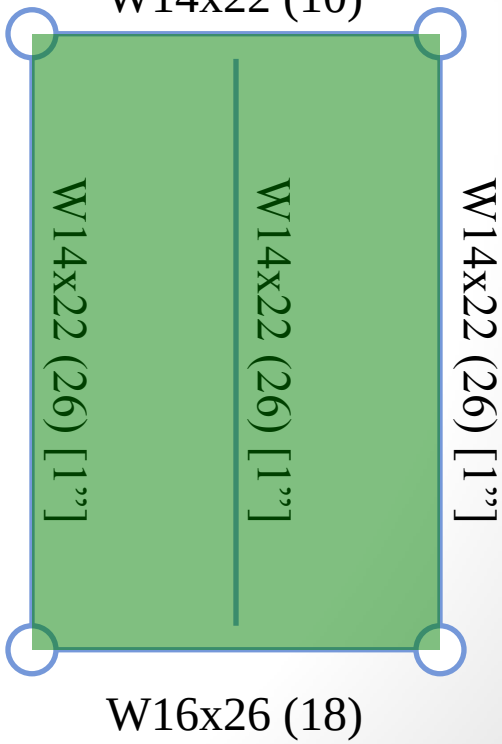


Image Courtesy: nexus.globalquakemodel.org

GRAVITY SPOT CHECKS | BEAM

W14x22 (26) [1”]

- **STRENGTH CHECK**
  - $\varphi M_n = 265.4'^k < M_u = 273'^k$

Pass!

- **UNSHORED STRENGTH CHECK**
  - $\varphi M = 125'^k > M_u = 118.3'^k$
  - No Shoring Required

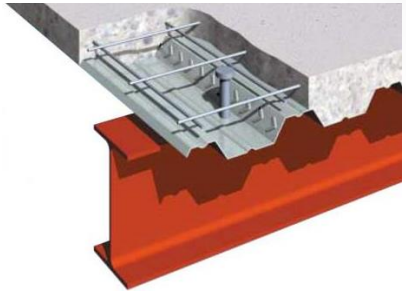
Pass!

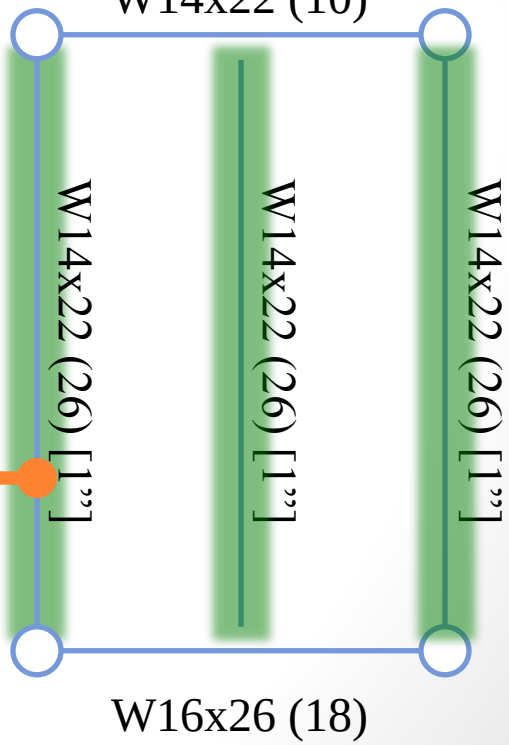
- **WET CONCRETE CHECK**
  - $\Delta_{wc,max} = 1.5“ < \Delta_{wc} = 1.84"$
  - Beam Requires Camber

Camber!

- **LIVE LOAD DEFLECTION CHECK**
  - $\Delta_{LL,max} = {}^{l}/_{360} = 1" > \Delta_{LL} = 0.850"$

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

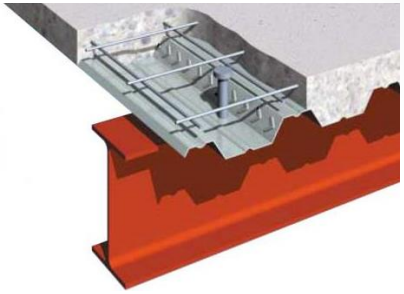
Shoring!

- **WET CONCRETE CHECK**
  - $\Delta_{wc,max} = 1.1" > \Delta_{wc} = 0.784"$

Pass!

- **LIVE LOAD DEFLECTION CHECK**
  - $\Delta_{LL,max} = {}^{l}/_{360} = 0.733" > \Delta_{LL} = 0.330"$

Pass!



Strength check passes with modified dead loads (not used in analysis)

Gravity Spot Checks | Girder

W14x22 (10)

- **Strength Check**
  - $\varphi M_n = 229'^k < M_u = 234'^k$

Pass!

- **Unshored Strength Check**
  - $\varphi M = 125'^k < M_u = 233'^k$
  - Shoring Required

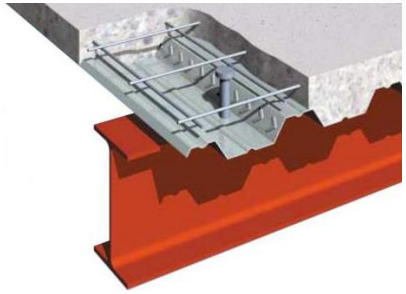
Shoring!

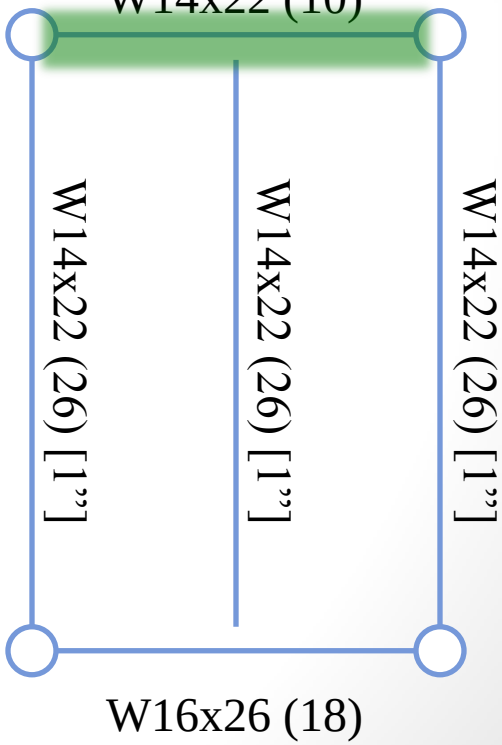
- **Wet Concrete Check**
  - $\Delta_{wc,max} = 1.1" > \Delta_{wc} = 0.6"$

Pass!

- **Live Load Deflection Check**
  - $\Delta_{LL,max} = {}^{l}/_{360} = 0.733" > \Delta_{LL} = 0.614"$

Pass!





Strength check passes with modified dead loads (not used in analysis)

GRAVITY SPOT CHECKS | COLUMNS

HSS24x0.5*

- **INTERIOR COLUMN**
  - $\varphi P_n = 1080^k > P_u = 511^k$

Pass!

- **EXTERIOR COLUMN**
  - $\varphi P_n = 1080^k > P_u = 262^k$

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

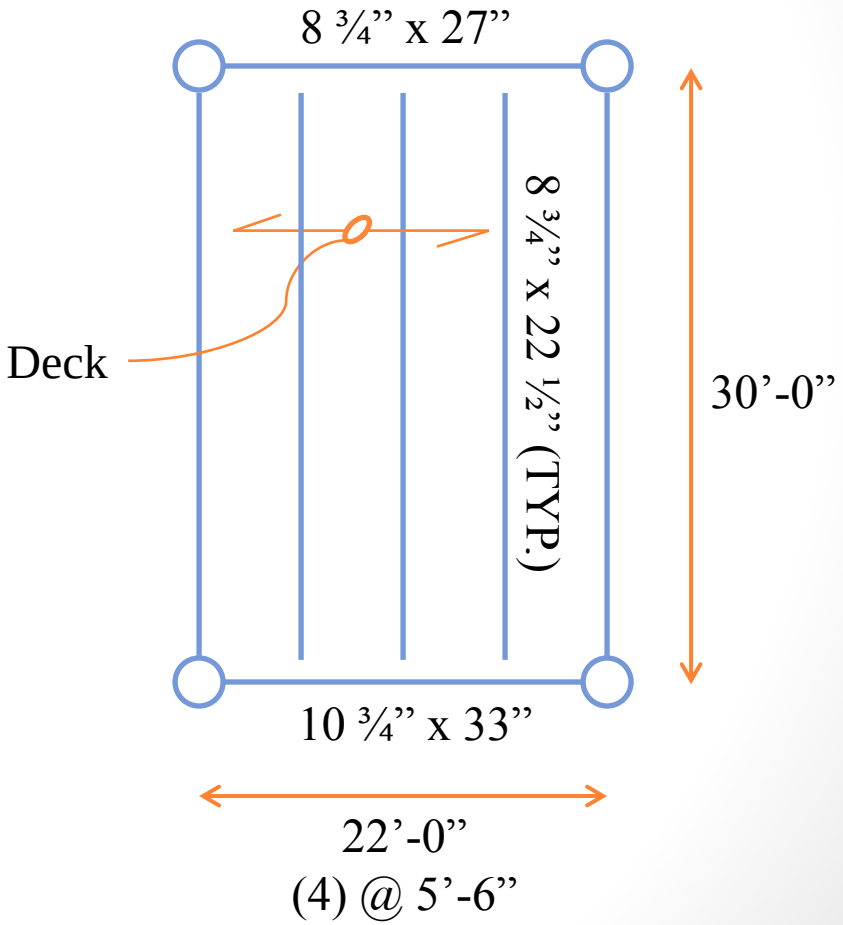
Alt. #1 - Glulam

Design

- (5) 8 ¾” x 22 ½” 24F-V4
  - @ 5’-6” spacing
- (1) 10 ¾” x 33” 24F-V4
- (1) 8 ¾” x 27” 24F-V4

Durability

- Common material for construction, currently in use Heifer International’s Visitor Center



ALT. #1 - GLULAM

SYSTEM DEPTH

37” > 21.2”

GLULAM EXISTING

SYSTEM FIRE RATING

1 HR

Char of 1.5” / HR

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.

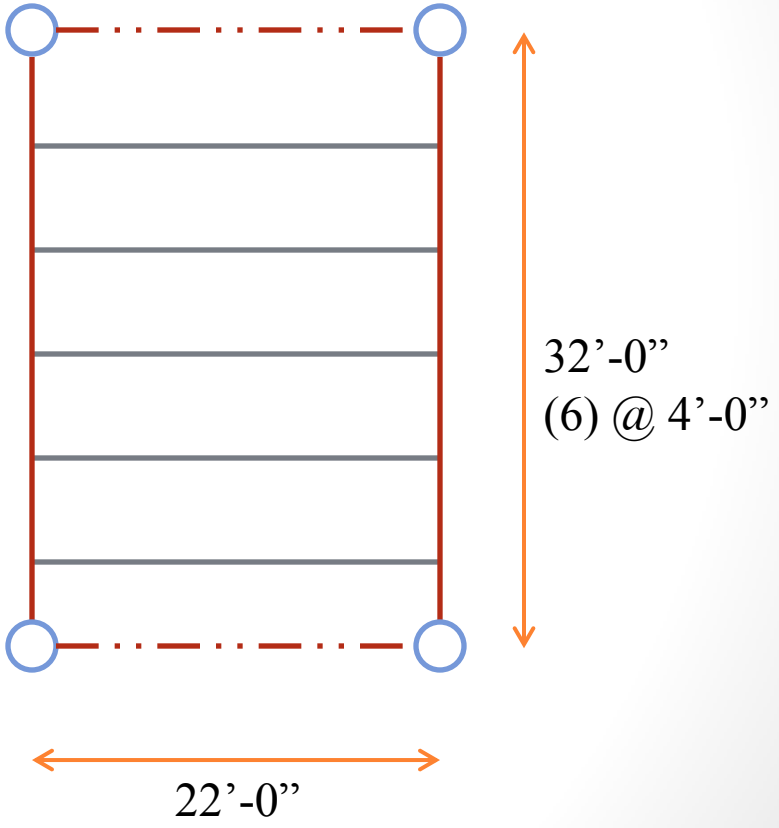
Alt. #2 – Hollow Core Planks

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

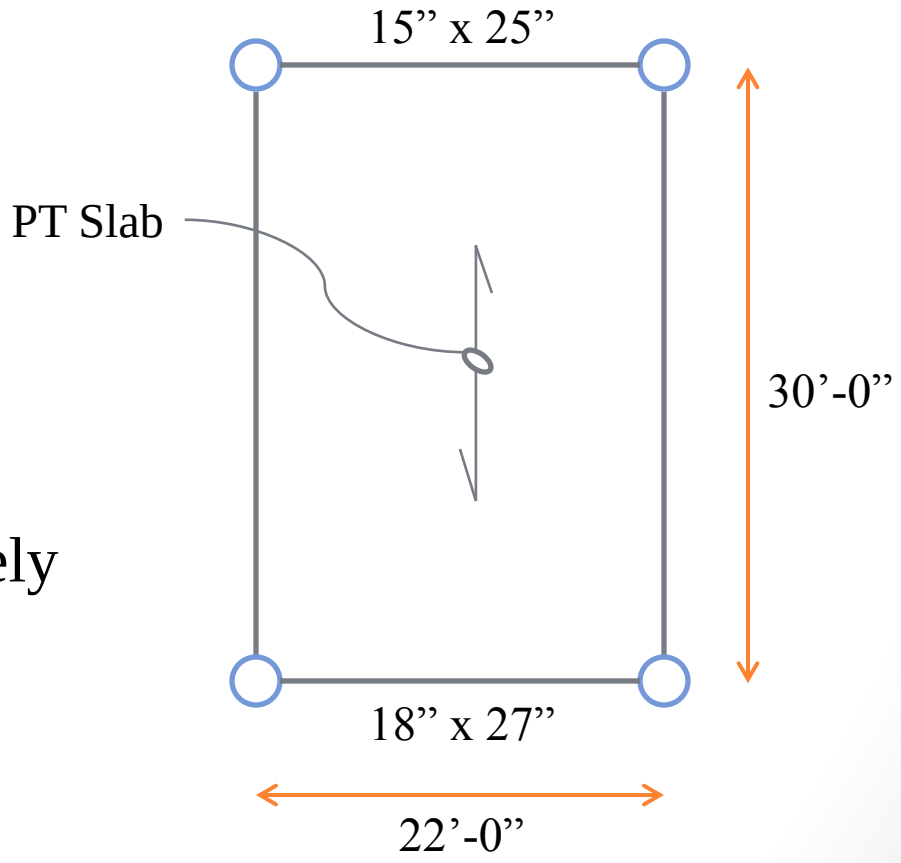
Alt. #3 – Post Tension Slab

Design

- 8” Slab Concrete Slab
  - 270kips @ 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

Structural Considerations & Future Investigation

Considerations		Graivty Systems			
		Composite Deck and Beam	**Glulam**	**Prefabricated Hollow Plank**	**Post Tension Slab**
Alterations	Gravity System	Composite deck and composite beams	Engineered glulam beams and girders, supporting 4" T&G floor decking	Prefabricated 4' hollow core planks supported by steel beams	Post tensioned 8" slab, supported by interior and exterior concrete girders
	Lateral System	Steel plate shear wall (SPSW)	SPSW or Prefabricated Wood Shear Wall	Concrete or masonry shear walls, SPSW not viable	Moment Frame or Concrete Shear Wall
	Impact	-	Minor adjustments	Minor adjustments to bay sizes	Increased weight will impact existing foundation system
Potential Future Investigation					
		-	Yes, Hybrid Steel and Wood System	No, semicircular building not viable in prefabricated rectangular sections	Yes, research viability on semi-circular building



ARCHITECTURAL CONSIDERATIONS

Considerations		Graivty Systems			
		Composite Deck and Beam	**Glulam**	**Prefabricated Hollow Plank**	**Post Tension Slab**
	Size of Bay	22' x 30'	22' x 30'	22' x 32'	22' x 30'
	Fire Protection	None*	None	None	None
	Fire Rating	1 HR	1 HR @ Char of 1.5" / HR	1 HR	2 HR ACHIEVED
	MEP Coordination	Underfloor Air Distribution (UFAD) System	No concealed spaces allowed, UFAD not possible	No impact	No impact
	Impact	Framing members not protected from fire	Decrease in floor to floor height	Decrease in floor to floor height	Decrease in floor to floor height

System Statistics

Considerations		Graivty Systems			
		Composite Deck and Beam	**Glulam**	**Prefabricated Hollow Plank**	**Post Tension Slab**
	System Weight	57 psf	18 psf	57 psf	132 psf
	Slab Depth	5.5"	4"	8"	8"
	System Depth	21.2"	37"	32.7"	35"
	Constructability	Easy	Easy	Easy	Challenge
	Durability	Acceptable	Acceptable	Acceptable	Acceptable
	Cost	$17.93 / SF	$20.43 / SF	$11.04 / SF	$18.92 / SF

THANK YOU