PACIFIC HOUSING SYSTEMS, INC

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Building on Expansive or Hydro Collapsible Soils? Hillsides or Areas with High Water Tables?

PHS has three foundation systems that will provide significant savings in materials, building cycle time, and future warranty costs.

Elevated SLAB

A raised post-tension slab foundation system especially for use in areas of critical and highly-critical expansive and hydro collapsible soils. Components include the **Winslow Geo Anchor** and **Lateral Resistance Device** products together with a 5" slab monolithically poured over a void form...

LEARN MORE ▶

Raised FLOOR

Built by a local timber provider, this system offers builders developing on areas of critical and highly-critical expansive soils, hillsides and areas with high water tables, a cost effective solution. Crawl spaces provide venting, eliminating mold. The **Raised Wood Floor System** has been successfully utilized by PHS for the past 13 years...

LEARN MORE ▶

Waffle MAT

The **Wafflemat**™ is the most innovative (and, with over 6.5 million sq. ft. of residential living space poured since 1995, the most proven) foundation forming system for low, moderate and highly-expansive soil conditions. It possess the greatest floor stiffness of any system in its class, with sufficient strength to resist differential swelling...

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Wafflemat System | Raised Floor System | Elevated Slab System | Winslow Geo Anchor | Lateral Resist. Device | Smart Floor | Smart Core

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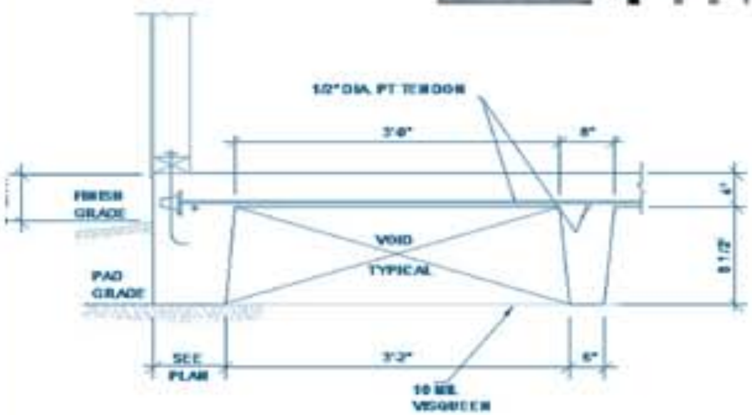
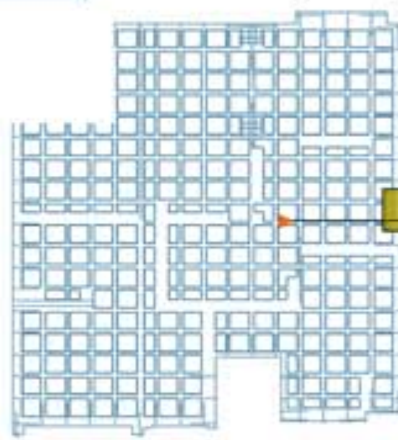
WAFFLEMAT SYSTEM



"The Wafflemat System is easily implemented in both rebar and post tension applications. It presents the best of both worlds to developers faced with the need to deliver maximum productivity with the highest possible reliability at the lowest cost."

Matt Gonsalves | **CHAIRMAN**
Conco Companies



WHERE SYSTEM FITS

Low, Moderate, and Highly-Critical Expansive and or Rocky Soil

BACKGROUND

The **Wafflemat** is the most innovative – and, with over 6.5 million sq. ft. of residential living space poured since 1995 without one structural callback, the most proven – foundation forming system for low, moderate and highly-critical expansive soil conditions. It posses the greatest floor stiffness of any system, and is easily the most economical system in its class, with sufficient strength to resist differential swelling resulting from landscaping practices, surface drainage or flooding from any source. The **Wafflemat** does not require presoaking underlying soil pads, and there is no need for footings – meaning no earth spoils. And, since the **Wafflemat** slab is typically 12" above grade, it requires no gravel, sand or moisture barrier.

The **Wafflemat** comes in either 8½" or 12" high, 19 x 19" thermal-grade heat resistant waffle boxes. It holds a 5" – 6" monolithically-poured post tension or rebar re-enforced concrete slab (again, no footings are required). The **Wafflemat** sits on the ground like a raft, the waffle boxes allowing for expansive soil movement.

The **Wafflemat** is created by connecting the boxes, and evenly spacing them throughout the footprint area. The monolithic pour creates concrete beams running through the footprint and perimeter. The system can be installed easily by a local concrete provider, and offers extensive set-up time savings (typical installation: one day). In addition, the plumbing is brought up through the waffle boxes, and can be re-enforced with rebar.

The system reduces building cycle time, and provides an overall cost savings while greatly mitigating future warranty and litigation issues.

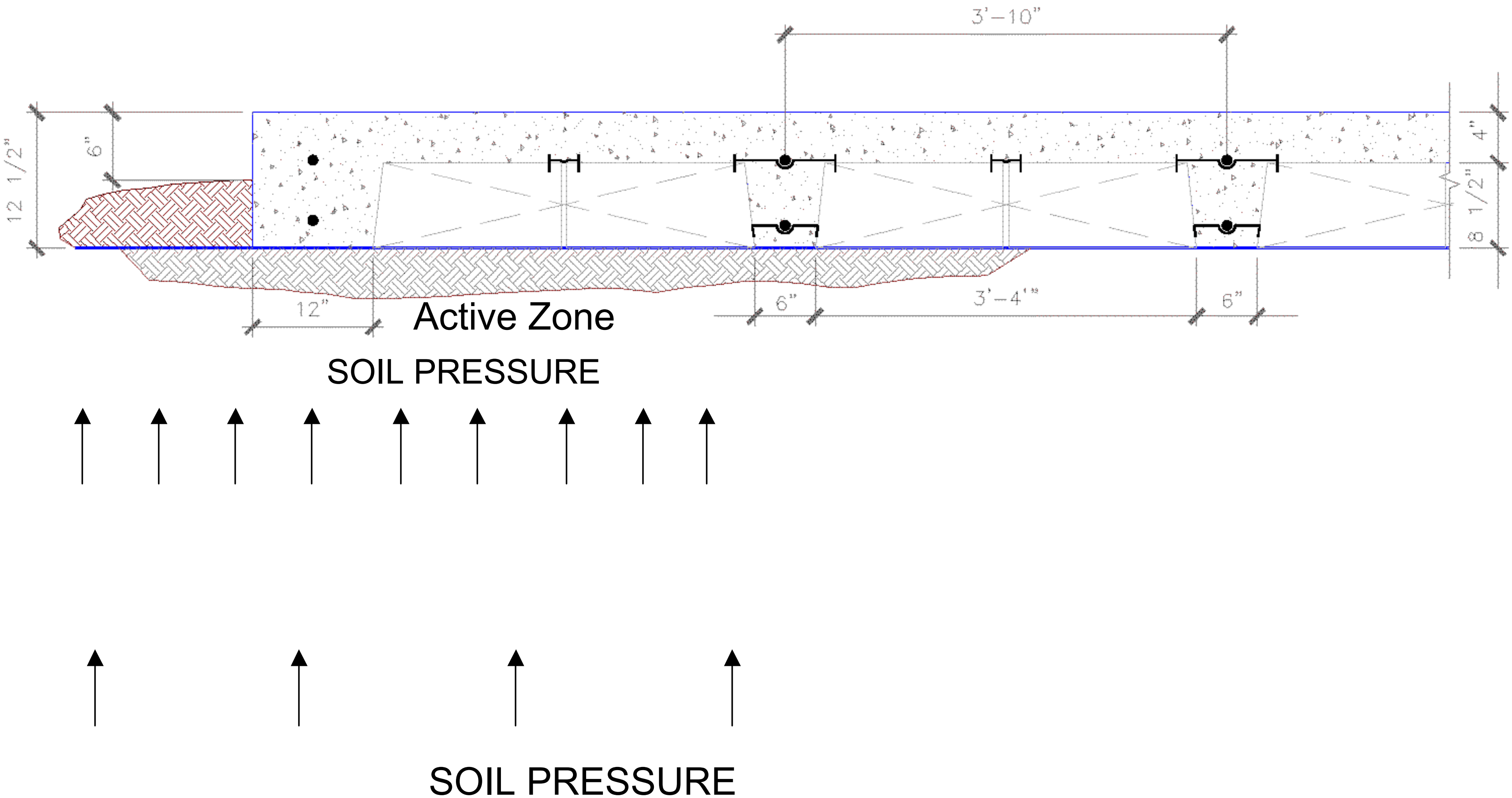
1,200 Homes
-Successfully Built on Wafflemat System

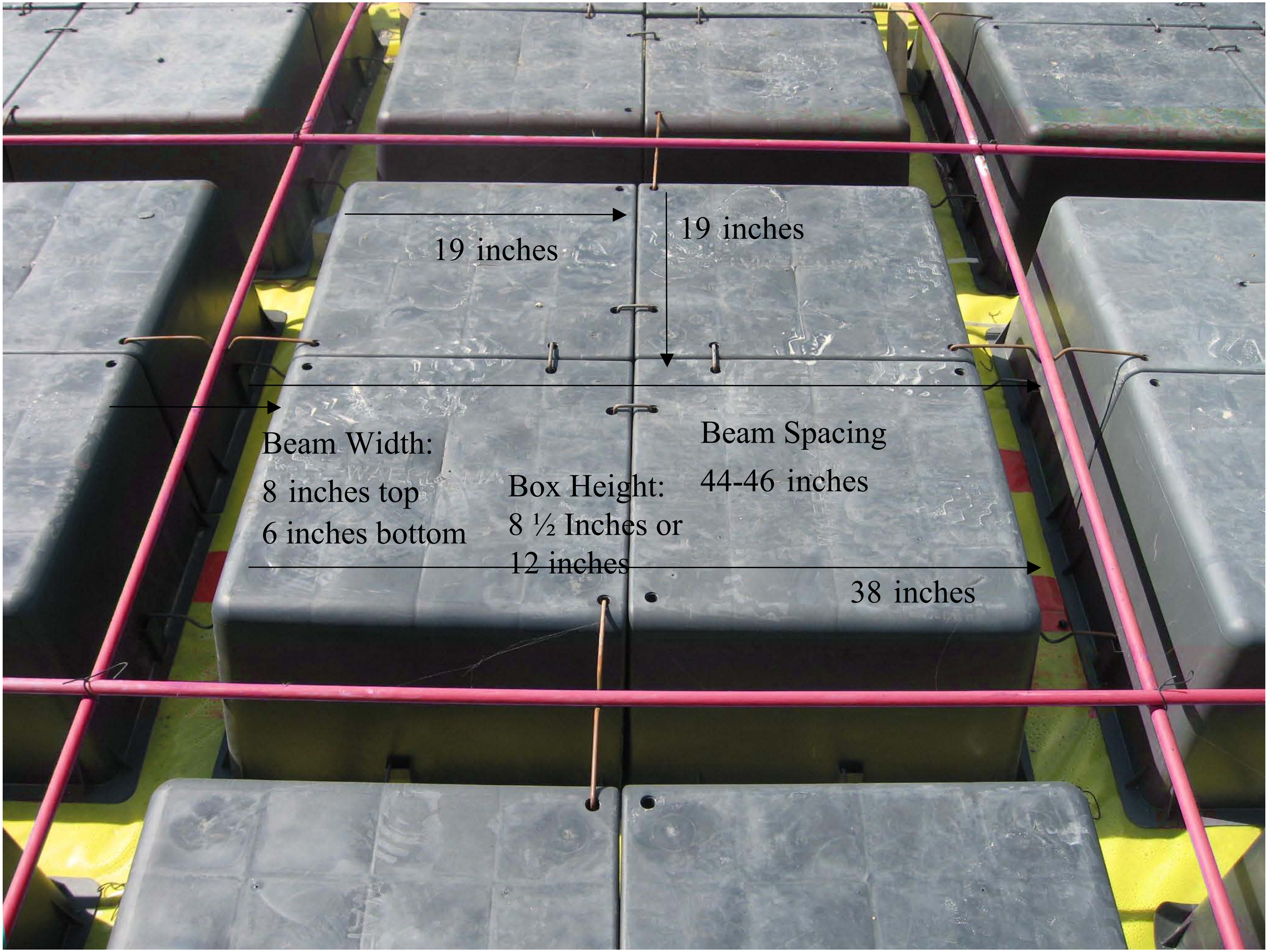
Richland Development has constructed 1200 homes over the last ten years in Northern California with the presence of expansive soil conditions. "We piloted the **Wafflemat System** back in August 1995 and have used it exclusively on our homes since late 1995. We believe the performance has exceeded our expectations, and wholeheartedly recommend the use of the **Wafflemat System** for any area with expansive soils," said **Steven Johnson, president Richland Development Corporation.**

6.5 Million Sq. Ft. Living Space
- Successfully Poured on Wafflemat System

The **Wafflemat System** is one of the most innovative and proven foundation forming systems for residential construction in expansive soils. It possesses the greatest stiffness of any system, and has been proven over the past ten years without one structural callback. "We have implemented the system in both rebar and post tension applications, and now have over 6.5 million square feet of **Wafflemat** slabs poured in numerous cities and counties in California for residential production homebuilders like Shea Homes, Delco Builders and Mission Peak Company," stated, **Matt Gonsalves, Chairman and founder, the CONCO Companies.**

Wafflemat View




19 inches
19 inches
Beam Width:
8 inches top
6 inches bottom
Box Height:
8 ½ Inches or
12 inches
Beam Spacing
44-46 inches
38 inches

Rich Treanor | Director of Planning + Production
Pacific Housing Systems
rich@pacifichousingsystems.com

MATERIAL + PROPERTIES

What type of material is used to make the WAFFLEBOX?

WAFFLEBOXES are made from 100% recycled reprocessed polypropylene (plastic), a "Green" product.

Why are the WAFFLEBOXES constructed of Polypropylene?

Polypropylene is a light weight and strong material, and it maintains its strength over a wide temperature range. The WAFFLEBOXES are strong enough to support the weight of the concrete workers during installation and the pouring process.

The Polypropylene material used is tough and impact resistant, ensuring that the WAFFLEBOXES will hold up well in the construction environment. It is a highly stable and chemically nonreactive resin that, when covered with concrete, will last decades before any degradation. It is impervious to water and water vapor, providing an effective moisture barrier.

Has the polypropylene gone through chlorine testing?

Polypropylene is inherently inert to chlorine and chlorides.

INDUSTRY CERTIFICATIONS

Why doesn't the plastic or the WAFFLEBOX have a UL listing?

UL listing in this case would refer to the fire resistance of the product. Again, since the WAFFLEMAT is a concrete form system and buried under several inches of concrete slab, the application does not warrant a UL listing.

Is there an NSF report for the plastic or the WAFFLEBOXES?

Since National Sanitation Foundation testing and certification is applicable to products that come in contact with potable water or food, a NSF would have no relevance to the WAFFLEBOXES.

STORAGE AND WAREHOUSING

What are the dimensions of a WAFFLEBOX?

19.25" x 19.25" by 8.5" high. The wall thickness of the boxes is .070"

What pertinent information can you give regarding storing/warehousing the WAFFLEBOXES?

Boxes per Pallet	104
Dimensions of Loaded Pallet	42"x42" pallet, about 80" high
Weight:	
Pallet [only]:	46 lbs.
Boxes [only]:	327 lbs.
Total:	373 lbs.


10 B

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[WHITE PAPER]

Lowering the Carbon Footprint When Using the Wafflemat™ System for Concrete Slab Foundations

A Climate Change Gas Emissions Analysis on the Production, Transportation, and Use of Concrete in Slab Foundations

Sam L. Altshuler | **State of California** P.E., M.E.,
+ Board Certified Environmental Engineer

February 2007

Use of the WAFFLEMAT System in residential home construction can reduce the level of climate change emissions by 20% [the equivalent of 4 to 9 tons less CO_2 released into the atmosphere per home] when compared to the use of conventional slab foundations. Other emissions reductions are also projected.

EXECUTIVE SUMMARY

Carbon dioxide (CO_2) is the main anthropogenic gas contributing to the buildup of greenhouse gases in the earth's atmosphere. Emissions of CO_2 from a specific project are collectively referred to as the "carbon footprint." CO_2 emissions result from use of fossil-derived energy during the production and transport of materials.

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[WHITE PAPER]

WAFFLEMAT™ SLABS PROVIDE SUPERIOR PERFORMANCE

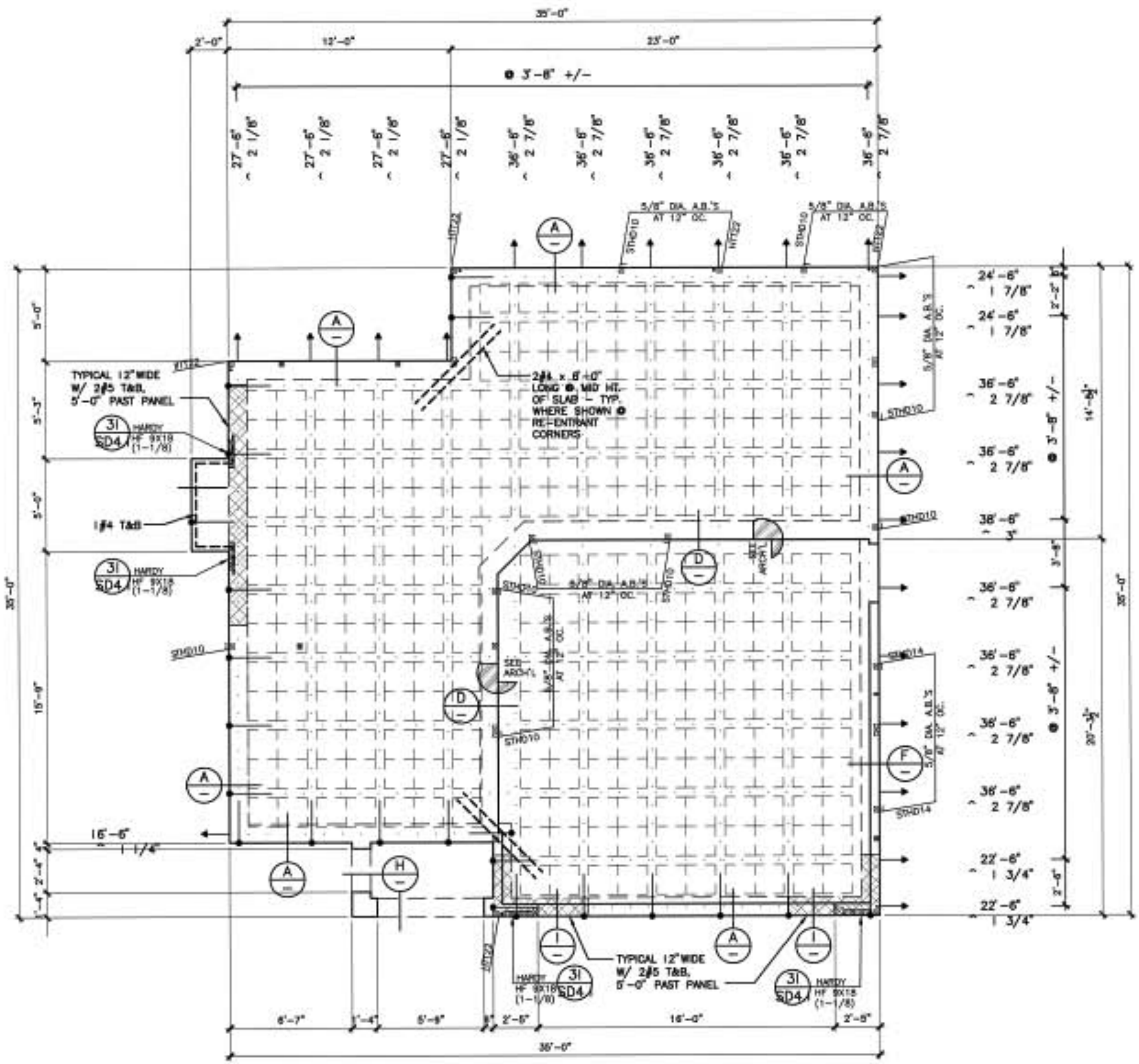
John Cook | **S.E.**
Principal, **MKM & Associates Structural Engineering**

April 2008

EXECUTIVE SUMMARY

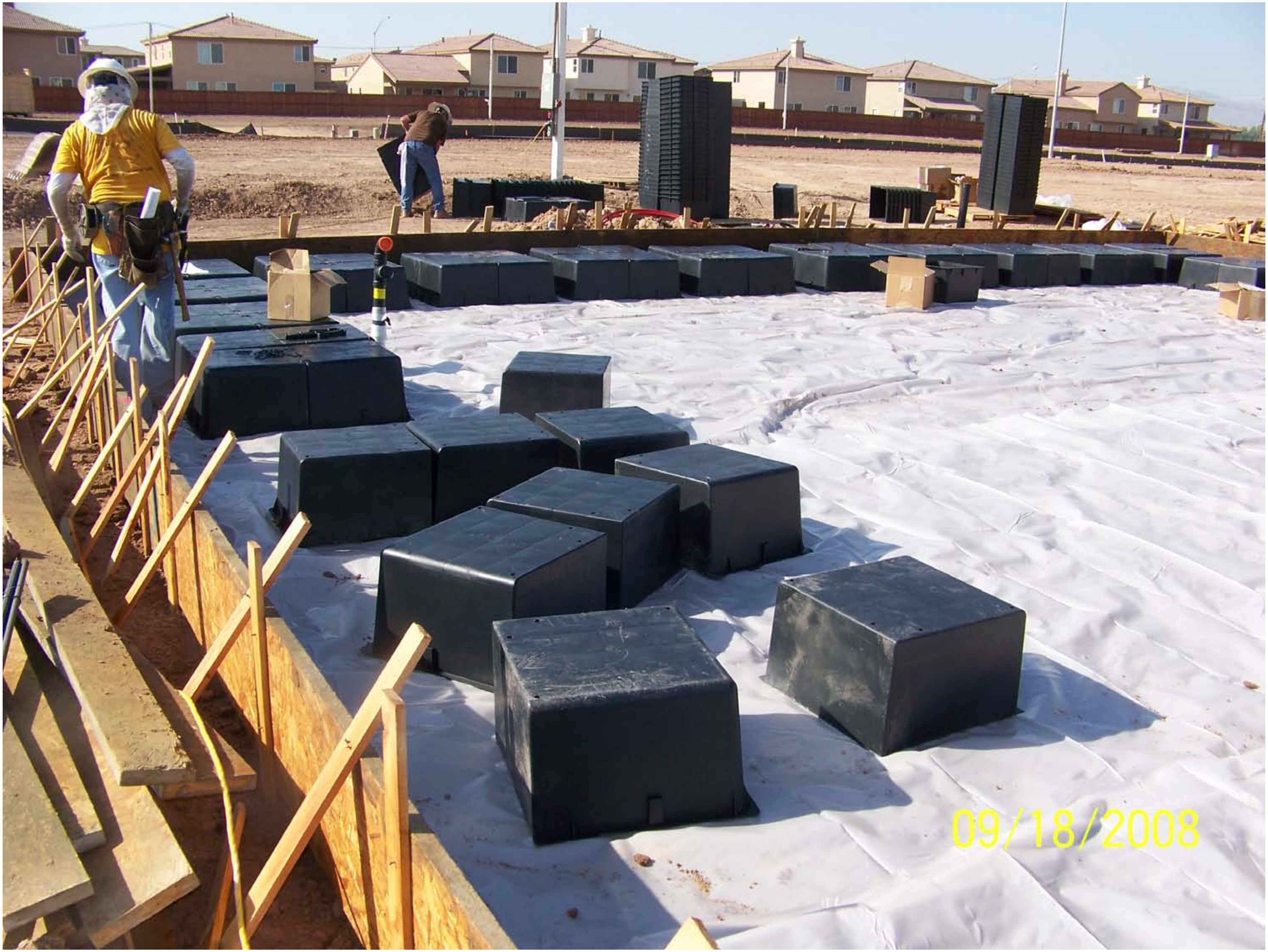
This paper provides a discussion and summary of the performance of Wafflemat™ (US Patent 5,540,524) slabs on grade. The discussion contained herein is based upon studies performed by the geotechnical firm of Purcell Rhoades & Associates (ref. 1), as well as observations of the performance of installed Wafflemat foundations (Appendices A-D) over a 15-year period.

Post-tensioned, slab-on-grade construction and mild reinforced mats have been used for decades to provide adequate support for residential and light commercial construction. The original, post-tensioned slabs were constructed by trenching to form in-ground beams (or "ribs") to provide stiffness when combined with a relatively thin slab. Subsequently, uniform thickness post-tensioned slabs (or, "UTF's" for "Uniform Thickness Foundation") were utilized with or without perimeter in-ground beams. The uniform thickness slabs are much thicker than slabs of the in-ground beam system, and have gained some prominence in certain parts of the world.



35'-0"
2'-0"
12'-0"
23'-0"
@ 3'-8" +/-
TYPICAL 12" WIDE W/ 2#5 T&B, 5'-0" PAST PANEL
2#4 x 8'-0" LONG @ MID HT. OF SLAB - TYP. WHERE SHOWN @ RE-ENTRANT CORNERS
5/8" DIA. A.B.'S AT 12" OC.
HARDY HF 9X18 (1-1/8)
1#4 T&B
STHD10
STHD14
HTT22
SEE ARCH'L
16'-6"
6'-7"
1'-4"
5'-9"
2'-5"
14'-0"
2'-5"
35'-0"

Multi-Family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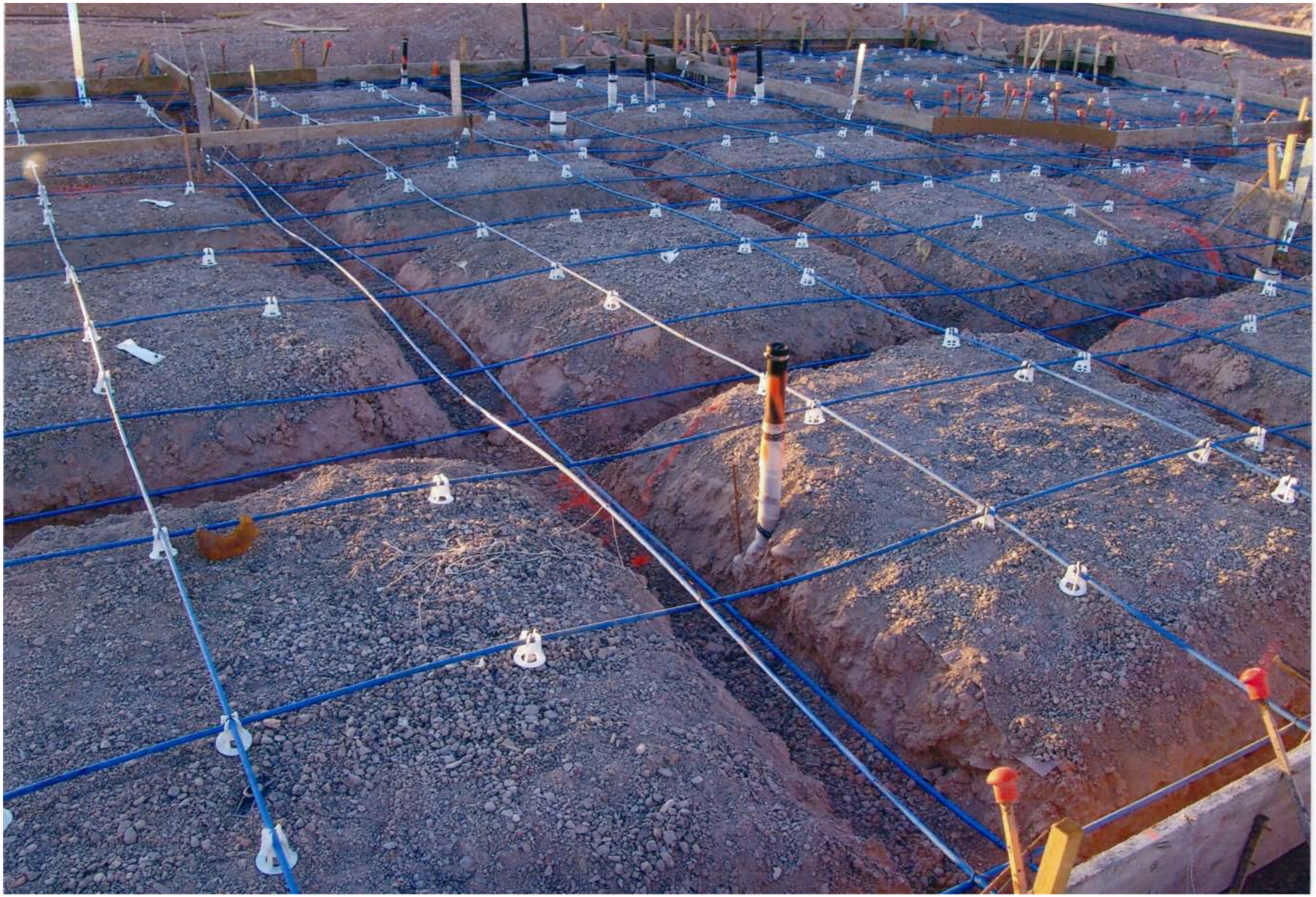
Typical Ribbed Foundation Layout

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CONQUEST

Design Calculations - Ribbed Slab

Minimum 6" beam width – PTI Standard 3rd Edition

Minimum 6' beam spacing – PTI Standard 3rd Edition

Strand spacing is set – 3 feet 8 inches

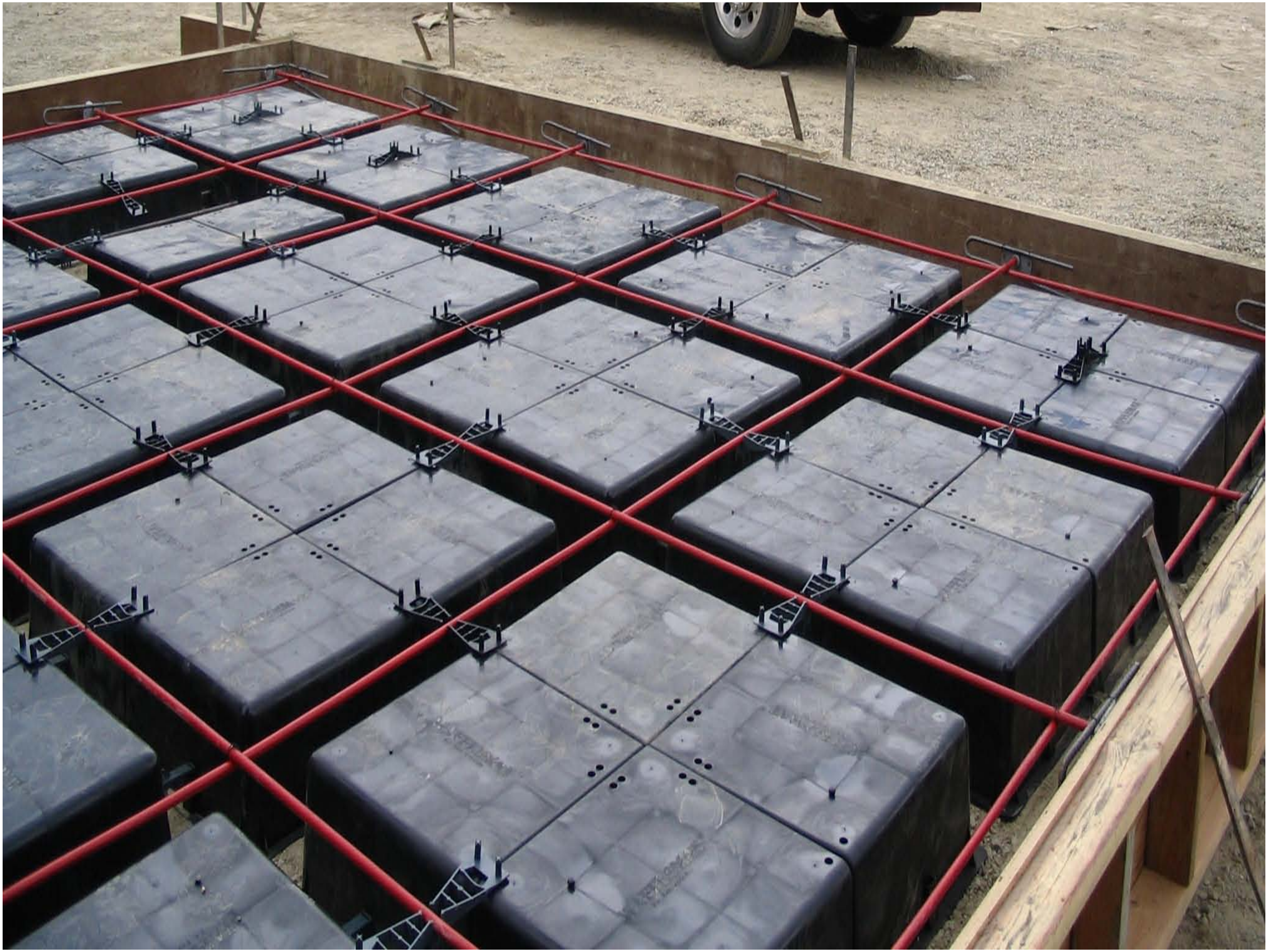
Can double either slab or beam tendons

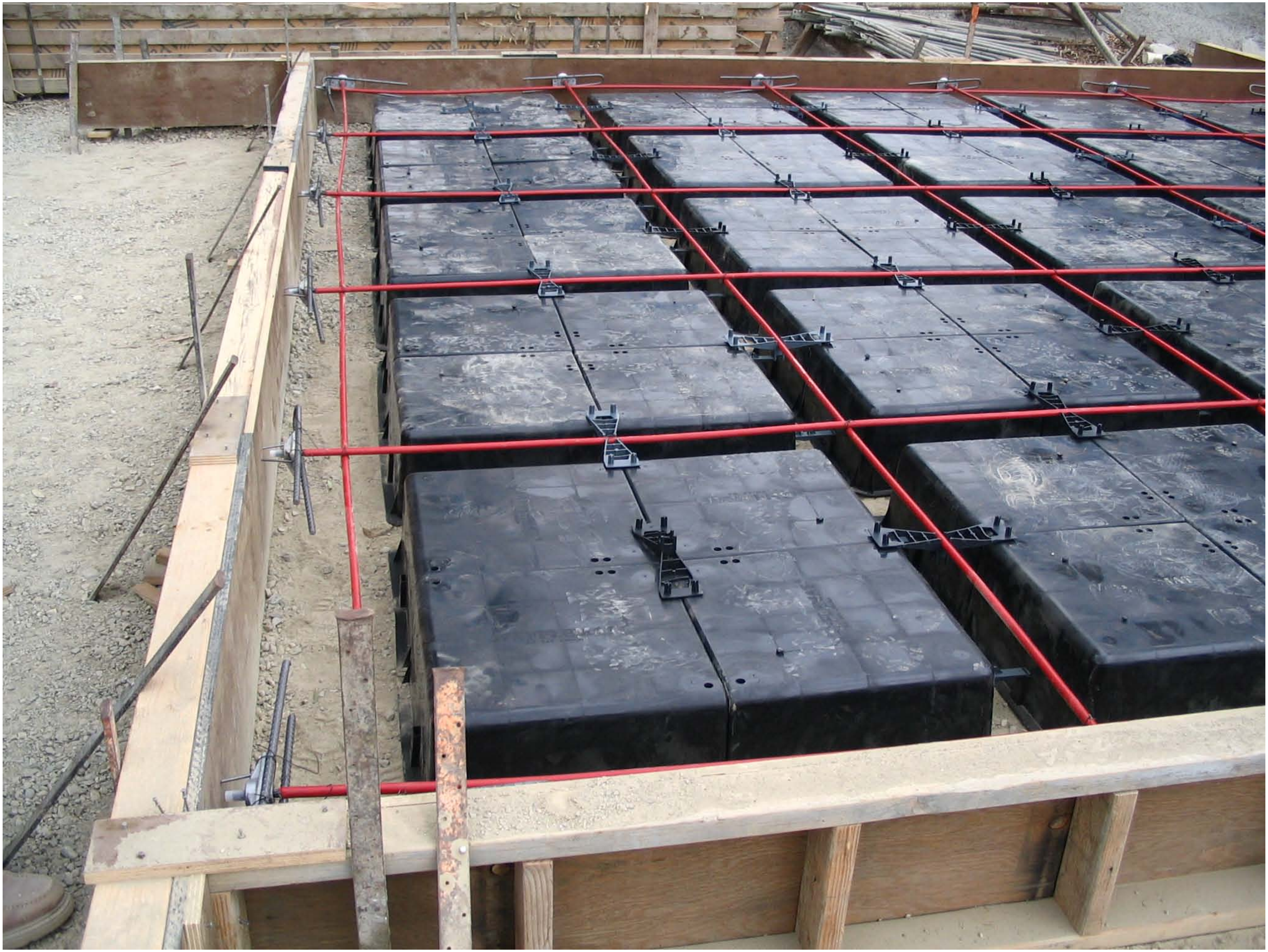
Can vary height of slab tendons

Can add tendons over top of boxes

Vary slab depth

Vary beam depth 12 ½ or 16"





4.3 – Ribbed Foundations – Calculations for ribbed foundations shall be based upon criteria specified in **4.3.1** through **4.3.5**. Geometry resulting in larger gross section properties may be used for actual construction.

4.3.1 – Minimum Slab Thickness – Minimum slab thickness t shall be 4 in.

4.3.2 – Ribs

4.3.2.1 – Minimum Size

(a) **Depth** – Minimum rib depth h shall be the larger of (t +7) in. or 11 in. When more than one rib depth is used in actual construction, ratio between the deepest and the shallowest rib depths shall not exceed 1.2.

(b) **Width** – Rib width b used in section property calculations shall be the actual rib width, subject to a minimum of 6 in. and a maximum of 14 in. Rib widths may vary within the specified ranges.

4.3.2.2 – Spacing - S used in moment and shear equations shall be the average rib spacing if the ratio between the largest and the smallest spacing does not exceed 1.5. If the ratio between the largest and the smallest spacing exceeds 1.5, S used in moment and shear equations shall be 0.85 times the largest spacing. S used in the moment and shear equations shall not be less than 6 ft or greater than 15 ft. The rib spacing used in the section properties shall be the actual rib spacing but not greater than 15 ft.

Standard Requirements for Design of Shallow Post-Tensioned Concrete Foundations on Expansive Soils

May 2008

POST-TENSIONING INSTITUTE ®
8601 N. Black Canyon Highway
Suite 103
Phoenix, Arizona 85021

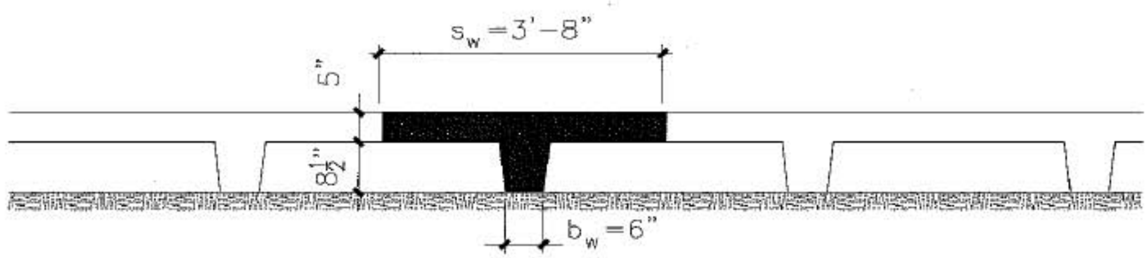
Telephone: (602) 870-7540
Fax: (602) 870-7541
Website: www.post-tensioning.org

S-137

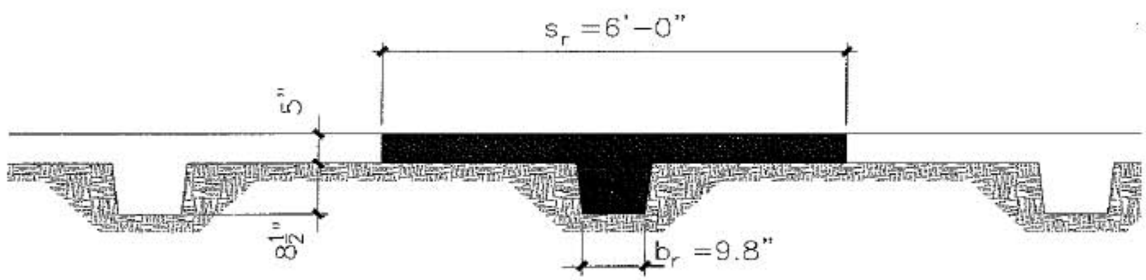
Verify that a ribbed foundation slab constructed using Wafflemat forms is stiffer than an in-ground ribbed foundation slab that strictly conforms to PTI 3.1 recommendations by comparing average Moment of Inertia values for each slab:

1) Ribbed slab created with Wafflemat forms
   5" slab, 3'-8" on center rib spacing, 8.5" deep ribs with tapered sides and 6" bottoms
2) In-ground Ribbed slab
   5" slab, 6'-0" on center rib spacing, 8.5" deep ribs with tapered sides and 9.8" bottoms
   Note: the 9.8" width was selected from the following ratio, to provide equivalent rib width between the two systems:

$$\frac{b_w}{b_r} = \frac{s_w}{s_r} \Rightarrow b_r = b_w \frac{s_r}{s_w} = (6")\frac{6.0'}{3.67'} = 9.8"$$



Wafflemat Slab



In-ground Ribbed Slab

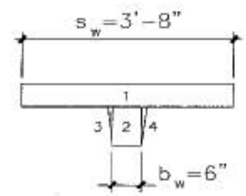
MKM & Associates structural engineering	**Wafflemat Foundations** Moment of Inertia Comparison (Wafflemat vs. In-ground Ribbed Slab)	Job 060052 Date 2/16/11 PE ELH 2 of 2

Wafflemat

5" slab, 3'-8" on center rib spacing, 8.5" deep ribs with tapered sides, 6" bottoms

Section	b_x	h_x	A	y	Ay	Ay^2	I_o	Geometric Shape
1	44.0	5.0	220.2	2.5	551	1376	459	slab (rectangle)
2	6.0	8.5	51	9.25	472	4364	307	rib (rectangle)
3	1.0	8.5	4.25	7.8	33	261	17	sloped rib wall (triangle)
4	1.0	8.5	4.25	7.8	33	261	17	sloped rib wall (triangle)
Σ =		30.5	279.7		1088.8	6261.5	799.9	

$y_t = \Sigma A_y/\Sigma A$ =	3.89	in
$y_b = \Sigma h - y_t$ =	26.61	in
$(\Sigma A)(y_t^2)$ =	4239	in^3
$I_{wafflemat} = (\Sigma Ay^2+\Sigma I_o)-(\Sigma A)(y_t^2)$ =	2823	in^4
$I_{w\text{-}avg} = I_w/s_w$ =	769	in^4/ft



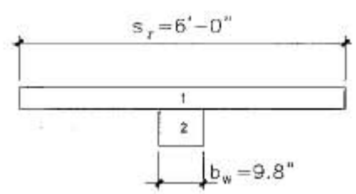
Wafflemat Repetitive Unit

In-ground Ribbed

5" slab, 6'-0" on center rib spacing, 8.5" deep ribs with tapered sides, 9.8" bottoms

Section	b_x	h_x	A	y	Ay	Ay^2	I_o	Geometric Shape
1	72.0	5.0	360	2.5	900	2250	750	slab (rectangle)
2	9.8	8.5	83.4	9.25	771	7134	502	rib (rectangle)
Σ =		13.5	443.4		1671.3	9384.1	1252.0	

$y_t = \Sigma A_y/\Sigma A$ =	3.77	in
$y_b = \Sigma h - y_t$ =	9.73	in
$(\Sigma A)(y_t^2)$ =	6300	in^3
$I_{ribbed} = (\Sigma Ay^2+\Sigma I_o)-(\Sigma A)(y_t^2)$ =	4337	in^4
$I_{r\text{-}avg} = I_r/s_r$ =	723	in^4/ft



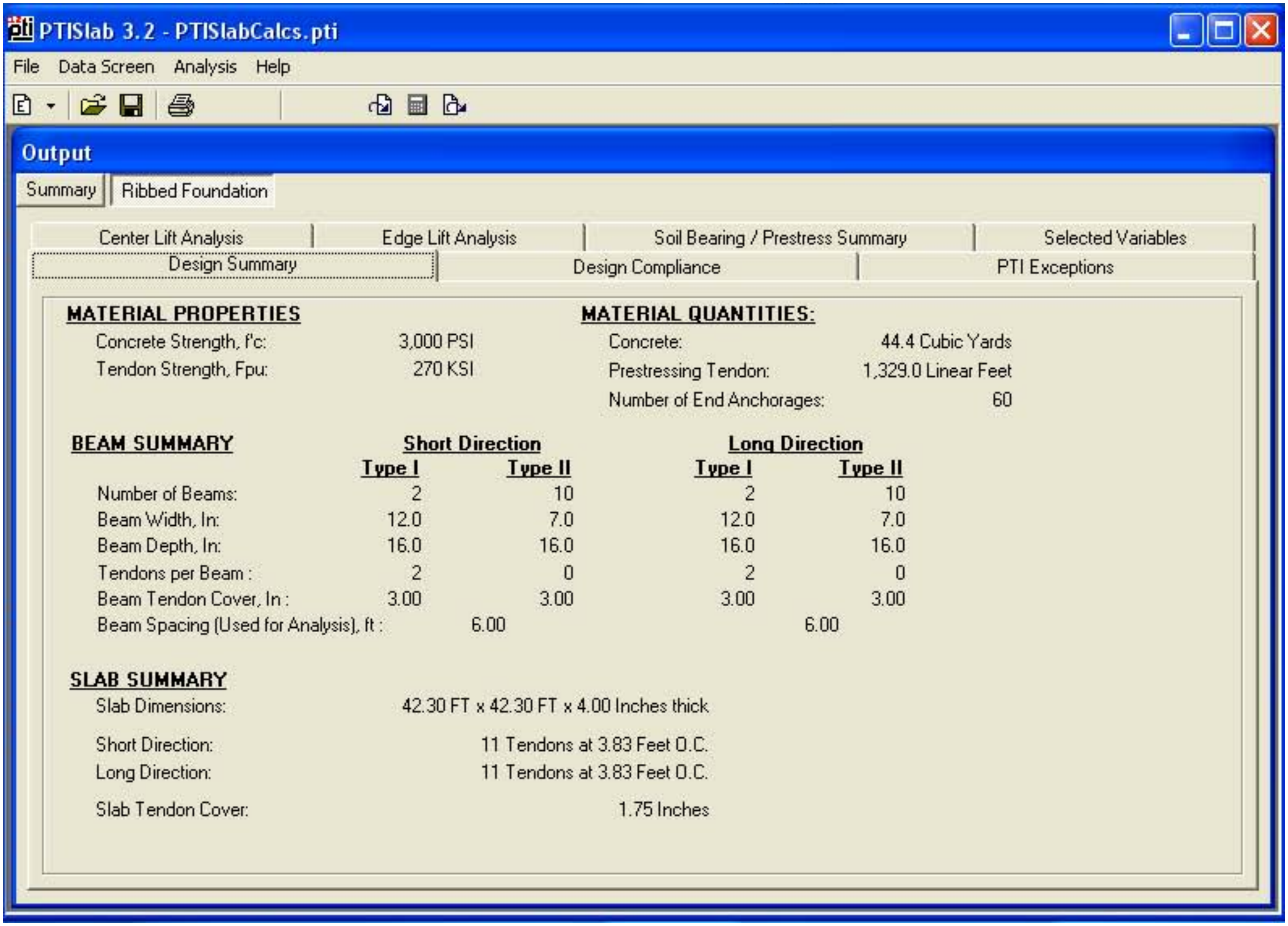
In-ground Ribbed Slab Repetitive Unit

Therefore,

$$I_{wafflemat\text{-}avg} = 769 \ \ in^4/ft \ > I_{ribbed\text{-}avg} = 723 \ \ in^4/ft$$

Design: 1,800 sf rectangle
12 inch boxes
12 X 16 inch exterior beams
4" slab

Soils: 1.7 inch edge lift
2.7 inch center lift


PTISlab 3.2 - PTISlabCalcs.pti

File Data Screen Analysis Help

Output

Summary | Ribbed Foundation

Center Lift Analysis | Edge Lift Analysis | Soil Bearing / Prestress Summary | Selected Variables

Design Summary | Design Compliance | PTI Exceptions

MATERIAL PROPERTIES

Concrete Strength, f'c:	3,000 PSI
Tendon Strength, Fpu:	270 KSI

MATERIAL QUANTITIES:

Concrete:	44.4 Cubic Yards
Prestressing Tendon:	1,329.0 Linear Feet
Number of End Anchorages:	60

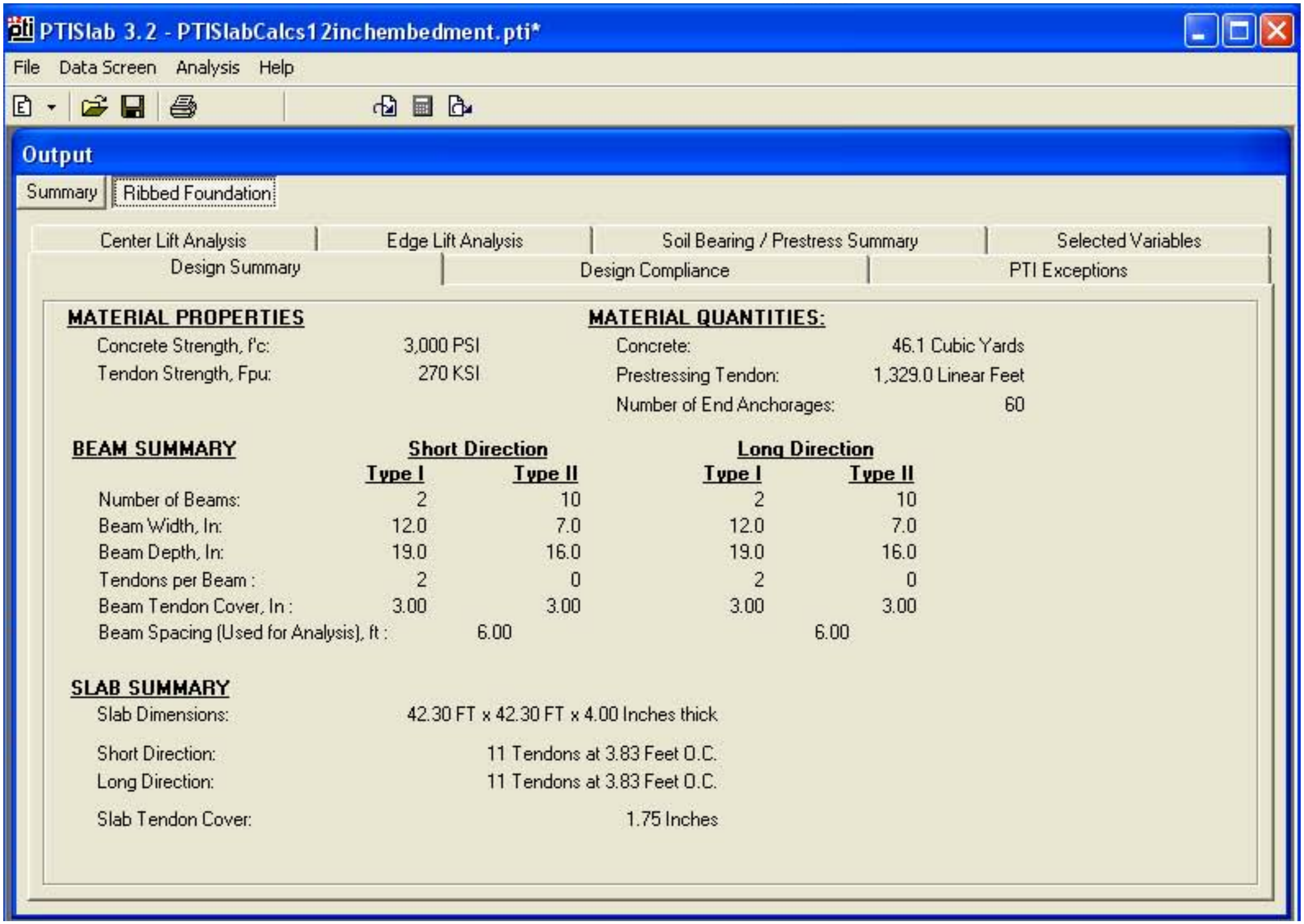
BEAM SUMMARY	Short Direction		Long Direction	
	Type I	Type II	Type I	Type II
Number of Beams:	2	10	2	10
Beam Width, In:	12.0	7.0	12.0	7.0
Beam Depth, In:	16.0	16.0	16.0	16.0
Tendons per Beam :	2	0	2	0
Beam Tendon Cover, In :	3.00	3.00	3.00	3.00
Beam Spacing (Used for Analysis), ft :	6.00		6.00	

SLAB SUMMARY

Slab Dimensions:	42.30 FT x 42.30 FT x 4.00 Inches thick
Short Direction:	11 Tendons at 3.83 Feet O.C.
Long Direction:	11 Tendons at 3.83 Feet O.C.
Slab Tendon Cover:	1.75 Inches

Design: 1,800 sf rectangle
12 inch boxes
12 X 19 inch exterior beams
20% max beam depth variance
4” slab

Soils: 2.0 inch edge lift



PTISlab 3.2 - PTISlabCalcs12inchembedment.pti*

File Data Screen Analysis Help

Output

Summary | Ribbed Foundation

Center Lift Analysis | Edge Lift Analysis | Soil Bearing / Prestress Summary | Selected Variables
Design Summary | Design Compliance | PTI Exceptions

MATERIAL PROPERTIES

Concrete Strength, f'c:	3,000 PSI
Tendon Strength, Fpu:	270 KSI

MATERIAL QUANTITIES:

Concrete:	46.1 Cubic Yards
Prestressing Tendon:	1,329.0 Linear Feet
Number of End Anchorages:	60

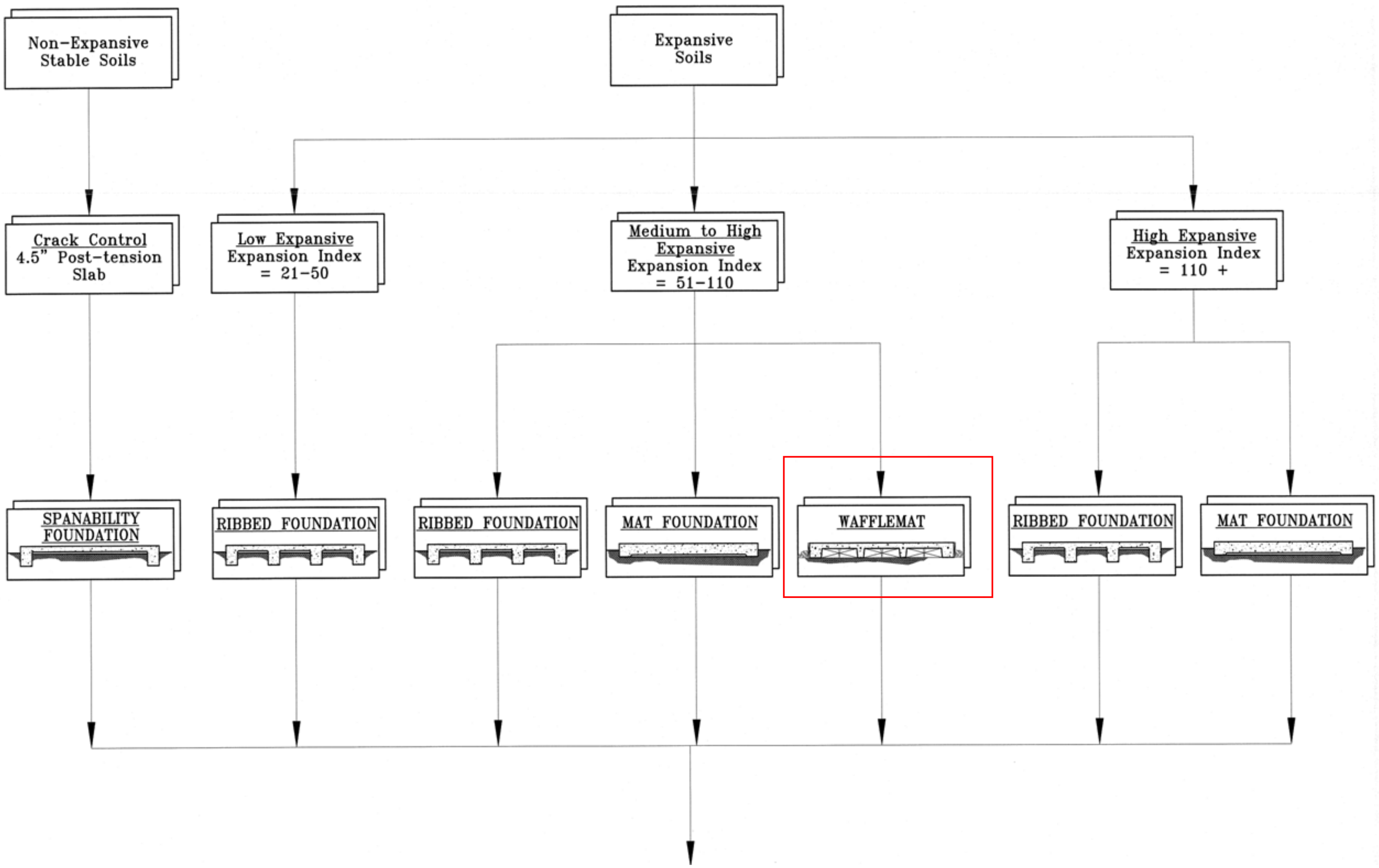
BEAM SUMMARY

	Short Direction		Long Direction	
	Type I	Type II	Type I	Type II
Number of Beams:	2	10	2	10
Beam Width, In:	12.0	7.0	12.0	7.0
Beam Depth, In:	19.0	16.0	19.0	16.0
Tendons per Beam :	2	0	2	0
Beam Tendon Cover, In :	3.00	3.00	3.00	3.00
Beam Spacing (Used for Analysis), ft :	6.00		6.00	

SLAB SUMMARY

Slab Dimensions:	42.30 FT x 42.30 FT x 4.00 Inches thick
Short Direction:	11 Tendons at 3.83 Feet O.C.
Long Direction:	11 Tendons at 3.83 Feet O.C.
Slab Tendon Cover:	1.75 Inches

Product Decision Tree



PTI Calculation Limitations

Beam Spacing: 6 ft minimum

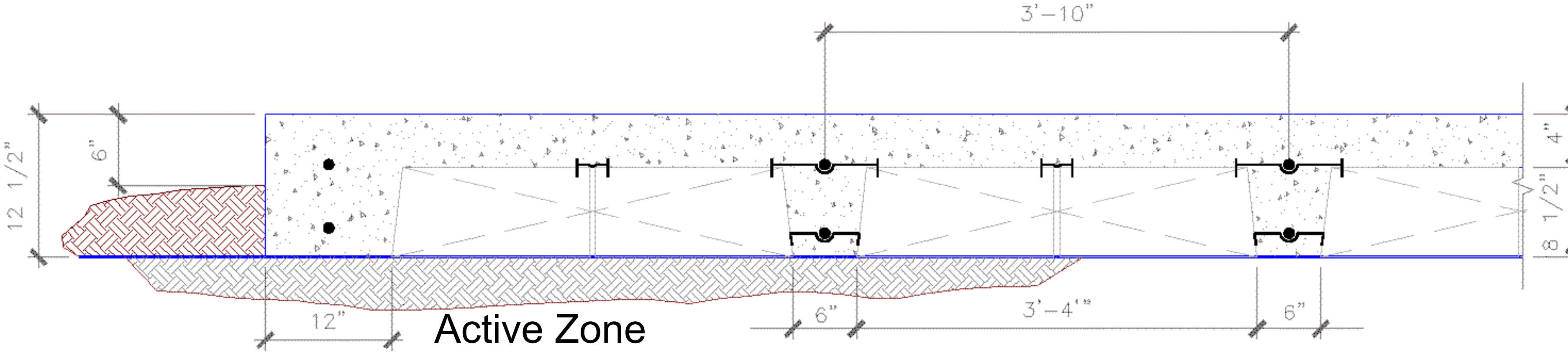
Beam Depth Limitation: 20% maximum variation

No reduction in swell pressure as a result of void boxes

ANY TRANSLATION TO REDUCTION IN Y_m ?

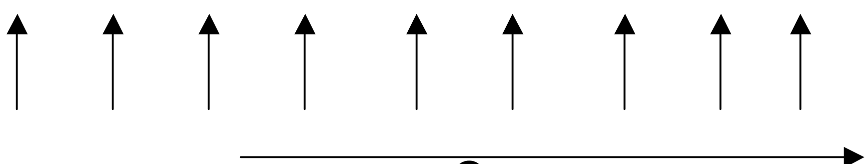
ANY REDUCTION IN SOIL PRESSURE ON BOTTOM OF SLAB
IN “ACTIVE AREA” ?

ANY REDUCTION OF UPLIFT IN EDGE LIFT (SWELL) CONDITION ?



Active Zone

SOIL PRESSURE



e_m (4.33 ft) 75% reduction in surface area in “active” zone

SOIL PRESSURE

Construction Improvements

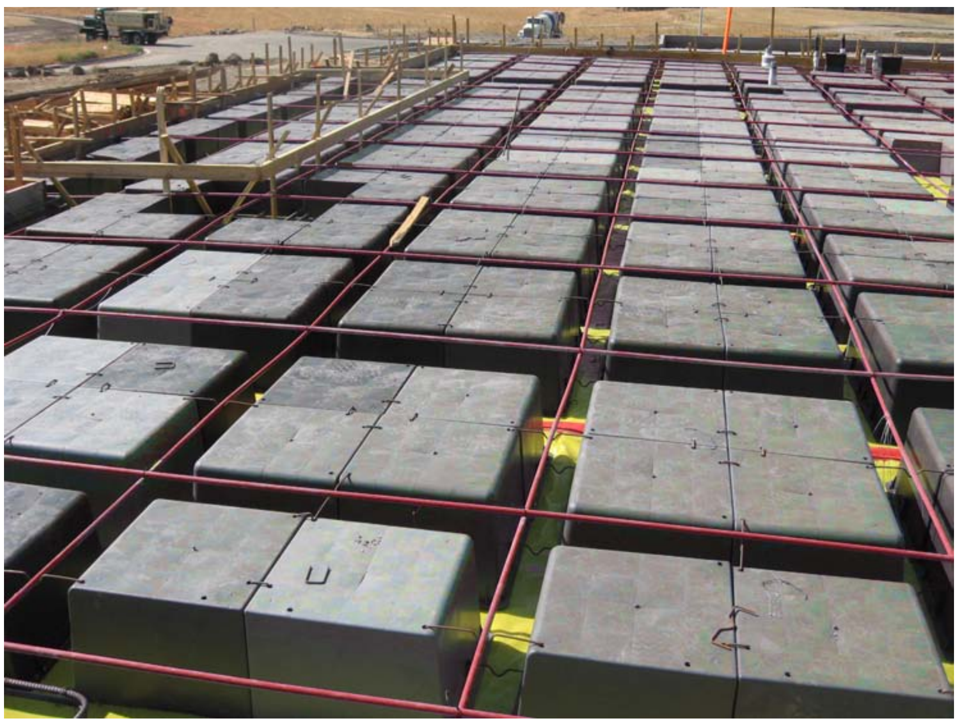
Better Control of Tendon Placement

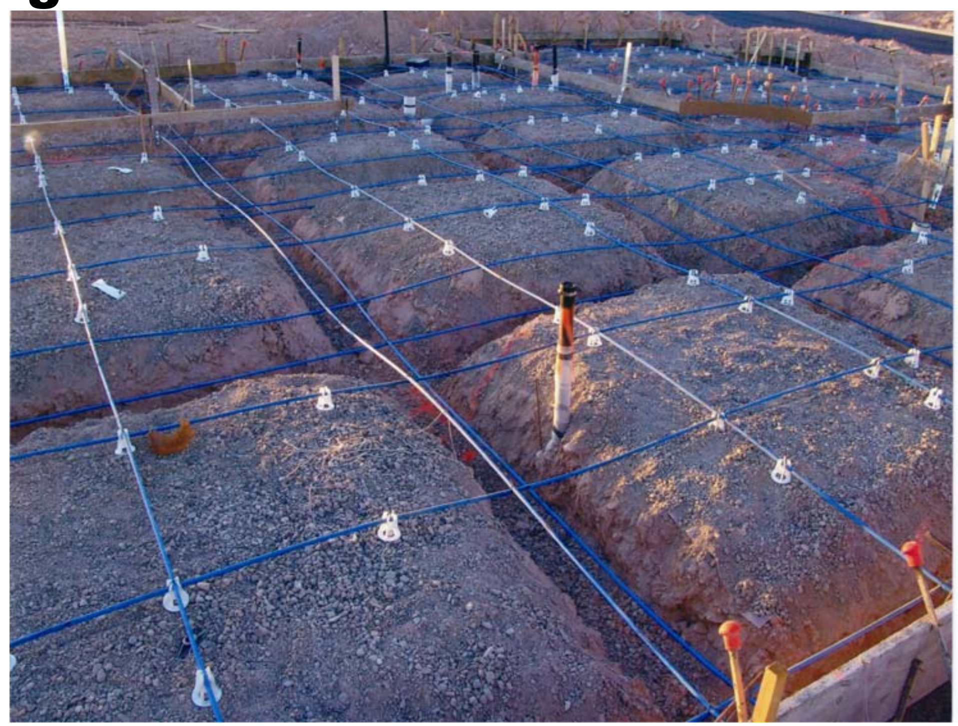
- **No Tendon Chairs**
- **Improved Reinforcing Placement**
- **Fewer Layout Mistakes**
- **Ease of Inspection**

Minimal Variance in Concrete Usage

- **Perfectly Shaped Beams**

Better Control of Drainage - Backfill After Pour





Advantages of Wafflemat Above-Ground Forming System

Minimal Trenching

Minimal Beam Cleanout

No Beam Water Pumping

Minimal Concrete Variance

Reduced Concrete Usage

Reduced Building Cycle Time

Reduced Weather Delays

Improved Vapor Barrier

Improved Control of Reinforcing & Placing

No Tendon Chairs

No Tendons to Walk On

Better Control of Tendon Placing

Potential Reduction of Lift / Less Surface Area on Soil

Building Cycle Time Components

- Site Preparation: Reduced Cut & Fill
- Beam Trenching
- Minimum Spoils & Removal
- Sand & Gravel
- Trenching Cleanout
- Pre-Soaking
- Weather Delays

Potential Cost Savings of Wafflemat

	RANGE	
Trenching	**$.30 / sf**	**$.40 / sf**
Beam Cleanout		
Concrete Variance – 15%	**$.40 / sf**	**$.50 / sf**
Site Work & Pad Preparation	**$.20 / sf**	**$.30 / sf**
Rough Grading		
Sand & Gravel		
Building Cycle Time – 2 days	**$.25 / sf**	**$.35 / sf**
Weather Delays	**$.15 / sf**	**$.25 / sf**
Reinforcing / Installation	**$.05 / sf**	**$.05 / sf**
Totals	**$1.35 / sf**	**$1.85 / sf**

Wafflemat Cost Components:

Box Cost
Sales Tax
Transport
Storage, Handling, Delivery
Royalties
Installation

Cost of Wafflemat Box = $7.25 ea. Installed

4.25 Square Ft per Box

Cost of Wafflemat = $1.70 per square ft

"Green" Advantages:

Less concrete waste
Means less emissions
Means lower carbon footprint
Component made from recycled material


STOP
STOP


10


2008.10.01


CONCO PUMPING


36
Recycle Only
08/24/2007


08/24/2007


658


656
658

THE END


APR 6 2004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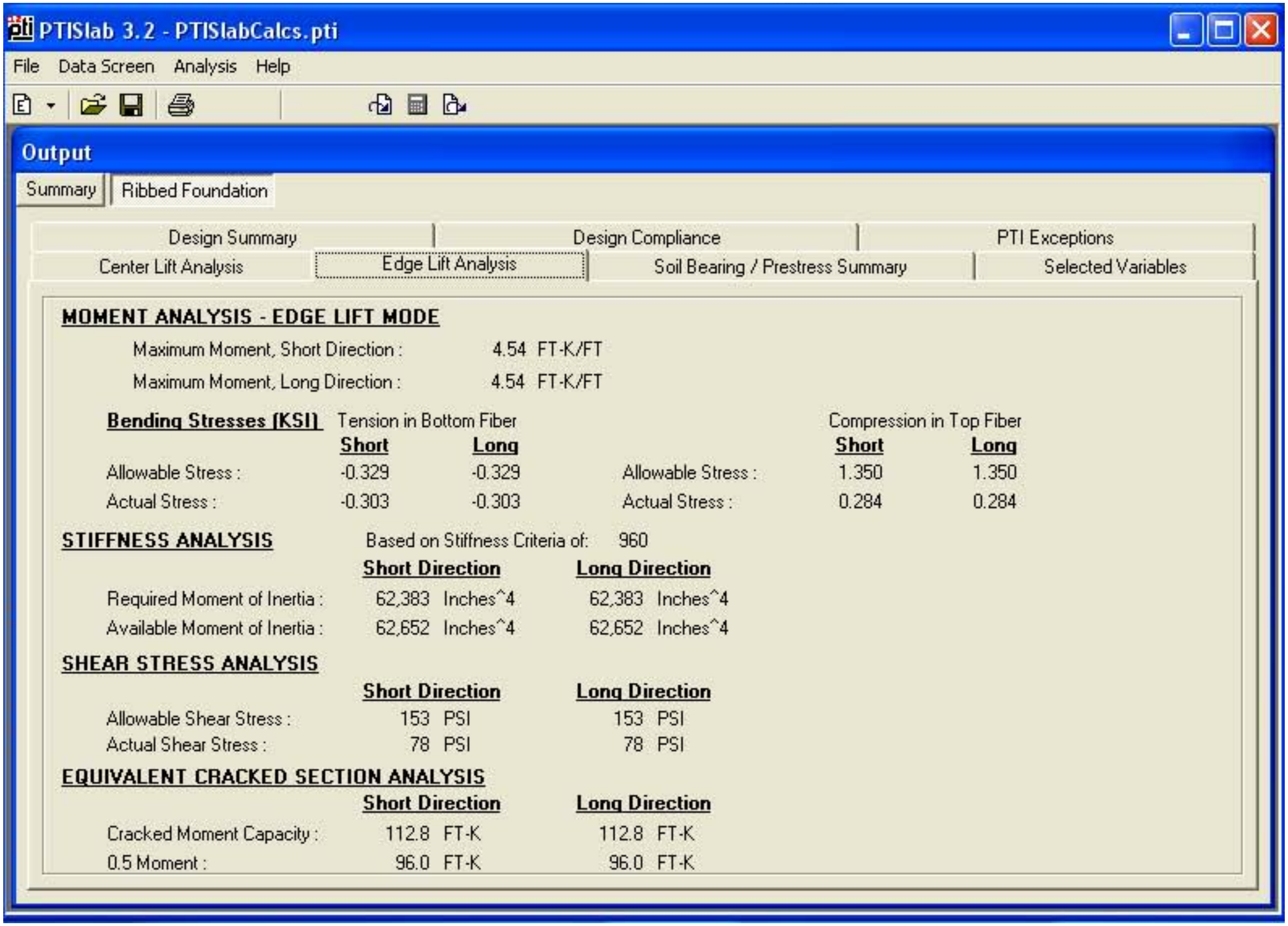
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File
Data Screen
Analysis
Help
Output
Summary
Ribbed Foundation
Design Summary
Design Compliance
PTI Exceptions
Center Lift Analysis
Edge Lift Analysis
Soil Bearing / Prestress Summary
Selected Variables
MOMENT ANALYSIS - EDGE LIFT MODE
Maximum Moment, Short Direction : 4.54 FT-K/FT
Maximum Moment, Long Direction : 4.54 FT-K/FT
Bending Stresses (KSI)
Tension in Bottom Fiber
Short Long
Allowable Stress : -0.329 -0.329
Actual Stress : -0.303 -0.303
Compression in Top Fiber
Short Long
Allowable Stress : 1.350 1.350
Actual Stress : 0.284 0.284
STIFFNESS ANALYSIS
Based on Stiffness Criteria of: 960
Short Direction Long Direction
Required Moment of Inertia : 62,383 Inches^4 62,383 Inches^4
Available Moment of Inertia : 62,652 Inches^4 62,652 Inches^4
SHEAR STRESS ANALYSIS
Short Direction Long Direction
Allowable Shear Stress : 153 PSI 153 PSI
Actual Shear Stress : 78 PSI 78 PSI
EQUIVALENT CRACKED SECTION ANALYSIS
Short Direction Long Direction
Cracked Moment Capacity : 112.8 FT-K 112.8 FT-K
0.5 Moment : 96.0 FT-K 96.0 FT-K

PTISlab 3.2 - PTISlabCalcs.pti

File Data Screen Analysis Help

Output

Summary | Ribbed Foundation

Design Summary | Design Compliance | PTI Exceptions

Center Lift Analysis | Edge Lift Analysis | Soil Bearing / Prestress Summary | Selected Variables

MOMENT ANALYSIS - CENTER LIFT MODE

Maximum Moment, Short Direction : 8.04 FT-K/FT

Maximum Moment, Long Direction : 8.04 FT-K/FT

Bending Stresses (KSI)

	Tension in Top Fiber			Compression in Bottom Fiber	
	Short	**Long**		**Short**	**Long**
Allowable Stress :	-0.329	-0.329	Allowable Stress :	1.350	1.350
Actual Stress :	-0.211	-0.211	Actual Stress :	0.832	0.832

STIFFNESS ANALYSIS

Based on Stiffness Criteria of: 480

	Short Direction	**Long Direction**
Required Moment of Inertia :	55,216 Inches^4	55,216 Inches^4
Available Moment of Inertia :	62,652 Inches^4	62,652 Inches^4

SHEAR STRESS ANALYSIS

	Short Direction	**Long Direction**
Allowable Shear Stress :	153 PSI	153 PSI
Actual Shear Stress :	50 PSI	39 PSI

EQUIVALENT CRACKED SECTION ANALYSIS

	Short Direction	**Long Direction**
Cracked Moment Capacity :	326.7 FT-K	326.7 FT-K
0.5 Moment :	170.0 FT-K	170.0 FT-K

Soil Properties