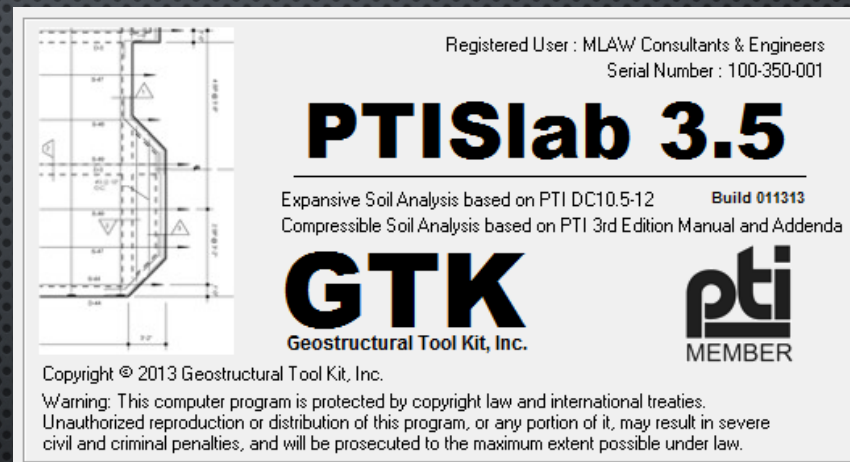
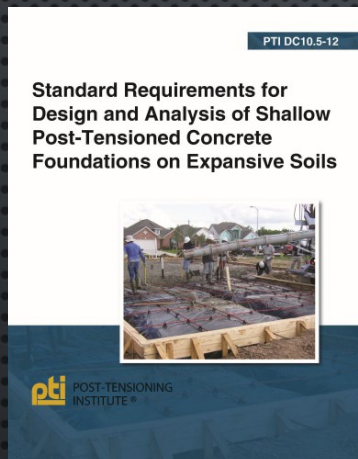


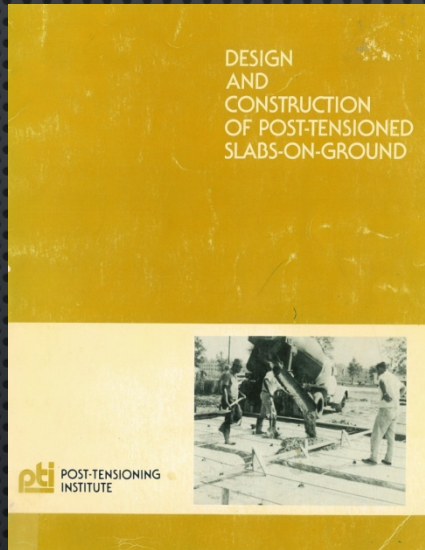
# SIGNIFICANT CHANGES IN PTI DC10.5-12 AND PTISLAB 3.5



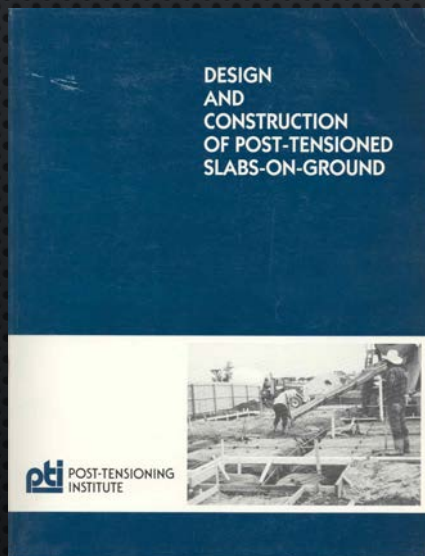
FOUNDATION PERFORMANCE ASSOCIATION – OCTOBER PRESENTATION  
OCTOBER 9, 2013 – HOUSTON, TEXAS

DEAN R. READ, P.E.  
MLAW CONSULTANTS & ENGINEERS  
GEOSTRUCTURAL TOOL KIT, INC.

# POST-TENSIONING INSTITUTE'S SLABS-ON-GROUND DESIGN PUBLICATIONS

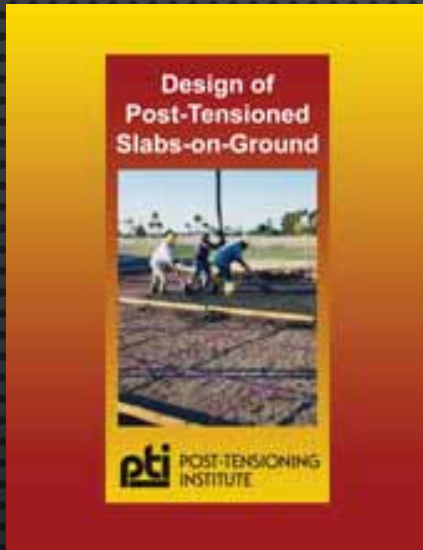


"1st Edition Manual"  
Published in 1980



"2<sup>nd</sup> Edition Manual"  
Published in 1996

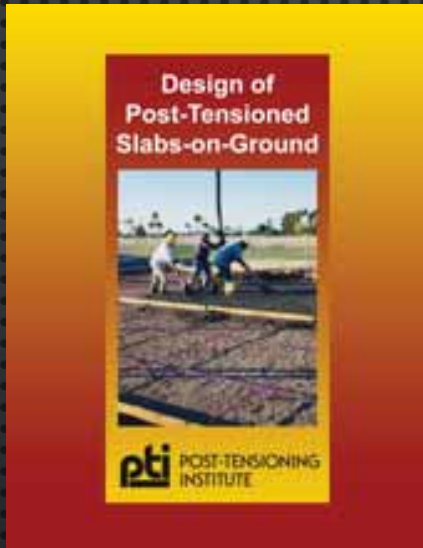
# POST-TENSIONING INSTITUTE'S SLABS-ON-GROUND DESIGN PUBLICATIONS



"3rd Edition Manual" and  
associated Standards  
Published in December 2004

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

# POST-TENSIONING INSTITUTE'S SLABS-ON-GROUND DESIGN PUBLICATIONS

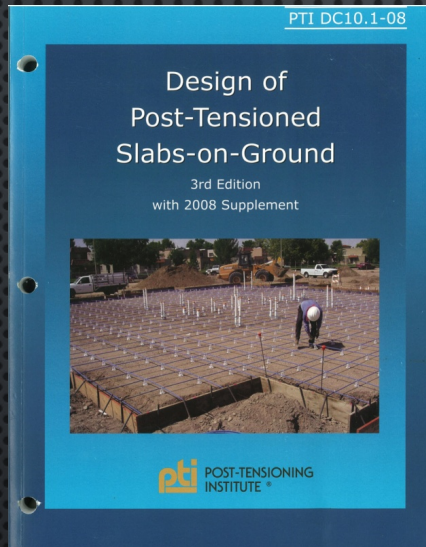


"3rd Edition Manual" and  
associated Standards  
subsequently modified

Addendum #1 Published in May 2007

Addendum #2 Published in May 2008

# POST-TENSIONING INSTITUTE'S SLABS-ON-GROUND DESIGN PUBLICATIONS

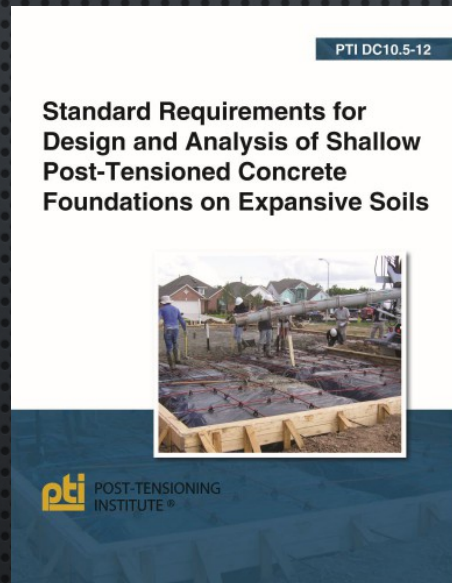


“3rd Edition Manual with 2008 Supplement”

Includes both standards, both  
addenda and errata

(three errata issued after publication of supplement)

# POST-TENSIONING INSTITUTE'S SLABS-ON-GROUND DESIGN PUBLICATIONS

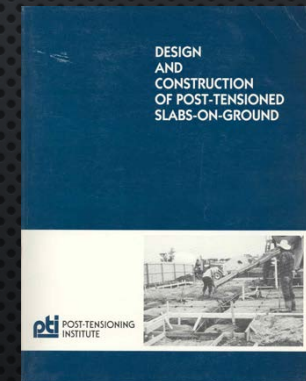
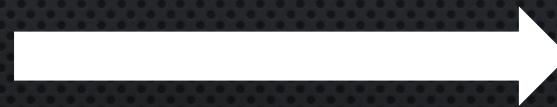
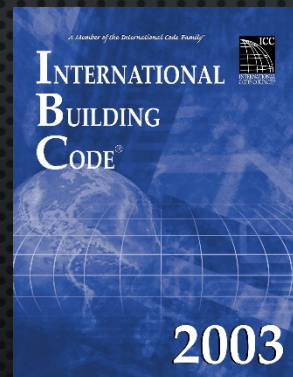
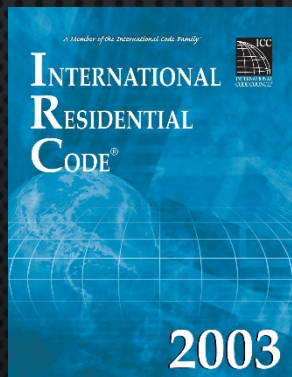
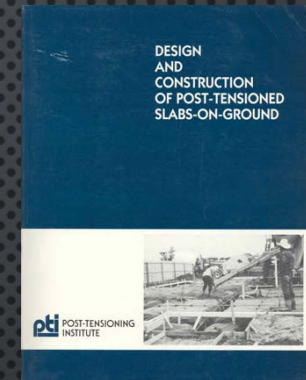
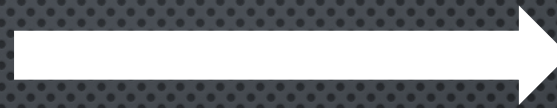
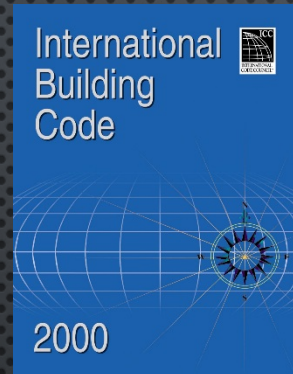
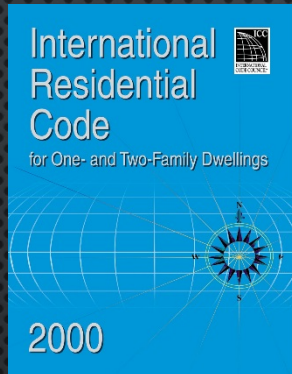


Standard Requirements for Design and  
Analysis of Shallow Post-Tensioned Concrete  
Foundations on Expansive Soils

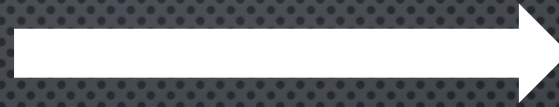
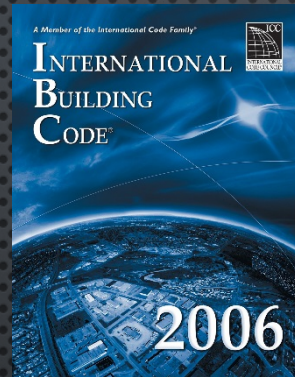
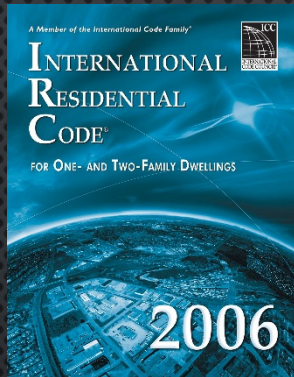
“Combined Standard”

This is not a design manual. It is written in mandatory code language with commentary. “User Guide” being developed.

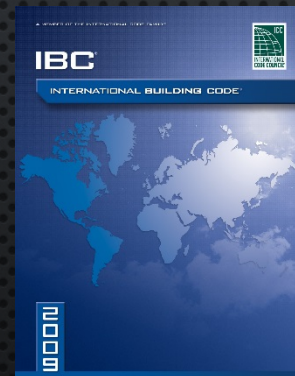
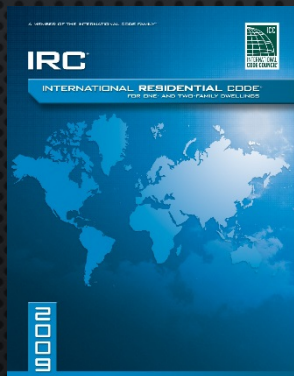
# BUILDING CODE REQUIREMENTS



# BUILDING CODE REQUIREMENTS



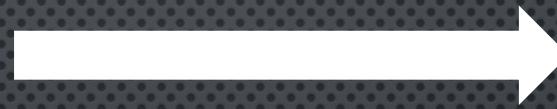
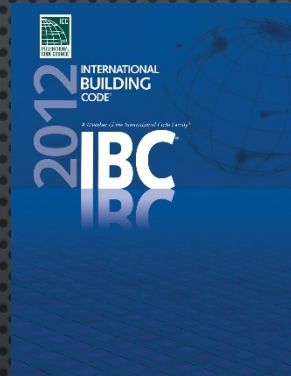
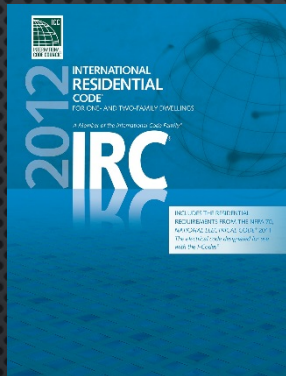
Standards



Standards

Addendum 1

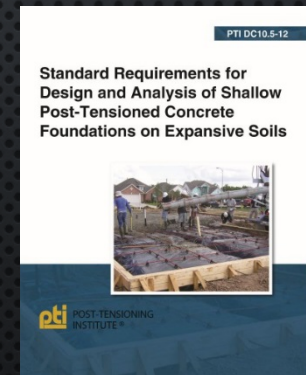
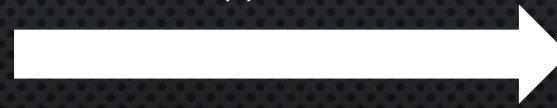
# BUILDING CODE REQUIREMENTS



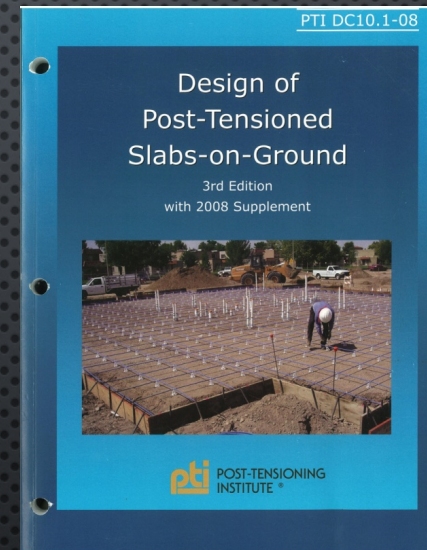
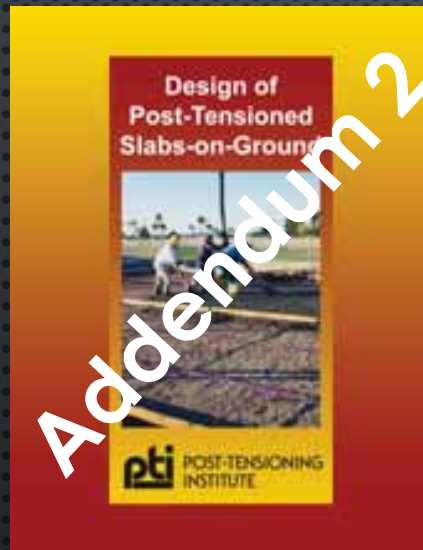
Standards



Submitted for approval.



# BUILDING CODE REQUIREMENTS



PTI documents not referenced in IRC or IBC

PTI DC10.5-12

## **Standard Requirements for Design and Analysis of Shallow Post-Tensioned Concrete Foundations on Expansive Soils**



**pti** POST-TENSIONING  
INSTITUTE®

# **“Combined Standard”**

Considered the “state of the art”

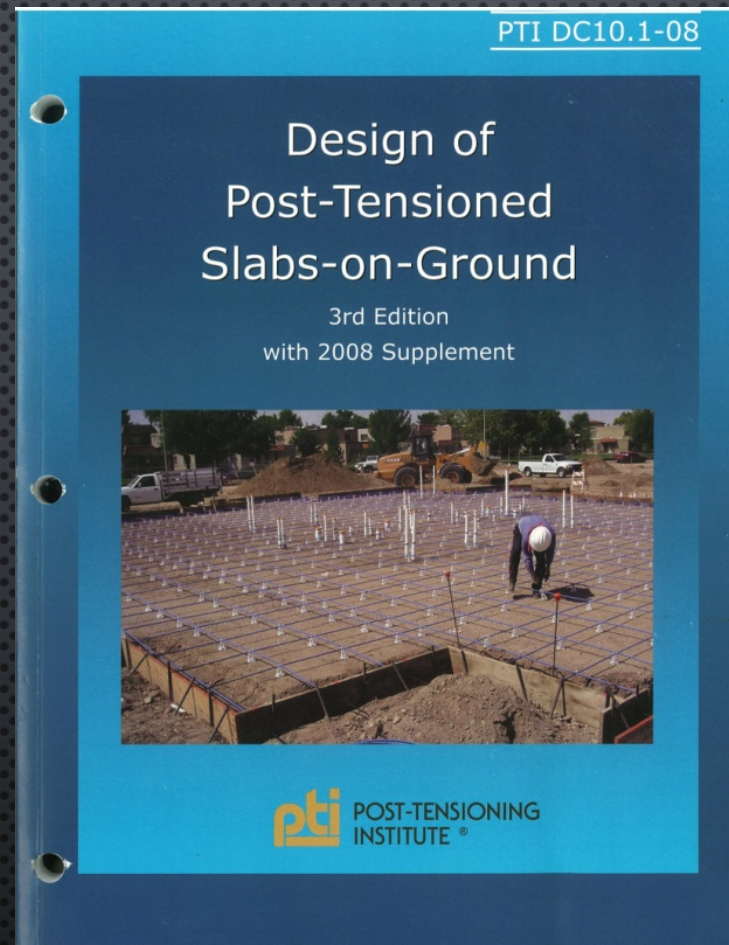
PTI DC10.5-12

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



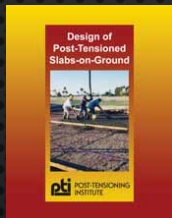
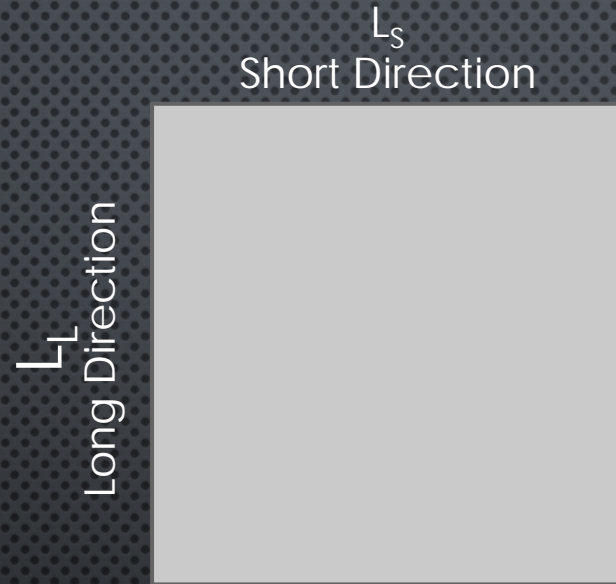
**pti** POST-TENSIONING  
INSTITUTE®

What do I use for compressible soils?

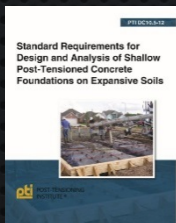


Should be used for compressible soils

# APPLIED SHEAR FOR “SQUARE” DESIGN RECTANGLE

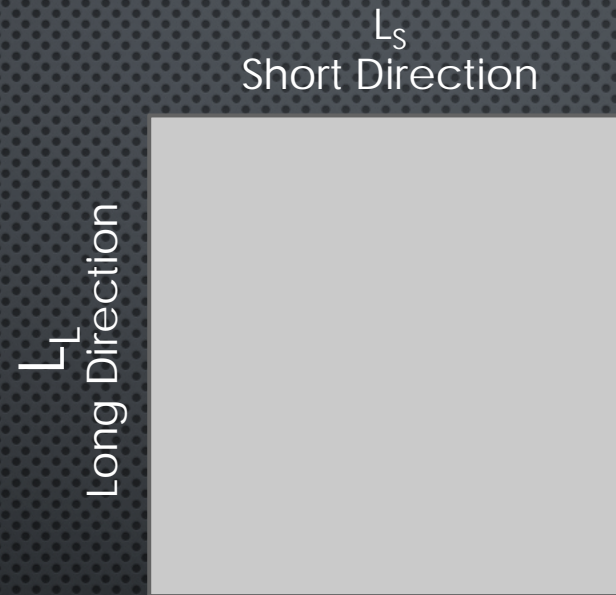


In 3<sup>rd</sup> Edition (and earlier), Center Lift  $V_S \neq V_L$   
for “square” design rectangle  
(Edge Lift  $V_S$  already equal to  $V_L$  for “square” design rectangle)



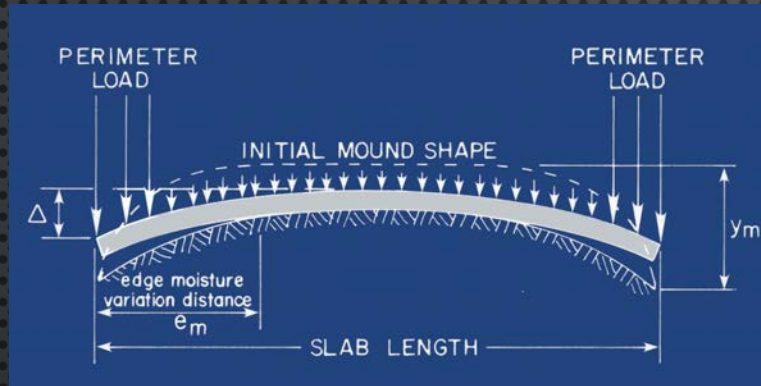
In Combined Standard,  $V_S = V_L$  for “square”  
design rectangle  
(this is consistent with the applied moment provisions)

# “SQUARE” DESIGN RECTANGLE

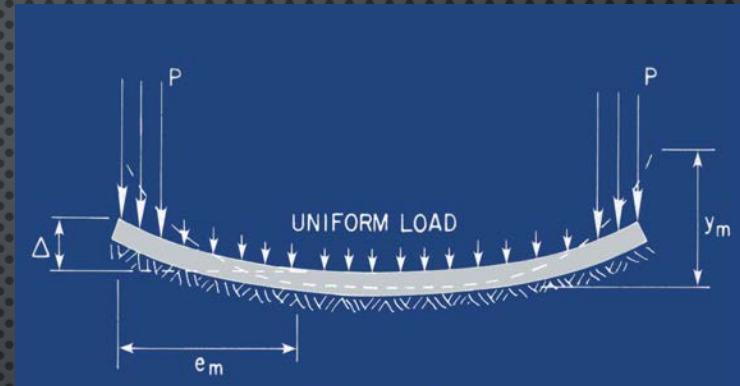


If  $L_L / L_S < 1.1$  the design rectangle  
considered a “square”

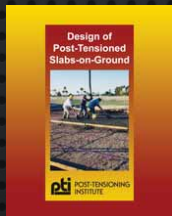
# APPLIED SHEAR FOR SOILS WITH $\gamma_m \leq 1$



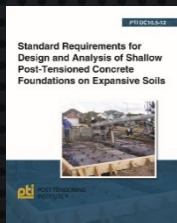
Center Lift



Edge Lift



In 3<sup>rd</sup> Edition,  $V_s$  and  $V_L$  are calculated using entire  $e_m$  length.

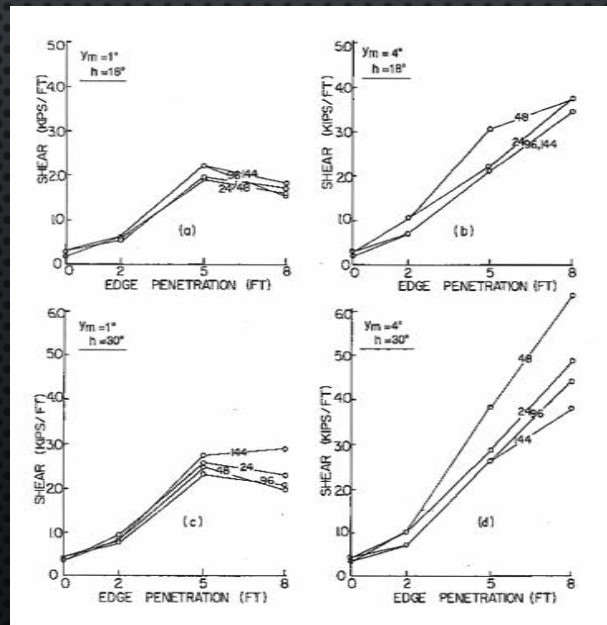


In Combined Standard,  $V_s$  and  $V_L$  are calculated by limiting  $e_m$  to 5 feet.

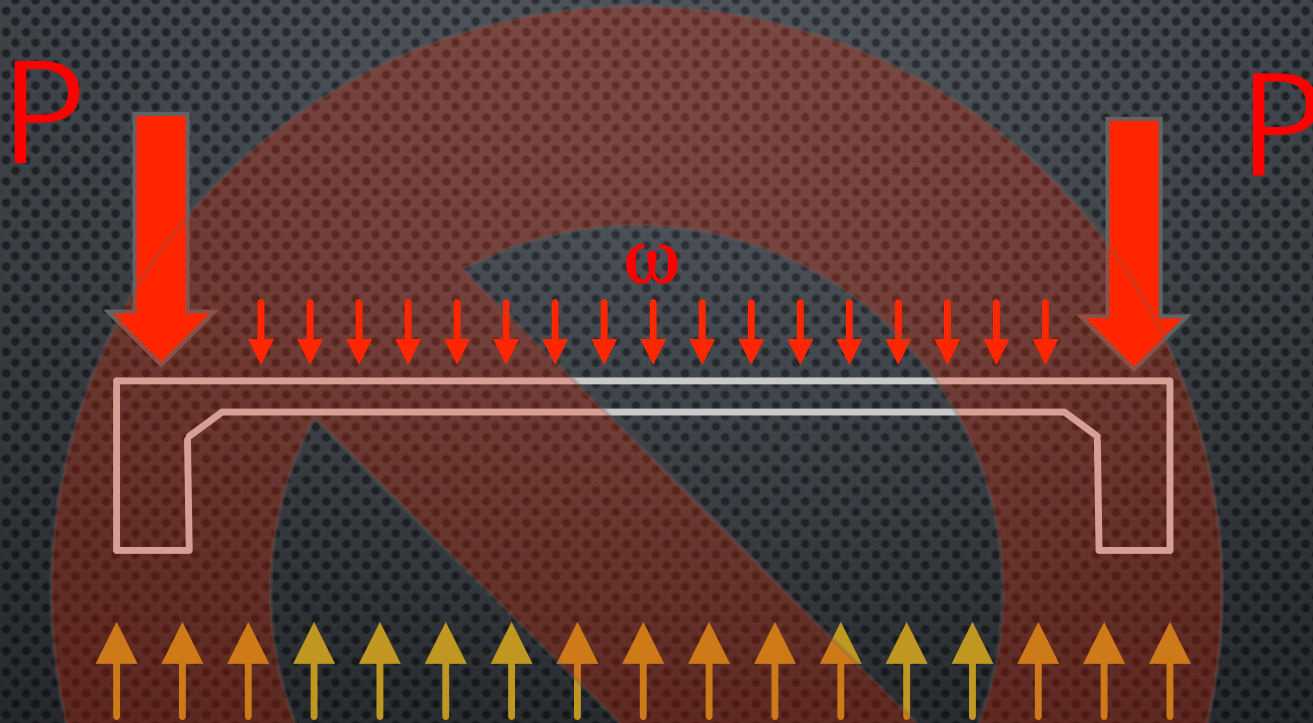
# APPLIED SHEAR FOR SOILS WITH $\gamma_m \leq 1$

Combined Standard limit "caps"  $V_s$  and  $V_L$  for  
soils with low shrink / swell potential

Justification for limit comes from original research by Lytton and Wray:



# SOIL BEARING



The 3<sup>rd</sup> Edition (and earlier) method assumes foundation stiff enough to apply uniform pressure to soil.

# SOIL BEARING

## 6.2.4 — Soil-bearing pressure

Applied soil-bearing pressure shall be evaluated using generally accepted techniques and shall not exceed  $q_{allow}$  as specified by the LDP with geotechnical experience.

## R6.2.4 — Soil-bearing pressure

Refer to PTI DC10.1-08<sup>2</sup> for one method of determining the applied soil-bearing pressure. Other generally accepted techniques may be used.

# SOIL BEARING

The “average uniform superimposed total load” ( $\omega$ ) variable is only used in the bearing calculations.

Since PTI no longer requires the “unrealistic” bearing analysis, this variable is no longer needed in PTISlab and has been disabled.

Most common question asked about PTISlab 3.5: “Why can’t I enter a value here?”

PTISlab 3.5 - Untitled

File Data Screen Analysis Help

Input

Project Information | Material Properties | Slab Properties | Beam Properties | Soil Properties | Load, Stiffness & Prestress | Line Load Analysis

Foundation Loads

Average Uniform Superimposed Total Load (psf): 40

Perimeter Total Load (lb/ft): 0

☐ Maximize Edge Lift Case with smallest load intensity or dead load only (per PTI 4.5.4.3)

Smallest Load Intensity (lb/ft):

Stiffness Coefficient

Center Lift: 480

Edge Lift: 960

More Information

**Load, Stiffness & Prestress Tab**

The Load, Stiffness & Prestress Tab contains various variables defining loads, stiffness criteria, and effective prestress determination.

Using the "Save ...." and "Open ...." toolbar buttons on the Input window the data on the Load, Stiffness & Prestress Tab can be saved to future use.

Right click on textbox, checkbox or option button labels for more information about the variables.

Prestress

Calculate Cumulative Subgrade Friction Resistance Using:

☒ PTI Manual Method

☐ "Full Length Drag Method"

☐ User Defined

Short Long

Maximum Subgrade Friction Used For Shear Calc. (K):

Subgrade Friction At Beta Used For Moment Calc. (K):

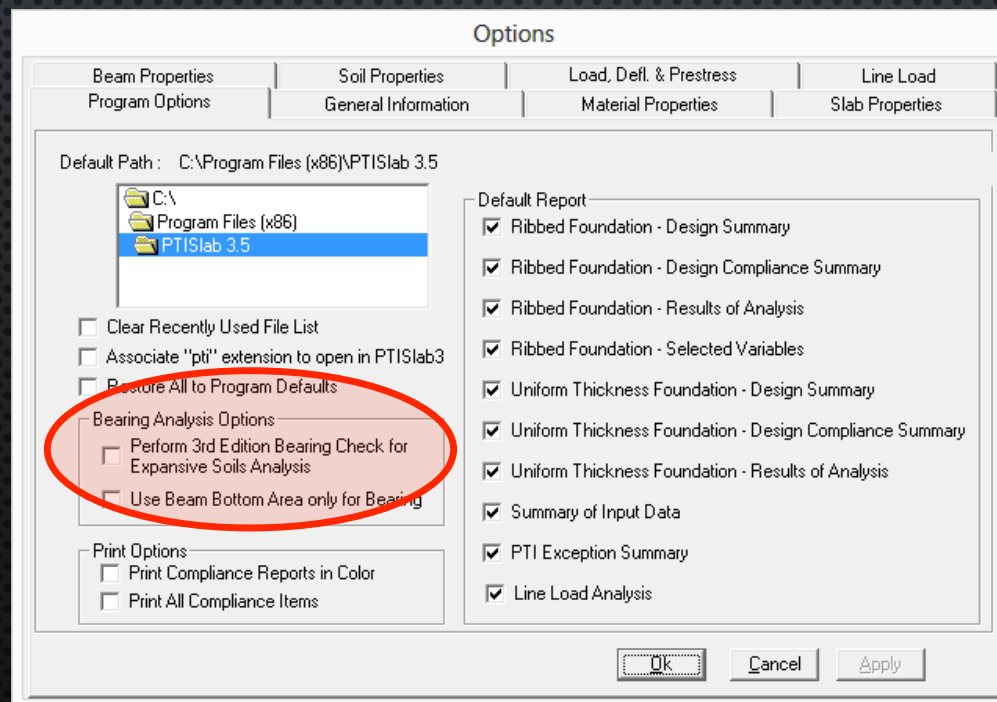
Prestress Loss (ksi): 15

Subgrade Friction Coefficient,  $\mu$ : 0.75

# SOIL BEARING

Why wasn't variable completely removed from PTISlab?

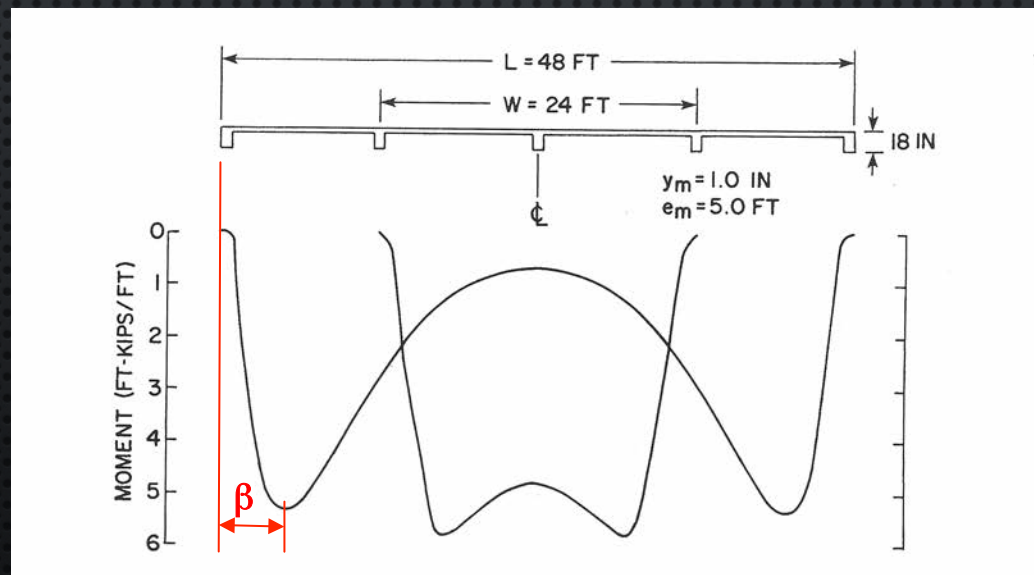
- It is still required for compressible soil analysis
- It can be "re-enabled" if an engineer wants to still perform the "unrealistic" analysis.



## PRESTRESS AT BETA

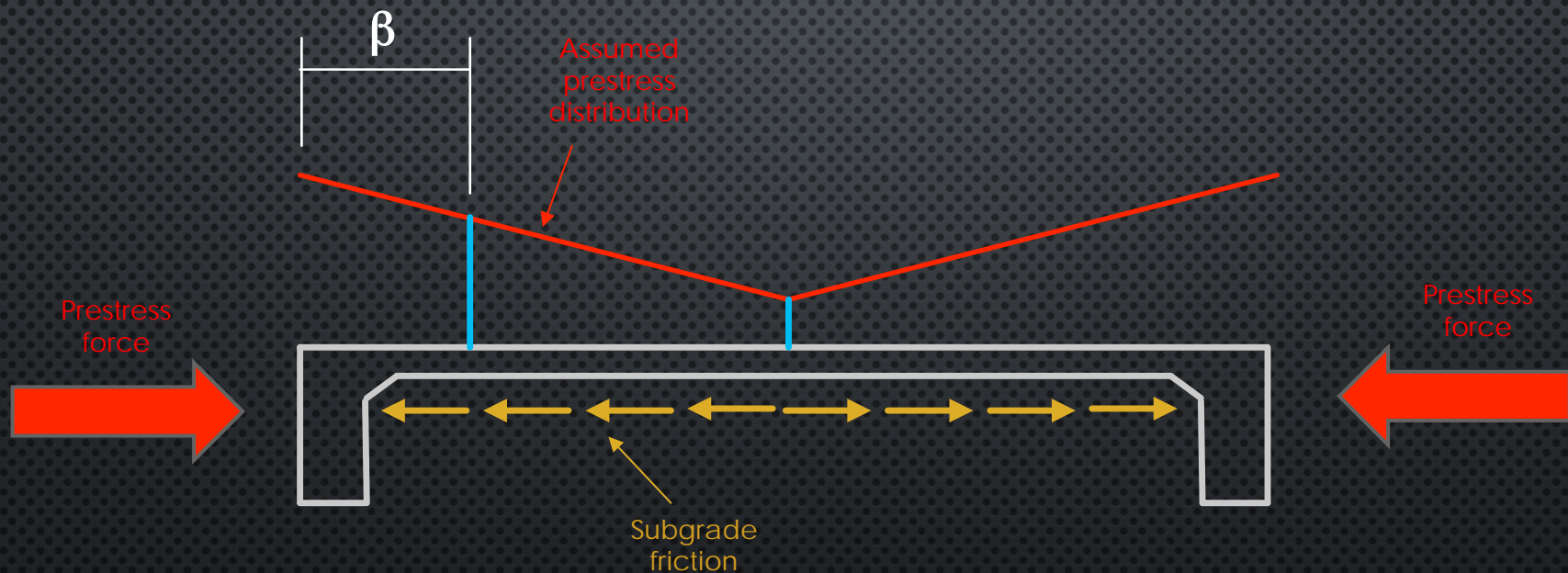
Based on the original analysis by Lytton and Wray, the location of the maximum moment "can closely be estimated by  $\beta$ . Maximum shear occurs within  $\beta$  of edge of slab.

$\beta$  is a function of the relative stiffness of the soil and stiffened slab.



## PRESTRESS AT BETA

In PTI 2<sup>nd</sup> and 3<sup>rd</sup> Edition Manuals,  $P_r$  is calculated at mid-slab.  $P_{r \text{ mid slab}} < P_{r \text{ beta}}$



In "Combined Standard"  $P_r$  is calculated at  $\beta$

# PRESTRESS AT BETA

## 6.1.1 — Loss of prestress

Effective prestress force in the concrete after all losses shall be

$$P_r = P_i - ES - CR - SH - RE - SG$$

For determination of the minimum effective prestress force  $P_r$ ,  $SG$  shall be calculated as follows:

$$SG = (W_{slab}/2000)\mu$$

For determination of the effective prestress force  $P_r$  used in the flexural and shear stress calculations,  $SG$  shall be calculated as follows

$$SG = (W_{slab}/2000)(\beta/L)(\mu)$$

where  $\beta$  and  $L$  are in the direction being considered.

The prestress at b is used in moment and shear stress calculations.

The prestress at mid-slab is still used for minimum effective prestress.

## PRESTRESS AT BETA

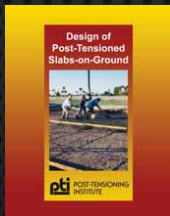
Concrete flexural stresses shall be calculated as follows

$$f = \frac{1000P_r}{A} \pm \frac{12,000M_{L,S}}{S_{T,B}} \pm \frac{1000P_r e_p}{S_{T,B}}$$

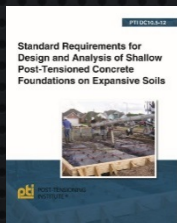
In general, change decreases the applied tensile stresses but.....

if eccentricity of prestress is large, change can actually increase applied tensile stresses.

# VERTICAL MOISTURE BARRIER

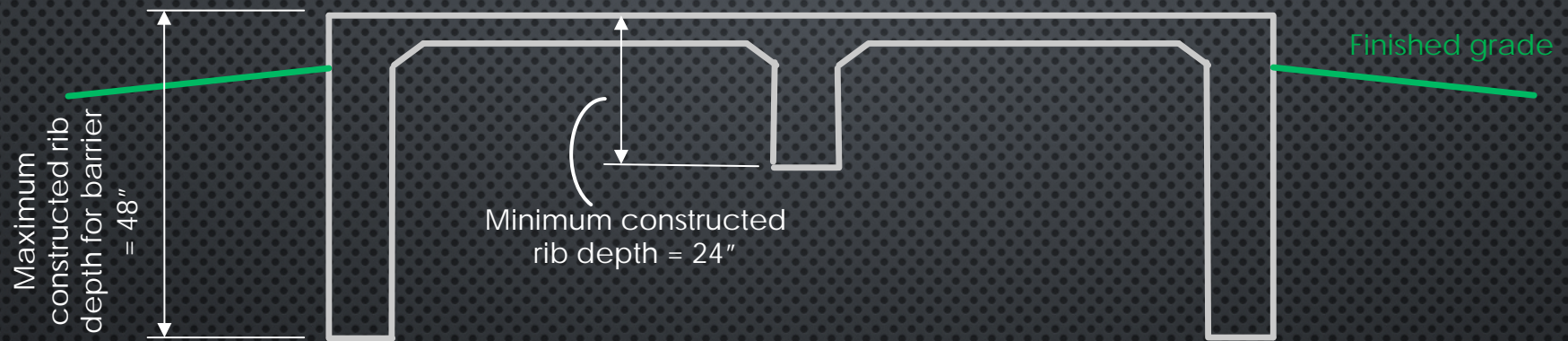


In 3<sup>rd</sup> Edition, the minimum barrier depth is 30 inches



In "Combined Standard", the minimum barrier depth is 24 inches

# VARIABLE RIB DEPTHS



What rib depth values do you use in PTISlab?

# VARIABLE RIB DEPTHS



In analysis, ratio of deepest to shallowest rib depth cannot exceed 1.2 (not new in combined standard but misunderstood).

The difference in the constructed ribs are not limited to the 1.2 ratio

# VARIABLE RIB DEPTHS

The screenshot shows the PTISlab 3.5 software interface with the 'Beam Properties' tab selected. The window title is 'PTISlab 3.5 - Untitled\*'. The menu bar includes 'File', 'Data Screen', 'Analysis', and 'Help'. The toolbar contains icons for file operations and analysis. The 'Input' section is active, showing 'Project Information', 'Material Properties', 'Slab Properties', 'Beam Properties', 'Soil Properties', 'Load, Stiffness & Prestress', and 'Line Load Analysis'. The 'Rectangle Geometry (WxDxT): 40.00 FT x 43.00 FT x 4.00 In' is displayed. The 'Beams' section is divided into 'Short Direction' and 'Long Direction'. Each direction has two columns for 'Type 1' and 'Type 2' beams. The 'Short Direction' has 2 Type 1 beams (28 in depth, 12 in width, 2 tendons, 3 in cover) and 1 Type 2 beam (24 in depth, 12 in width, 1 tendon, 3 in cover). The 'Long Direction' has 2 Type 1 beams (28 in depth, 12 in width, 2 tendons, 3 in cover) and 1 Type 2 beam (24 in depth, 12 in width, 1 tendon, 3 in cover). Below this, there are radio buttons for 'Analysis Beam Spacing Based on Maximum and Minimum Spacings' and 'Analysis Beam Spacing Based on Average'. The 'Maximum and Minimum Spacings' section has input fields for 'Minimum Spacing' and 'Maximum Spacing' under 'Short' and 'Long' directions. The 'Analysis Beam Spacing Based on Average' option is selected. On the right, the 'Beam Properties Tab' section contains text explaining the variables used to define the stiffening beams or ribs used in the analysis, and a note about saving data using the 'Save ...' and 'Open ...' buttons.

PTISlab 3.5 - Untitled\*

File Data Screen Analysis Help

Input

Project Information Material Properties Slab Properties **Beam Properties** Soil Properties Load, Stiffness & Prestress Line Load Analysis

Rectangle Geometry (WxDxT): 40.00 FT x 43.00 FT x 4.00 In

Beams

Short Direction

Long Direction

Type 1 Type 2 Type 1 Type 2

Quantity: 2 1 2 1

Depth (IN): 28 24 28 24

Width (IN): 12 12 12 12

Tendons: 2 1 2 1

Cover (IN): 3 3 3 3

☐ Analysis Beam Spacing Based on Maximum and Minimum Spacings

Short Long

Minimum Spacing

Maximum Spacing

☒ Analysis Beam Spacing Based on Average

**Beam Properties Tab**

The Beam Properties Tab contains variables used to define the stiffening beams or ribs used in the analysis.

Using the "Save ..." and "Open ..." toolbar buttons on the Input window the data on the Beam Properties Tab can be saved for future use.

Right click on textbox, checkbox or option button labels for more information about the variables.

Typically Type 1 ribs used for perimeter ribs

Typically Type 2 used for interior ribs

## OTHER CHANGES

- Explicitly permits use of horizontal barriers to reduce  $e_m$  and  $y_m$ . (5.3.2)
- Limits placed on effectiveness of vertical and horizontal barriers at reducing  $e_m$  and  $y_m$ . (5.3.1 and 5.3.2)
- Replaced specific PPM Chloride limit with limit determined by local experience and practice. (4.3.2.2)