

Addendum No. 2

to the

3rd Edition of the Design of Post-Tensioned Slabs- on-Ground

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Summary of Addendum No. 2 Revisions

1. Table 3.1 – Soil Fabric Factor

Table restructured to clarify that the use of higher Soil Fabric Factors applies only to CH-type soils. Table values have also been revised downward to better reflect design experience.

2. Slab Shape Factor

Sections 3.8 and 4.5.1 have been rewritten to clarify that a designer has options that may be considered when the slab shape factor exceeds 24.

3. Rib Spacing

Section 4.5.2.1 has been revised to permit rib spacings less than 6 feet and to clarify what spacing shall be used to compute moments and shears.

4. Rib Width

Section 4.5.2.3 has been revised to limit rib widths to a range of 6 to 14 in.

5. Uniform Thickness Conversion

Section 6.12 has been revised to clarify that when converting to an equivalent uniform thickness foundation, the conformant ribbed foundation need not satisfy the cracked section provisions.

6. The Modulus of Elasticity of Soil, E_{soil} in the equation for β has been set as a constant = 1,000. Because this is the only location that the variable, E_{soil} appears in this manual, the definition for E_{soil} has been dropped from the List of Symbols and Notation in Appendix A.1.

The major factor in determining the edge moisture variation distance is the unsaturated diffusion coefficient, α . This, in turn, depends on the level of suction, the permeability, and the cracks in the soil. For the same diffusion coefficient, the e_m value will be larger for the center lift case in which moisture is withdrawn from soil around the perimeter of the foundation. The e_m value will be smaller for the edge lift case in which moisture is drawn beneath the building into drier soil. Roots, layers, fractures or joints in the soil will increase the diffusion coefficient and increase the e_m value for both the edge lift and center lift conditions. Using representative values based on laboratory test results in each layer, the following values are required to determine edge moisture variation distance, e_m :

- Liquid Limit, LL
- Plastic Limit, PL
- Plasticity Index, PI
- Percentage of soil passing No. 200 sieve (%-#200) expressed as a percentage of the total sample.
- Percentage of soil finer than 2 microns (%-2 μ) expressed as a percentage of the total sample.
- Percent fine clay, $\%f_c = \left(\frac{\% - 2\mu}{\% - \#200} \right) \times 100$

For example: $45\% / 80\% = 0.56 \times 100$

$= 56$, report as 56%

Calculate the unsaturated diffusion coefficient, α

$$\alpha = 0.0029 - 0.000162 (S_s) - 0.0122 (\gamma_h)$$

Where:

$$S_s = -20.29 + 0.1555 (LL) - 0.117 (PI) + 0.0684 (\% \#200)$$

The resulting unsaturated diffusion coefficient, α , for each significant layer should be converted to the modified unsaturated diffusion coefficient, α' , using F_f .

$$\alpha' = \alpha F_f$$

where F_f is the soil fabric factor from Table 3.1:

The modified unsaturated diffusion coefficient, α' , should be calculated for each significant soil layer by the procedure outlined above. One modified unsaturated diffusion coefficient, α' , is calculated for $\gamma_{h \text{ swell}}$ and another coefficient, α' , is calculated for $\gamma_{h \text{ shrink}}$. Significant soil layers are to a minimum depth of nine

Table 3.1 - Soil Fabric Factor

Condition		Ff
Non CH Soils		1.0
CH Soils	Profile with 1 root, crack, sand/silt seam all less than or equal to 1/8" width/dimension in any combination	1.0
	Profile with 2 to 4 roots, cracks, sand/silt seams all larger than 1/8" width/dimension in any combination	1.1
	Profile with more than 4 roots, cracks, sand/silt seams all larger than 1/8" width/dimension in any combination	1.2

feet. Depths greater than nine feet may be used if justified by geotechnical analysis. The evaluation of the edge moisture variation requires using a weighted average of the modified unsaturated diffusion coefficient. The weighting procedure is given in 3.2.9, and an example of the calculations for $\gamma_{h \text{ mod}}$ is given in 3.6.3.

Determine edge moisture variation distance, e_m for both center lift and edge lift from the e_m Selection Chart, Figure 3.6, using the larger value obtained from I_m chart or α' chart.

3.6.2 Calculate γ_h

Determine γ_o using the following steps:

Step 1

Determine Mineral Classification Zone I, II, III, IV, V or VI from the Mineral Classification Chart, (See Figure 3.7). If the data does not fall within one of the six zones, use the nearest zone. **No data should plot above the U-Line.** If data plots within the area below Plasticity Index of 7, bounded by the U-Line and the A-Line, use $\gamma_o = 0.01$

Step 2

Proceed to the chart corresponding to the zone determined in Step 1 to determine γ_o . (See Figures 3.7, 3.8, 3.9, 3.10, 3.11, 3.12 and 3.13). Interpolate between γ_o lines. Beyond extreme values of the contours, use the nearest values for γ_o .

Table 3.7 - Determining the Weighted Suction-Compression Index

Layer	Depth, D (ft)	Weight Factor, F	$F \times D$	PI	LL	Zone	(% f_c)	$PI/(\%f_c)$	$LL/(\%f_c)$
1	2	3	6	35	55	II	35	1.00	1.57
2A	1	3	3	62	80	I	55	1.13	1.45
2B	2	2	4	62	80	I	55	1.13	1.45
3A	1	2	2	48	70	II	50	0.96	1.40
3B	3	1	3	48	70	II	50	0.96	1.40
Sum	9		18						

Layer	γ_o	$\gamma_h = \gamma_o \times (\%f_c)$	$\gamma_h \text{ swell}$	$\gamma_h \text{ swell} \times F \times D$	$\gamma_h \text{ shrink}$	$\gamma_h \text{ shrink} \times F \times D$
1	0.17	0.060	0.063	0.379	0.056	0.336
2A	0.15	0.083	0.090	0.269	0.076	0.228
2B	0.15	0.083	0.090	0.358	0.076	0.228
3A	0.17	0.085	0.093	0.185	0.078	0.156
3B	0.17	0.085	0.093	0.278	0.078	0.234
Sum				1.469		1.259
			$(\gamma_h \text{ swell})_{\text{mod}}$	0.082	$(\gamma_h \text{ shrink})_{\text{mod}}$	0.070

3.7 Moisture Barriers

Vertical moisture barriers may be used to reduce the soil support parameters (e_m and γ_m) provided the barriers are properly designed to virtually stop moisture migration to or from the foundation area on a permanent basis, around the entire perimeter.

The effect of a barrier on e_m and γ_m may be estimated by the principles of un-saturated soil mechanics, most easily by the use of a two-dimensional moisture flow analysis computer program, such as VOLFLO³⁶.

A vertical barrier should extend at least 2.5 ft below adjacent ground surface to be considered as having any significant effect.

An approximation of the effect of a vertical barrier on e_m can be obtained by using Table 3.8.

3.8 Slab Shape Factor

The Shape Factor (SF) is defined in 4.5.1. If the Shape Factor (SF) exceeds 24 the designer should consider modifications to foundation foot print, strengthened foundation systems, soil treatment to reduce swell or the use of additional non-prestressed reinforcement and/or additional ribs in areas of high torsional stresses. Analysis by finite element procedures may also be used in the case of $SF > 24$. Geotechnical approaches should reduce $\gamma_{m\text{-center}}$ to less than 2.0 in. and $\gamma_{m\text{-edge}}$ to less than 1.0 in. Techniques to accomplish this could include

water injection, lime or chemical injection, removal and replacement with low expansive soil materials or perimeter barriers. Geotechnical analysis should also consider the reduction of e_m by the selected technique. The depth of removal and replacement with low expansive or moisture conditioned materials, or of moisture pre-conditioned soil depth may be considered as having an effect equal to a perimeter barrier of similar depth, but each treatment approach should be individually evaluated by the geotechnical engineer. When select fill or granular material is used in the removal and replacement method, extreme care needs to be taken so that an undrained "bathtub" is not created.

Table 3.8 Values of Reduced e_m for Various Perimeter Vertical Moisture Barriers

		Depth of Barrier (ft)					
		2.5	3.0	3.5	4.0	4.5	5.0
e_m (ft) (Center or Edge)	2	2.0	2.0	2.0	2.0	2.0	2.0
	3	2.0	2.0	2.0	2.0	2.0	2.0
	4	3.1	2.6	2.0	2.0	2.0	2.0
	5	4.3	4.0	2.8	2.0	2.0	2.0
	6	5.5	5.2	4.2	3.0	2.0	2.0
	7	6.5	6.3	5.5	4.5	3.2	2.0
	8	7.6	7.4	6.6	5.7	4.7	3.3
	9	8.6	8.5	7.7	6.9	6.0	4.9

The change of γ_m for various barrier depths requires analysis using a computer program, such as VOLFLO³⁶.