DECEMBER 2011 MEETING

Wednesday, December 14, 2011 *(1.0 PDH)*

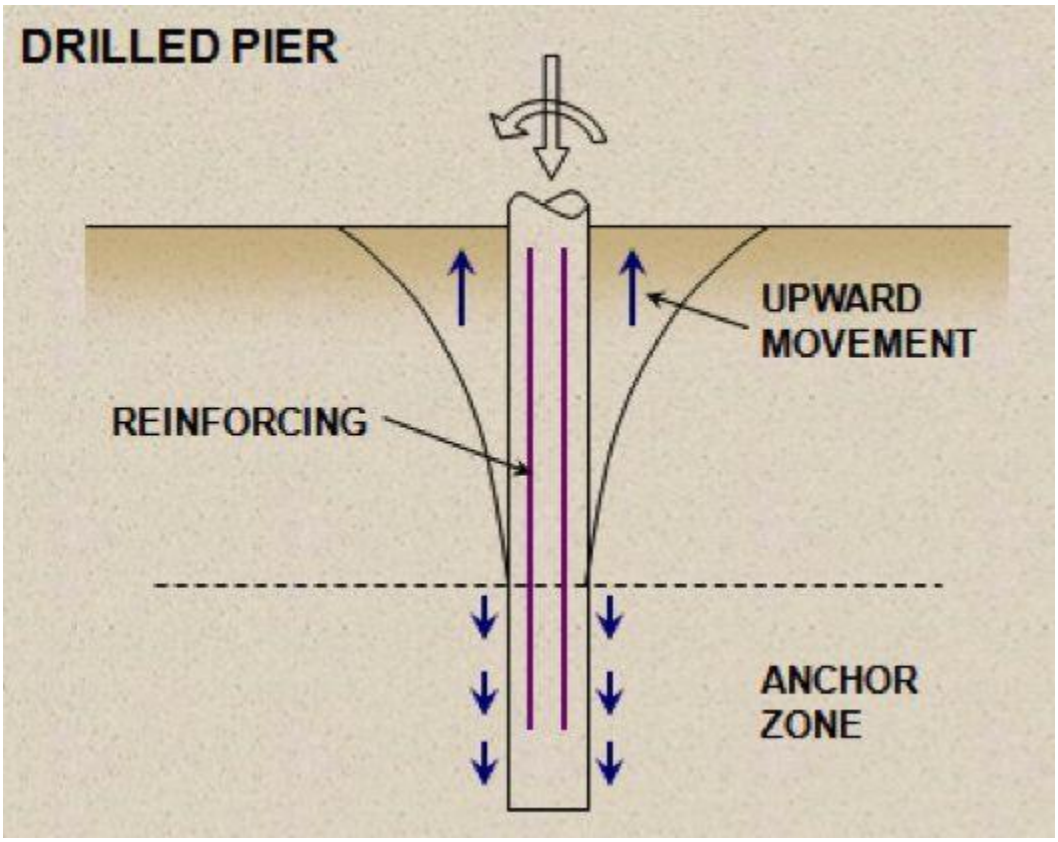
TECHNICAL PROGRAM

Design of Drilled Shafts in Expansive Soils

Speaker: Professor Robert L. Lytton, Ph.D., P.E. Professor of Civil Engineering at Texas A&M University, Bryan TX, Tel. No. 979-845-9964

Dr. Lytton is an Honorary FPA Life Member, Professor of Civil Engineering in the Zachry Civil Engineering Department of the Texas A&M University, and a Licensed Professional Engineer in Texas with a Ph.D. in Civil Engineering from the University of Texas (1967). He is internationally famous for his work in the study of expansive soils on foundations, giving presentations on the subject worldwide. He has selflessly presented to this forum at least 10 times in the last 12 years and has also presented in past FPA seminars.

PRESENTATION SUMMARY



To an audience of about 90 at the HESS Club, Dr. Lytton presented "Design of Drilled Shafts in Expansive Soils". Dr. Lytton provided a summary of procedures for the design of drilled piers in expansive soils using data that is readily available in the public domain. The design procedures are based on long standing and proven methods of analysis. The design procedures presented were initiated by a request from the FPA Structural Committee with a scope to develop a method comparable to the Lytton Method that does not require suction testing, but rather utilizes the soil parameters commonly reported in the local market. The design procedure developed allows the sizing of drilled piers to resist movement due to heave and shrinkage.

Dr. Lytton opened his presentation with an overview of soil mechanics and common geotechnical report results and the data included. Dr. Lytton proceeded to give an overview of common design results using all the data from a generic but thorough geotechnical report. In developing the new method, he found using the hydrometer test data (percent clay) from the USDA NRCS county soil maps (public domain) and the simplified suction based approach detailed below, he got a reasonable comparison with his original design method that required site specific data for both parameters.

Describing the basis for Dr. Lytton's new suction approach, a suction envelope is used rather than site specific data. At the surface is the widest range of suction variation and the limits of that range are well known (Wet: pF = 2.9 ; Dry: pF = 4.5). At the bottom, the equilibrium suction is set by the Thornthwaite Moisture Index, using an empirical formula that summarizes the results of field measurements made all over the U.S. of suctions at considerable depth below the surface by a variety of organizations including the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, Texas A&M, UT-El Paso, Texas Tech Univ., and Univ. of New Mexico. Some engineers have been reluctant to use suction because of the variations measured in the lab, thinking that suction was too time-dependent and would not match the suction when the foundations are installed. However the log of suction does not vary and it must to be used to design accurate pier depths.

Dr. Lytton's procedure designs for uplift and bearing capacity. It addresses shaft size, both depth and diameter, including straight shafts, bells, and reinforcing and addresses available skin friction for loading piers in the active zone and anchoring piers below the active zone, using Reese, Touma and O'Neill's belled piers and straight-sided shaft test research (the Alpha Method). The procedure is also based on his "Lytton Method" and on a publication # 4518-1 he co-authored for TxDOT as part of the Texas Transportation Institute (TTI).

Dr. Lytton further illustrated that the public domain soil data from USDA NRCS County Soil Maps is very relevant when compared to current onsite measurements and helps to overcome the lack of soil information, specifically for hydrometer test data. Dr. Lytton then went on to illustrate an actual design using the meta-analysis method.

Some interesting comments made by Dr. Lytton include:

- "Suction is the key to understanding the strength of the soil.'
- "Suction governs the movement of water in soil and the strength of the soil."
- "Clay soil with (root) cracks in it has the permeability of gravel."
- "It is hard to imagine that a responsible soils lab would *not* log tree root fibers."
- "In designing pier reinforcement, you need to use the smallest rebar diameter possible to decrease concrete crack widths."

Dr. Lytton noted that this design method is in the beta testing stage and will require some additional work and refinement. He also pointed out that this method is not a substitute for onsite geotechnical testing and engineering, which should always be included as part of the final design. The goal of Dr. Lytton is to make the details of this design procedure available to the FPA Structural Committee in 2012 to develop into a peer reviewed design procedure.

To download a copy of Dr. Lytton's slide presentation, click **here**.

To download Dr. Lytton's TTI publication, "Design Procedure for Pavements on Expansive Soils, Report No. 0-4518-1, Vol.1", click **here**.

To access the USDA NRCS county soil maps referred to by Dr. Lytton, click here.

To read summaries of previous FPA presentations by Dr. Lytton, please click:

December 2010 - Effects of Trees on Foundations
December 2009 - Contrasting Design Approaches for Slabs-on-Ground and Raised Floor Foundations on Expansive Soils
December 2008 - How to use the PTI-3rd Edition to Design Foundations in Houston
December 2007 - Design of Structures to Resist the Pressures and Movements of Expansive Soils
December 2006 - Revisitation of Expansive Soils
December 2004 - Case Studies of Residential Foundation Movements in Southern Houston Area
August 2003 - How to Run Soil Suction Tests
August 2002 - Shallow Slope Failures and Suction from Vegetation
August 2001 - Methods to Aid Structural and Geotechnical Engineers in Designing Slab-on-Grade