

## DECEMBER 2016 MEETING

Wednesday, December 14, 2016 (1.5 PDH)

### TECHNICAL PROGRAM

#### Design of Drilled Shafts in Expansive Soils, Part 3

**Speakers:** [Robert L. Lytton, Ph.D., P.E.](#) Professor of Civil Engineering at Texas A&M University, Bryan TX, Tel. No. 979-845-9964 and [Nicole Wylie, P.E.](#) of Forensic Engineers Inc., Houston TX, Tel. No. 713-468-8100.

**Dr. Lytton** is an Honorary FPA Life Member, FPA Structural Committee 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 recognized for his work in the study of the effect of expansive soil on foundations, having given presentations on the subject worldwide. Dr. Lytton has selflessly presented to this forum at least 14 times and has also presented in past FPA seminars.

**Ms. Wylie** is an FPA Member, FPA Structural Committee Member, FPA-SC-16 Subcommittee Chair and Past Chair of the [FPA-SC-12](#) and [FPA-SC-14](#) subcommittees and is a Licensed Professional Engineer in Texas. Ms. Wylie earned her BSME from the University of Houston, her MSME from Rice University and has completed 2 years of postgraduate work in Civil Engineering at Rice University. She has been performing forensic investigations of foundations and other structures for Forensic Engineers Inc. since 1999 and is a past presenter to the FPA.

As the FPA-SC-16 subcommittee chair, Ms. Wylie coordinated the development of the new design procedure and its associated software being presented. Dr. Lytton is a member of the FPA-SC-16 subcommittee and has provided the research the subcommittee used to develop the portion of the design procedure quantifying the magnitude of vertical loading exerted on the sides of drilled pier shafts by active soil in the movement zone. The subcommittee is currently scheduled to submit its procedure to peer review near the end of December 2016.

### PROCEDURE DEVELOPMENT HISTORY

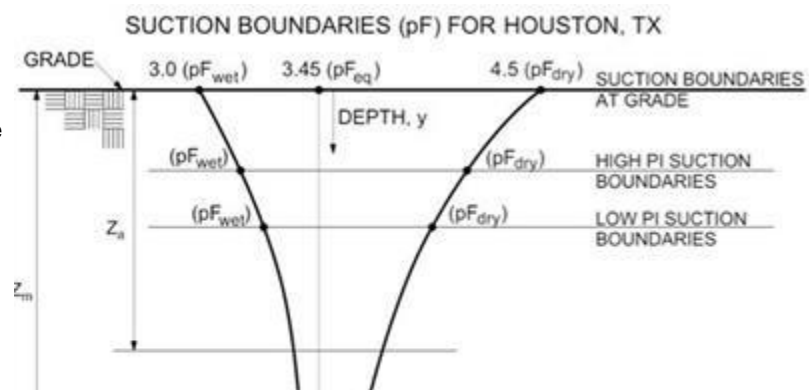
The design procedure being presented is the brainchild of the FPA Structural Committee. As with most procedures and guidelines authored by the Structural Committee, its members believed a new design procedure was needed in the local industry because the current methods for sizing drilled pier shafts in expansive soil allowed some lightly loaded piers to heave excessively, even in cases where the slabs and grade beams supported by the piers were adequately isolated from the upper soil with void spaces.

In December 2010, the committee requested Dr. Lytton's assistance in developing a new procedure to design drilled concrete shafts in expansive soil using parameters commonly provided in local geotechnical reports and excluding suction and other associated test data not normally provided for residential and lightly loaded commercial foundations on sites with expansive soil. After a year of development, Dr. Lytton summarily presented his proposed procedure to the FPA in December 2011 and again in more detail in a half-day workshop to the FPA Structural Committee in January 2012.

In March 2012, the committee voted to sanction the project and form the ad hoc subcommittee No. FPA-SC-16, chaired by Ms. Wylie in order to convert Dr. Lytton's research into a useful design tool. As the subcommittee uncovered problems, Dr. Lytton continued to research each new issue as a subcommittee member, presenting new intermediate results to the FPA in December 2013 (Part 2) and now what appears to be the final procedure in this (Part 3) presentation. Summaries of these past FPA presentation parts are linked below along with all of the two speakers' other past presentations to the FPA.

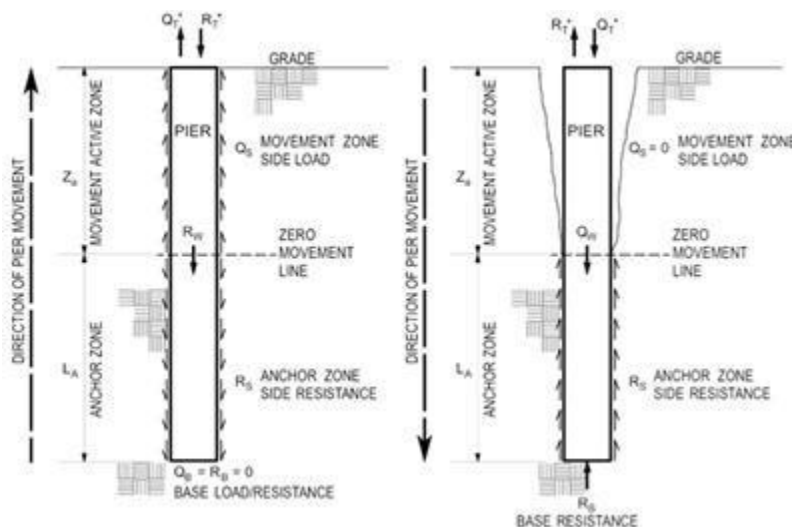
### PRESENTATION SUMMARY

In December 2013, Dr. Lytton presented Part 2 of his research giving the subcommittee a method to accurately determine the design suction of an active soil based on limited (non-suction) geotechnical data, which takes into account when the soil sample is taken and when the pier gets installed. The developed procedure allowed the subcommittee to calculate the design suction envelope based on the



properties of the sample taken, the depth from which it was sampled, and the day of the year on which it was sampled. Because the Part 2 procedure presented was developed for the Houston area, it would not apply to other areas of the country unless those areas' climatological data for the past 20 years are retrieved from public sources and inputted into the equations, a task too large for the subcommittee to include in its procedure.

Since 2013, Dr. Lytton further revised the procedure to more conservatively determine the design suction of an active soil based on limited (non-suction) geotechnical data, allowing the procedure to be useful across the country. In addition, the revised procedure means the engineer would not need to worry on what day the geotechnical data is sampled or which day the concrete piers would be drilled and placed. As with previous versions of this revised procedure, though suction and other locally less common geotechnical data are not needed by the engineer to use the procedure, the internal workings of the procedure continue to be based on suction that is derived from more common geotechnical data.



Ms. Wylie presented an update of the revised procedure that her subcommittee is submitting to peer review. She detailed the input needed to use the procedure and demonstrated the equations used to design drilled shafts in clays, silts, sands and gravel. Ms. Wylie also demonstrated the current version of the software developed by the subcommittee to vet the research by Dr. Lytton for the cohesive layers and by other subcommittee members for cohesionless layers, pier reinforcing, etc.

### PAST FPA PRESENTATIONS

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

- [December 2015](#) - Edge Cracking in Pavements on Expansive Soils: Causes and Countermeasures
- [December 2014](#) - Methylene Blue Test of Soil Properties: A Rapid and Accurate Field Test
- [December 2013](#) - **Design of Drilled Shafts in Expansive Soils. Part 2**
- [December 2012](#) - Design of Pavements on Expansive Clay Subgrades
- [December 2011](#) - **Design of Drilled Shafts in Expansive Soils**
- [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

To read summaries of previous FPA presentations by Ms. Wylie, please click:

- [December 2013](#) - Design of Drilled Shafts in Expansive Soils, Part 2
- [January 2006](#) - Guidelines for Evaluating Foundation Performance by Monitoring