ENHANCED IN-SITU TESTING FOR GEOTECHNICAL ANALYSIS & FOUNDATION DEISGN

Professor: Paul Mayne, PhD, PE

ABSTRACT
The course provides an overview on the types of in-situ geotechnical tests (SPT, CPT, CPTu, DMT, PMT, VST) and geophysical methods (Refraction, CHT, DHT, SASW), and places special emphasis on the utilization of the expedient SCPTù (and related SDMTà) for efficient collection of site-specific data for geotechnical investigations. Up to five independent readings on soil response are collected in a single sounding, in particular, the cone tip stress, sleeve friction, porewater pressure, time rate dissipations, and downhole shear wave velocity. Interpretative methods are reviewed for obtaining a suite of soil parameters & properties often required in geotechnical analyses, especially numerical modelling simulations. The importance and usefulness of the small-strain shear modulus (Gmax), obtained from shear wave velocities, is documented as an initial state parameter, representing the beginning of all stress-strain-strength curves (drained, undrained, static, dynamic). Numerous case studies are interwoven to show the general applicability of the approaches in soil behavior, as well as applications to full-scale foundation response.

COURSE OUTLINE

01 - In-Situ Testing Introduction
- Drilling and Sampling
- Overview of various in-situ tests, including:
  - Standard Penetration Testing (SPT)
  - Vane Shear Test (VST)
  - Flat Plate Dilatometer Test (DMT)
  - Pressuremeter Test (PMT)
  - Cone Penetration (CPT)
  - Piezocone (CPTu)

02 - Geophysical Methods
- Mechanical waves (compression P-, shear S-, Rayleigh R-waves)
- Methods for measurement by in-situ geophysics, including:
- Refraction (RF), Crosshole (CHT), Downhole (DHT), Surface Waves (SASW), and direct push methods (SCPT and SDMT)
- Electromagnetic Waves: ground penetrating radar (GPR), surface resisitivity and electrical conductivity, electromagnetic conductivity (EM), magnetometer.

03 – Effective Friction Angle from In-Situ Tests
- Drained Penetration – clean quartz sands
- Case Study – west campus - Georgia Tech
- Undrained Effective Penetration Method NTH Method)
- Case Study: Gloucester test site, Ottawa

04 – Critical State Soil Mechanics for Dummies
- Overview on CSSM in simple terms
- Shear strength and consolidation

05 - Profiling OCR in Clays by CPTU and DMT
- Cavity Expansion-Critical State Formulation

- Type 1 and 2 piezocones
- Calibrations with laboratory chamber tests
- Field case studies
- Approach for flat plate dilatometer

06 – First-Order Preconsolidation from In-Situ Tests
- Approximate methods for evaluating Pc' from in-situ tests
- Cone, Piezocone, Dilatometer, Vane, Pressuremeter, and Vs
- Case studies: 1. Port of Anchorage, Alaska; 2. Sandpoint, Idaho

07 – Undrained Shear Strength
- Characteristic Mode
- Strength Anisotropy
- Critical State Soil Mechanics (CSSM)
- Case Study – Troll Offshore Site, North Sea
- Case study - Cooper Marl, Charleston, SC

08 – Evaluation of Ko in Soils
- General Ko-OCR relationships in Soils
- CPT Calibration Chamber database method for quartzitic sands
- Case study applications

09 - Permeability & Time Rate: Piezo-Dissipation Tests
- Monotonic Porewater Pressure Decays
- Dilatory Response

10 - Piedmont Residual Soils
- Nontextbook Geomaterials
- Opelika National Geotechnical Experimentation Site

11 - Equivalent Elastic Soil Modulus
- Strain and stress-level dependency
- Foundation displacements evaluated by elastic continuum solutions
- Case study: Dorm B mat settlements evaluated by DMT

12 - Nonlinear Stress-Strain-Strength of Soils
- Approximate nonlinear stress-strain-strength evaluations from SCPT

13 - Nonlinear Footing Response
- Hybrid limit plasticity-elastic solutions for load-displacement capacity
- Class "A" and "C" Predictions – Case Studies at TAMU, Bothkennar, Belfast

14 - Axial Pile Response from SCPTu
- Direct vs Indirect (rational) CPT Methods for Capacity
- Elastic Continuum Framework for Displacements
- Case Studies at Amherst NGES, Texas A&M NGES, Opelika NGES, I-85 Coweta County, GT Campus, Southern Companies, GDOT Viaduct at CNN, Calgary O-cell testing, and other examples.

15 - Future Directions & Research

Upcoming advances in field testing and in-situ test devices, improved interpretation, and data processing are discussed.