Bentley PLAXIS 2D Essentials

1. **Course Objective:**

The objective is to develop a reliable foundation in PLAXIS 3D for creating, calculating, checking, and documenting common three-dimensional geotechnical models. The course emphasises efficient geometry creation, correct modelling assumptions, core soil and structural inputs, staged construction, everyday deformation and safety analysis, and clear interpretation of results.

2. **Target Audience:**

This course is intended for graduate engineers, geotechnical and civil engineers, foundation and excavation designers, engineering geologists, researchers, and CAD/CAE users who are beginning to use PLAXIS 3D.

Prerequisites
Participants should have:

- Basic knowledge of soil mechanics and foundation engineering.
- A general understanding of geotechnical investigation data and engineering drawings.
- Familiarity with stress, strain, settlement, bearing capacity, and factor of safety concepts.
- No previous PLAXIS or finite element software experience is required.

3. **Course Outcomes:**

After completing this course, participants will be able to:

- Set up PLAXIS 3D projects with suitable dimensions, boundaries, units, and modelling assumptions.
- Create three-dimensional stratigraphy and assign appropriate basic soil properties and material models.
- Build geometry and model structures, interfaces, loads, and prescribed displacements.
- Generate and refine 3D meshes and establish initial stresses and water conditions.
- Create realistic construction phases and perform Plastic and Safety calculations.
- Analyse basic shallow foundations, piles, pile groups, excavations, slopes, and embankments.
- Interpret soil and structural results and perform essential model-quality checks.
- Prepare clear plots, curves, exported data, and an engineering calculation summary.

4. Course Outline

The course comprises **40 hours** of instructor-led explanation, live demonstrations, and guided hands-on exercises divided into **ten modules**. It focuses on the core PLAXIS 3D workflow and everyday deformation and safety analysis suitable for beginner users. Each application module includes practical modelling, calculation, result checking, and engineering interpretation.

Table of Contents: (40hrs)

Module 1: Introduction to PLAXIS 3D and Geotechnical FEA

- Applications, benefits, and limitations of three-dimensional geotechnical analysis.
- Understanding the PLAXIS 3D modelling and calculation workflow.
- Navigating Soil, Structures, Mesh, Staged Construction, and Output modes.
- Creating projects; defining units, model dimensions, axes, and file organisation.
- Hands-on Exercise: Create and review a basic 3D project.

Module 2: Subsurface Geometry and Ground Conditions

- Creating boreholes, soil contours, layers, and three-dimensional stratigraphy.
- Defining groundwater levels and reviewing the ground model in 3D.
- Creating and editing soil volumes and checking geological continuity.
- Selecting model extents and recognising boundary influence.

Hands-on Exercise: Build a layered 3D subsurface model from simplified borehole data.

Module 3: Soil Properties and Basic Material Models

- Creating soil datasets and understanding strength, stiffness, unit weight, and permeability inputs.
- Understanding drained, undrained, and non-porous behaviour.
- Using the Linear Elastic and Mohr-Coulomb models for introductory analysis.
- Introduction to Hardening Soil behaviour and when a more advanced model may be required.
- Parameter checks, unit consistency, realistic ranges, and common input errors.

Hands-on Exercise: Define, compare, and assign soil materials to 3D soil volumes.

Module 4: 3D Geometry, Structural Elements, Interfaces, and Loads

- Creating points, lines, surfaces, volumes, plates, beams, embedded beams, anchors, and geogrids.
- Using extrusion, intersection, array, and basic geometry-editing tools.
- Defining structural properties and selecting suitable element idealisations.
- Using interfaces to represent soil-structure slip and separation.
- Applying point, line, surface loads, and prescribed displacements.

Hands-on Exercise: Model a loaded foundation or retaining structure with interfaces.

Module 5: Mesh, Initial Stresses, and Calculation Phases

- Generating a 3D finite element mesh and applying local refinement.
- Establishing initial stresses using K0 or gravity loading.
- Defining basic water conditions and initial pore pressures.
- Creating phases and activating or deactivating soil, structures, and loads.
- Using Plastic and Safety calculations and recognising calculation warnings.

Hands-on Exercise: Mesh a model and create a staged-construction sequence.

Module 6: Shallow Foundation and Raft Analysis

- Modelling isolated footings, combined footings, and raft foundations.
- Applying vertical, horizontal, moment, and combined loading.
- Reviewing settlement, contact pressure, stress distribution, and plastic points.
- Understanding symmetry and efficient model-size reduction.

Hands-on Exercise: Analyse settlement and load response of a shallow foundation.

Module 7: Piles and Pile Groups

- Understanding volume piles and embedded beam representations.
- Modelling a single pile and a basic pile group.
- Reviewing axial force, skin resistance, base resistance, settlement, and group interaction.
- Creating load-settlement curves and comparing pile modelling choices.

Hands-on Exercise: Calculate the load-settlement response of a single pile.

Module 8: Excavations and Retaining Systems

- Creating open and supported excavations using staged construction.
- Modelling walls, struts, anchors, slabs, interfaces, and surcharge loads.
- Reviewing wall deformation, bending moments, support forces, and ground settlement.
- Comparing construction sequences and identifying critical phases.

Hands-on Exercise: Analyse a simplified 3D braced excavation.

Module 9: Slopes, Embankments, and Safety Analysis

- Modelling slopes, embankments, staged fills, and basic reinforcement zones.
- Understanding strength reduction and interpreting the calculated safety factor.
- Reviewing deformation patterns and potential failure mechanisms.
- Checking boundaries, mesh sensitivity, and construction-stage influence.
- Hands-on Exercise: Evaluate deformation and safety for a slope or embankment.

Module 10: Output Interpretation, Reporting, and Final Project

- Navigating Output and using phases, cross-sections, slices, and result selections.
- Reviewing displacement, stress, strain, pore pressure, plastic points, and structural forces.
- Creating curves and exporting tables, plots, images, and animations.
- Checking convergence, equilibrium, mesh dependency, boundary effects, and unrealistic results.

Integrated Final Project: Build, calculate, validate, and document a complete PLAXIS 3D model.