Bentley PLAXIS 2D Essentials

Course Objective:

The objective is to develop a reliable foundation in PLAXIS 2D for creating, calculating, checking, and documenting common two-dimensional geotechnical models. The course emphasises correct modelling assumptions, core soil and structural inputs, staged construction, everyday deformation and safety analysis, and clear interpretation of results.

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 2D.

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.

Course Outcomes:

After completing this course, participants will be able to:

- Select plane-strain or axisymmetric idealisation for common problems.
- Create soil stratigraphy and assign appropriate basic soil properties and material models.
- Model structural elements, interfaces, loads, and prescribed displacements.
- Generate and refine meshes and establish initial stresses and water conditions.
- Create realistic construction phases and perform Plastic and Safety calculations.
- Analyse basic foundations, excavations, retaining structures, slopes, embankments, and tunnels.
- Interpret soil and structural results and perform essential model-quality checks.
- Prepare clear plots, curves, exported data, and an engineering calculation summary.

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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 2D 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 2D and Geotechnical FEA

- Applications and limitations of 2D finite element analysis in geotechnical engineering.
- Understanding plane-strain and axisymmetric modelling assumptions.
- Navigating Soil, Structures, Mesh, Staged Construction, and Output modes.
- Creating projects; defining units, model contour, boundaries, and file organisation.

Hands-on Exercise: Create and review a basic plane-strain project.

Module 2: Soil Stratigraphy and Ground Conditions

- Creating boreholes, soil layers, soil polygons, and non-horizontal stratigraphy.
- Defining groundwater levels and reviewing subsurface conditions.
- Translating basic site-investigation information into a PLAXIS 2D model.
- Checking soil-layer continuity, model extent, and boundary influence.

Hands-on Exercise: Build a layered ground profile 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 a layered profile.

PLAXIS

Module 4: Structural Elements, Interfaces, and Loads

- Creating plates, embedded beam rows, anchors, node-to-node anchors, and geogrids.
- Defining structural properties and selecting appropriate element idealisations.
- Using interfaces to represent soil-structure interaction, slip, and separation.
- Applying point loads, distributed loads, prescribed displacements, and line contractions.

Hands-on Exercise: Model a retaining wall or strip footing with interfaces and loading.

Module 5: Mesh, Initial Stresses, and Calculation Phases

- Generating the finite element mesh and applying local refinement.
- Establishing initial stresses using the K0 procedure or gravity loading.
- Defining basic water conditions and initial pore pressures.
- Creating calculation 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 realistic staged-construction sequence.

Module 6: Shallow Foundation Analysis

- Modelling strip and circular footings using plane-strain and axisymmetric idealisations.
- Applying load-controlled and displacement-controlled foundation loading.
- Reviewing settlement, contact pressure, stress distribution, and plastic points.
- Creating load-displacement curves and comparing serviceability responses.

Hands-on Exercise: Determine the load-settlement response of a circular footing.

Module 7: Excavations and Retaining Structures

- Creating open-cut and supported excavations using staged construction.
- Modelling walls, struts, anchors, excavation interfaces, and surcharge loads.
- Reviewing wall movement, bending moments, anchor forces, and ground settlement.
- Comparing construction sequences and identifying the critical phase.

Hands-on Exercise: Analyse a braced excavation with a simplified water level.

Module 8: Slopes, Embankments, and Safety Analysis

- Modelling natural slopes, cut slopes, embankments, and basic reinforcement.
- Understanding shear-strength reduction and interpreting the calculated safety factor.
- Reviewing deformation patterns, incremental displacement, and failure mechanisms.
- Checking mesh sensitivity, model boundaries, and the influence of construction stages.

Hands-on Exercise: Evaluate deformation and safety for a slope or embankment.

Module 9: Introduction to Tunnel Modelling

- Identifying when a 2D tunnel idealisation is appropriate.
- Creating basic tunnel geometry using Tunnel Designer.
- Defining lining, interfaces, excavation stages, and simplified support.
- Reviewing lining forces, deformation, and ground-surface settlement.

Hands-on Exercise: Build and calculate a basic supported tunnel model.

Module 10: Output Interpretation, Reporting, and Final Project

- Navigating Output and selecting phases, result types, structural elements, and cross-sections.
- Reviewing displacement, stress, strain, pore pressure, plastic points, and structural forces.
- Creating curves and exporting tables, plots, and images for calculation notes.
- Checking convergence, equilibrium, mesh dependency, boundary effects, and unrealistic results.

Integrated Final Project: Build, calculate, validate, and document a complete PLAXIS 2D model.