GENERAL

ansys workbench 14 tutorial civil engineering

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ANSYS Workbench 14 Tutorial for Civil Engineering

For civil engineers, simulation and analysis tools are indispensable for designing safe, efficient, and cost effective structures. Among the most powerful platforms available is ANSYS Workbench 14, which combines a user friendly interface with advanced finite element capabilities. This comprehensive tutorial will guide you through the essential steps of using ANSYS Workbench 14 for civil engineering projects—from setting up a new project and importing geometry to defining material properties, applying loads, meshing, solving, and interpreting results. By the end of this article, you will have a solid foundation to tackle a variety of civil engineering analyses, including bridge design, soil structure interaction, and foundation performance.

Why ANSYS Workbench 14 is a Game Changer for Civil Engineers

ANSYS Workbench 14 offers a modular, drag and drop environment that streamlines the workflow for complex simulations. Key advantages for civil engineers include:

- Integrated pre and post processing tools that reduce the need for external software.
- Robust finite element models for solids, shells, beams, and soil.
- Extensive material libraries covering concrete, steel, timber, and geotechnical materials.
- Support for non linear, dynamic, and static analyses—essential for seismic, impact, and long term load studies.
- Compatibility with Revit, AutoCAD, and other BIM tools, enabling seamless data exchange.
- Advanced post processing visualization with contour plots, deformation animations, and stress trajectories.

Whether you are a seasoned analyst or a student learning the ropes, ANSYS Workbench 14 provides a powerful yet approachable platform for civil engineering simulation.

Getting Started: Installing and Launching ANSYS Workbench 14

Before diving into the tutorial, ensure that ANSYS Workbench 14 is properly installed on your workstation. The installation process typically involves:

1. Running the ANSYS installer from the official download page.
2. Choosing the “WorkBench” component during the component selection step.
3. Accepting the license agreement and selecting the installation directory.
4. Completing the installation and launching the application.

Once launched, you will see the Workbench project window, where you can create and manage your simulation projects.

Step by Step ANSYS Workbench 14 Tutorial for Civil Engineering

1. Creating a New Civil Engineering Project

Begin by creating a new project that will house all components of your simulation.

1. Click File > New or use the New Project icon.
2. Give your project a meaningful name, such as “Bridge_Structure_Analysis.”

3. Save the project to a desired folder.

2. Importing Geometry

Geometry can be imported from various sources, including CAD files (.DWG, .DXF), Revit models, or directly created within the ANSYS DesignModeler.

1. Drag the Geometry cell into the project schematic.
2. Double click the cell to open DesignModeler.
3. Use File > Import to bring in your CAD file or open a Revit model.
4. Clean up the geometry by removing unnecessary edges, merging coincident surfaces, and ensuring proper orientation.
5. Once satisfied, click Save and Close to return to Workbench.

3. Defining Material Properties

Accurate material data is critical for realistic simulation results. ANSYS Workbench 14 offers a material editor with a vast library.

1. Drag the Engineering Data cell into the schematic.
2. Double click to open the material editor.
3. Create new materials for concrete, steel, timber, or soil by selecting New Material and entering the required parameters such as density, Young's modulus, Poisson's ratio, and yield strength.
4. For soil, define parameters like cohesion, friction angle, and modulus of elasticity.
5. Save the material database.

4. Applying Boundary Conditions and Loads

Boundary conditions define how the model interacts with its environment, while loads represent forces acting on the structure.

1. Drag the Static Structural cell into the schematic.
2. Double click to open the solver interface.
3. Under Environment, add Fixed Support constraints to simulate foundations or abutments.
4. Add Distributed Loads for dead weight, live traffic, wind, or seismic forces.
5. Use Point Loads for concentrated forces like vehicle loads or seismic ground motion.
6. Define load combinations for safety analysis, e.g., 1.4 Dead + 1.0 Live.

5. Meshing Strategies for Civil Structures

A good mesh is essential for accurate results. ANSYS Workbench 14 provides several meshing options.

1. Drag the Mesh cell into the schematic.
2. Double click to open the Mesh editor.
3. Choose appropriate element types: SOLID185 for solid elements, SHELL181 for shell elements.
4. Set Element Size based on the geometry size and expected stress gradients.
5. Apply Mesh Refinement in critical areas such as beam column joints or near load application points.
6. Use Boundary Layer Meshing for fluid structure interaction if analyzing wind loads.
7. Run a mesh check to ensure element quality metrics (aspect ratio, skewness) are within acceptable ranges.

6. Solving the Model

After setting up the model, it is time to solve.

1. Right click the Static Structural cell and select Solve.
2. Monitor the solver progress and watch for convergence.

3. Once the solution is complete, click Post Processing to view results.

7. Interpreting Results

ANSYS Workbench 14 offers a rich post processing environment.

- Use Deformation Plots to visualize global displacement.
- Plot Stress Contours (e.g., Von Mises, Normal Stress) to identify critical points.
- Generate Force Vectors to inspect load directions.
- Export Reports that summarize key results, including maximum stresses and deflections.

Case Study 1: Bridge Design Using ANSYS Workbench 14

Let's apply the steps above to a practical civil engineering scenario: analyzing a simply supported concrete bridge span.

1. Geometry Setup

The bridge deck is modeled as a rectangular slab, 30 m long, 5 m wide, and 0.5 m thick. Two steel piers support the deck at each end.

2. Material Assignment

- Concrete deck: Density /= /2400 /kg/m³, Young's modulus /= /30 /GPa, Poisson's ratio /= /0.2.
- Steel piers: Density /= /7850 /kg/m³, Young's modulus /= /200 /GPa, Poisson's ratio /= /0.3.

3. Load Cases

1. Dead Load: Self weight of the deck and piers.
2. Live Load: Uniform traffic load of 5 /kN/m².
3. Seismic Load: Ground acceleration of 0.2 /g in the horizontal direction.

4. Boundary Conditions

Fixed supports at the bottom of the piers simulate concrete foundations. The deck's outer edges are free, allowing for realistic flexural behavior.

5. Meshing

Use **SOLID185** elements with an average size of 0.3 /m for the deck and **BEAM188** elements for the piers. Refine the mesh near the pier deck interfaces.

6. Solution and Post Processing

After solving, examine:

- Maximum deflection at the deck midspan (should be within design limits).
- Stress distribution in the deck and piers (check against allowable stress).
- Seismic response—evaluate the displacement and stress amplification.

Case Study 2: Soil Structure Interaction Analysis

Soil structure interaction (SSI) is critical for foundations, retaining walls, and underground structures. ANSYS Workbench 14 can model soil as a continuum with appropriate constitutive models.

1. Soil Model Definition

- Use ISOL elements for soil, representing a linear elastic or elasto plastic behavior.
- Define soil parameters: Cohesion /= /25 /kPa, Friction Angle /= /30°, Young's modulus /= /30 /MPa, Poisson's ratio /= /0.35.

2. Foundation Geometry

Model a circular footing, 3 /m diameter, 2 /m depth, embedded in the soil.

3. Boundary Conditions

Apply **Fixed Support** at the bottom of the soil domain and **Symmetry** planes on the sides.

4. Load Cases

- Vertical load of 200 /kN applied to the footing.

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