Example of a coupled pile simulation with *PFC* and *FLAC3D*

Problem Statement

This example demonstrates the use of coupled *FLAC3D-PFC* simulations. The model simulates the application of a pile system, which is often used in geotechnical or civil engineering projects for ground stabilization or foundation setup.

A simple pile with a hollow setup is shown in this example, which is typically used for the foundation setup of offshore wind energy turbines. During the simulation, the pile will intrude into the soil ground material, which is generated of *PFC* particles. In order to improve calculation time, the outside areas of the model consist of *FLAC3D* zones. The implemented coupling plugin in *FLAC3D* and *PFC* was used to set up and run the simulation. The code works in *FLAC3D* 7.0 as well as in *PFC3D* 6.0.

Numerical Model

The model is divided in two main parts.: 1) the ground material consists of particles in a “bed” of zones; and 2) a pile constructed with zones. In order to create the ground material, a box of zones is created. The box dimensions are defined as variables in the code. Inside the box of zones is a free space for particles. The space for particles is also free of choice and defined by variables in the code. For the model installation, all zones of the ground material are created initially. Also, the constitutive model and material properties for the zones are set at this point (Table 1). For this example, a simple elastic constitutive model is installed. After installation of zones, the free space is filled with particles and the particle contact model is set with the contact assignment table. The ground material is complete (Figure 1) and can be saved as an initial model for pile simulations with different setups.

Table 1: Ground material properties

Young’s modulus [MPa]	150
Density [kg/m³]	2400
Poisson’s ratio [-]	0.25

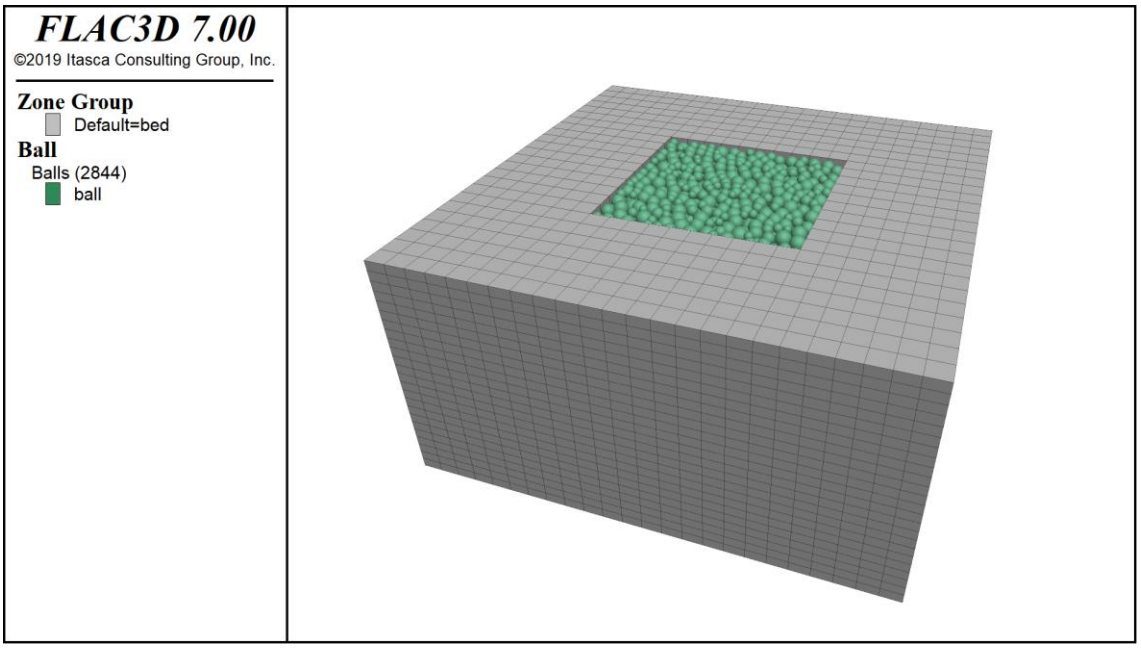

Figure 1: Initial ground material model.

Next, the pile is installed by a function searching for the actual model top in the particle area to set up the initial position of the pile. The pile is then installed as a hollow cylinder (Figure 2). The length, radius, and wall thickness of the pile is free of choice and defined as variables in the code. The constitutive model and material properties for the pile zones are set at this point. For the ground material, a simple elastic model is installed for the pile zones. The pile material properties were set to simulate a steel material (Table 2). For the intrusion into the ground material, a pre-defined velocity is applied to the pile.

Table 2: Pile material properties

Bulk modulus [GPa]	160
Shear modulus [GPa]	80
Density [kg/m³]	7850

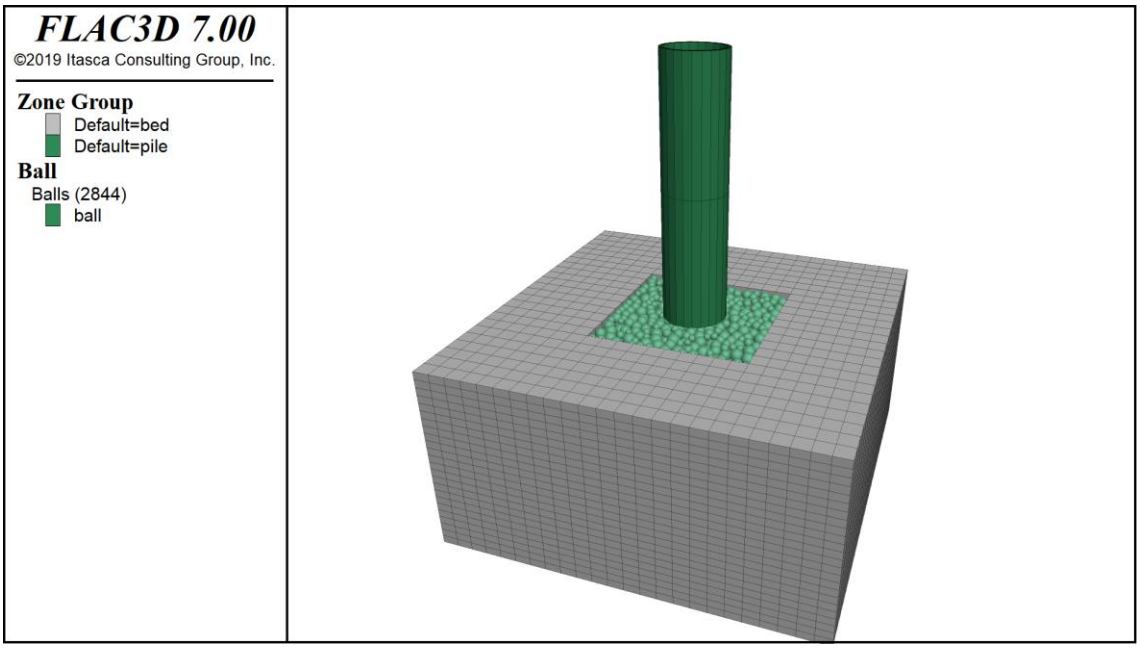

Figure 2: Model after pile installation.

Simulation Results

Figure 3 shows the simulation after the pile intrudes the ground material. The most displacements accrue at the pile tip. The boundary between *PFC* particles and *FLAC3D* zones shows a smooth transition of the displacements. The pile velocity is constant.

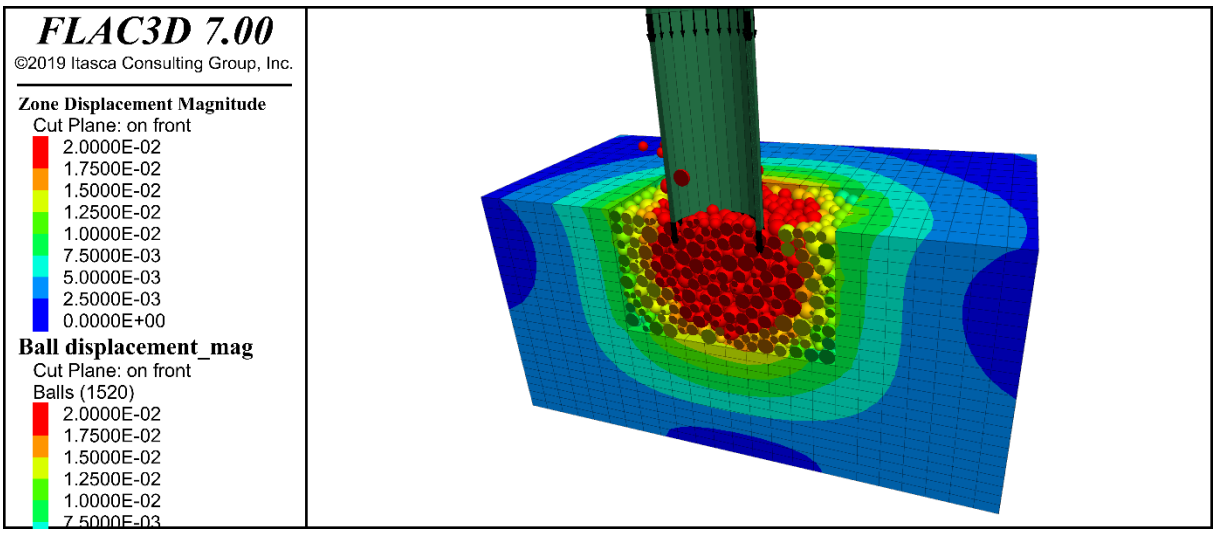

Figure 3: Displacement in ground material during intrusion of the pile.

Listing of Data Files

The example project contains the following input files:

- Example-Pile.dat
- generalFunctions.fis