Bearing Capacity of Layered Soil

Keywords

Axisymmetric, Modified Mohr-Coulomb model, arclength.

Problem Description

LUSAS is used to calculate the bearing capacity of a footing on a two-layer soil. For this case, the bearing capacity is compared to that calculated using the Brinch-Hansen formula. The example considers a circular load with a diameter of 1m applied to the surface of a soil made up of two distinct layers of undrained clay, the upper layer being 0.5m thick. Figure 1 illustrates the problem.

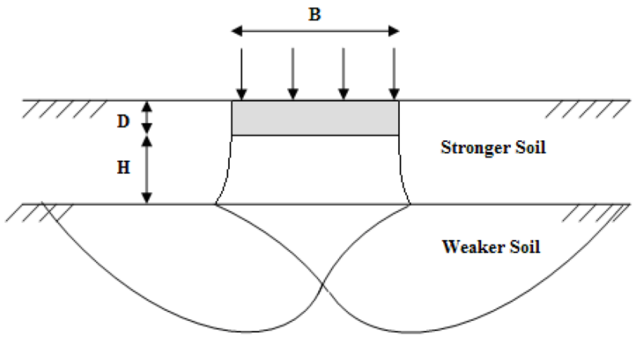

Figure 1: Problem definition

Discretisation

The model consists of an axisymmetric quadratic element mesh (QAX8). The model is totally restrained from moving in the x and y directions. The finite element mesh can be found in Figure 2.

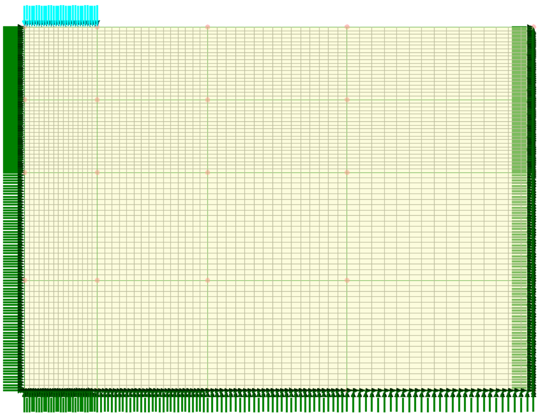

Figure 2: Mesh and boundary conditions

Material Properties

The table 1 lists the soil parameters for the upper and lower soils.

Table 1: Modified Mohr-Coulomb material properties.
Upper Soil

Young's modulus, E	Poisson's ratio, ν	Angle of friction, ϕ	Cohesion, c	Angle of dilation ψ
20E3 kPa	0.3	0°	4 kPa	0°

Lower Soil

Young's modulus, E	Poisson's ratio, ν	Angle of friction, φ	Cohesion, c	Angle of dilation ψ
20E3 kPa	0.3	0°	1 kPa	0°

Loading Conditions

The applied load on the top surface is gradually increased using arclength until failure occurs.

Theory

The Brinch Hansen bearing capacity equation is one of the most widely used methods for calculating allowable bearing capacity of soil. It is an extension of the Terzaghi method that takes into account foundations on slopes and other conditions that the Terzaghi method does not. The collapse load is given by the following equation (1).

$$q_u = cN_c\lambda_{cs}\lambda_{ci}\lambda_{c\alpha}\lambda_{cd}\lambda_{ct} + qN_q\lambda_{qs}\lambda_{qi}\lambda_{q\alpha}\lambda_{qd}\lambda_{qt} + 0.5\gamma BN_\gamma\lambda_{\gamma s}\lambda_{\gamma i}\lambda_{\gamma\alpha}\lambda_{\gamma d}\lambda_{\gamma t} \quad (1)$$

Comparison

The bearing capacity calculated by Brinch Hansen is 17.83 kPa which is 1.3% greater than the 17.59 kPa calculated by LUSAS. Figure 3 depicts a plot of applied load versus displacement. We can see how the curve transforms into a plateau at the critical value. The displacement at failure is illustrated in figure 4.

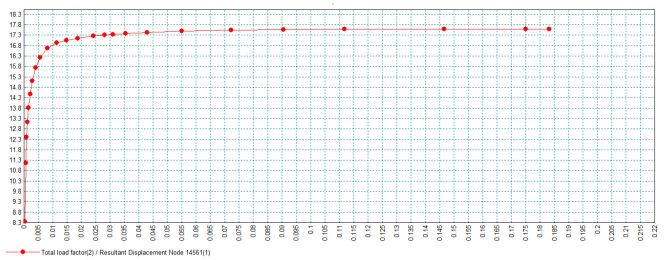

Figure 3: Displacement versus applied load

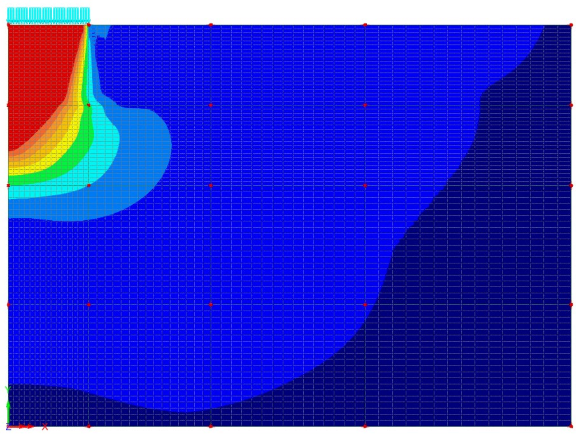

Figure 4: Displacement at failure

References

[1] Brinch Hansen, J, A revised and extended formula for bearing capacity, Danish Geotechnical Institute, Bulletin 28,5-11, 1970

Input Data

layered_soil.lvb