Bearing Capacity of Undrained Footing on Clayey Soil

Keywords

2D, Plane Strain, Arclength, Bearing Capacity.

Problem Description

The bearing capacity of a shallow footing on a purely cohesive soil is considered in this problem. It is assumed that the stratum is homogeneous and isotropic. A uniform strip load is applied at the surface, the footing is assumed to be flexible. The strip load B has a width of 1 m. 2D plane strain analysis is used (Figure 1).

Discretisation

The problem is modelled using triangle plane strain elements, TPN6. The finite element mesh can be found in Figure 1.

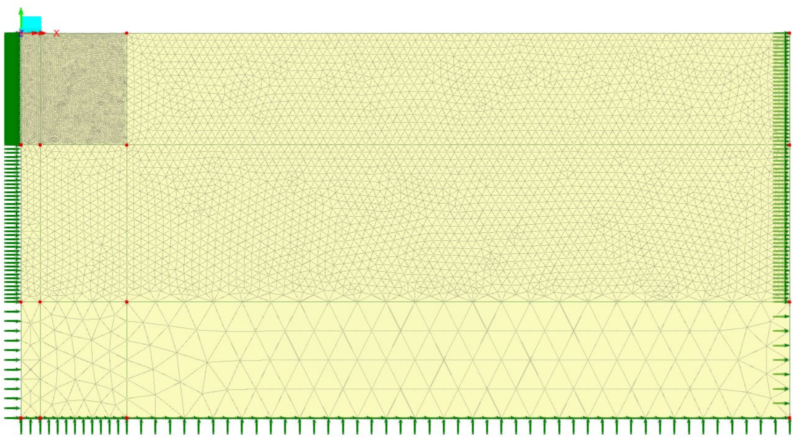

Figure 1: Finite element mesh showing supports.

Material Properties

The material properties are defined using the Modified Mohr-Coulomb material model as shown in the table 1.

Table 1: Modified Mohr-Coulomb material properties

Young's modulus, E	Poisson's ratio, ν	Angle of friction, φ	Cohesion, c	Dilation
10E3 kPa	0.3	0°	1 kPa	0°

Loading Conditions

A 1 kPa surcharge load is applied to the ground surface as well as a 1 kPa load to the foundation. The foundation load is increased until failure of the footing.

Theory

The bearing capacity of a shallow strip footing on a clay layer can be written in the form

$$q_u = c_u N_c + q$$

where N_c is a bearing capacity factor and q is a surcharge.

Modelling Hints

The strip load on the foundation is increased using the arclength method until the soil fails.

Comparison

The value of N_c is tabulated [1] as 5.14 when the internal friction is equal to zero, so the bearing capacity can be calculated as follows

$$q_u = 1 * 5.14 + 1 = 6.14\ kPa$$

Figure 2 shows the load factor/displacement plot for the point under the load at the axis origin. A maximum load factor of 5.17 is reached at failure so giving a bearing capacity of 6.17 kPa. Figure 3 is a plot of the effective strain at failure with vectors of displacement plotted on top.

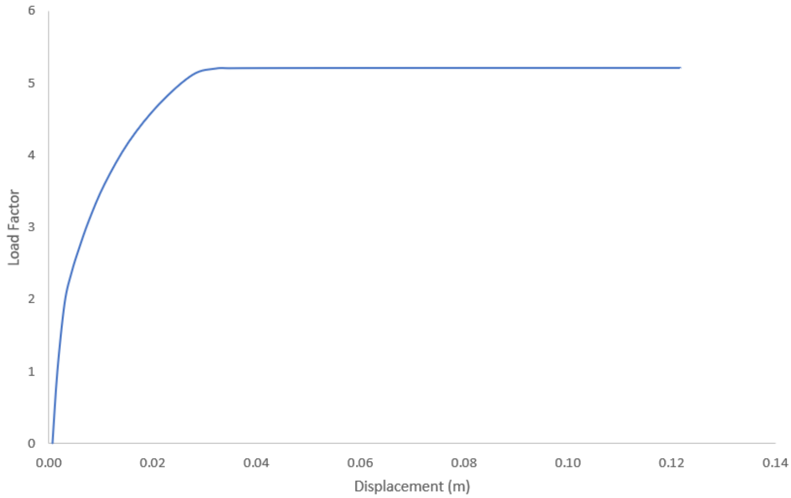

Figure 2: Load factor-displacement curve

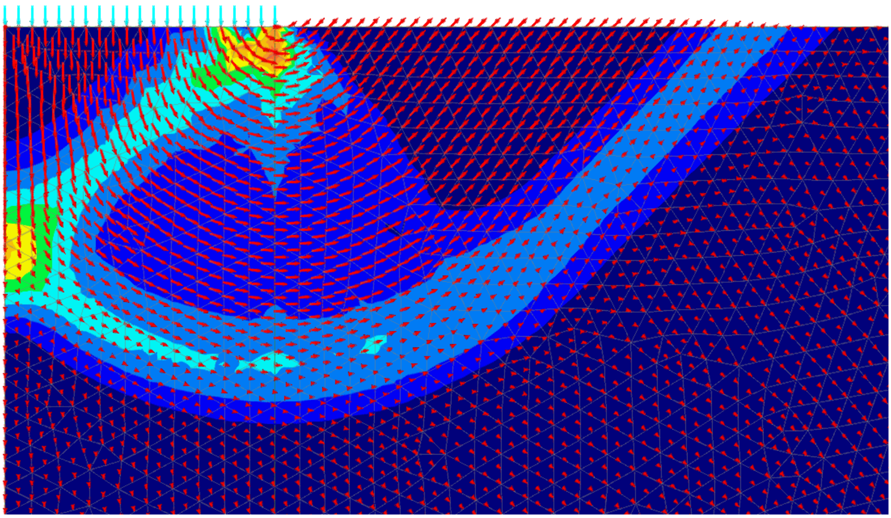

Figure 3: Displacement vectors – effective strain contours

References

[1] Braja M. Das and Nagaratnam Sivakugan, Principles of foundation engineering, Nelson Education Ltd, 2019.

Input Data

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