Footing Stability

1 Introduction

Terzaghi's bearing capacity formula makes the assumption that the slip surface that develops under a strip footing exits the ground surface at an angle of 45° - ϕ/2, which is the angle of passive earth pressure. With the grid and radius slip surface, you have the option of defining active or passive projection angles, which are especially useful when you know that the slip surface will not follow the arc of a circle throughout the soil profile.

The purpose of this example is to illustrate the use of the slip surface projection feature to simulate the slip surface that develops under a footing load. Other features of this example include:

- Pressure boundary
- Use of Ru coefficients
- Grid and radius slip surface with a limited projection exit angle

2 Configuration and setup

The anticipated failure surface under the strip footing has been sketched on the simple profile, as shown in Figure 1. Since this is a left to right failure, the right projection angle is the passive earth pressure projection angle. We know that the slip surface will include the bottom left corner of the footing. This is the location where the search radius is defined as a single point. For this simulation, the friction angle, ϕ, is equal to 30°. When defining the single point radius, a right (passive) projection angle will also be defined as 45° - ϕ/2 = 45 – 30/2 = 30°.

Pressure lines are used to simulate a pressure applied over a portion of the soil surface (e.g., to model a footing on the ground surface). Unlike line loads, which are a concentrated force applied at one point, pressure lines are applied over an area. The pressure over the applied area is then converted into a line load (i.e., a force per unit depth) for each slice that exits underneath the pressure boundary.

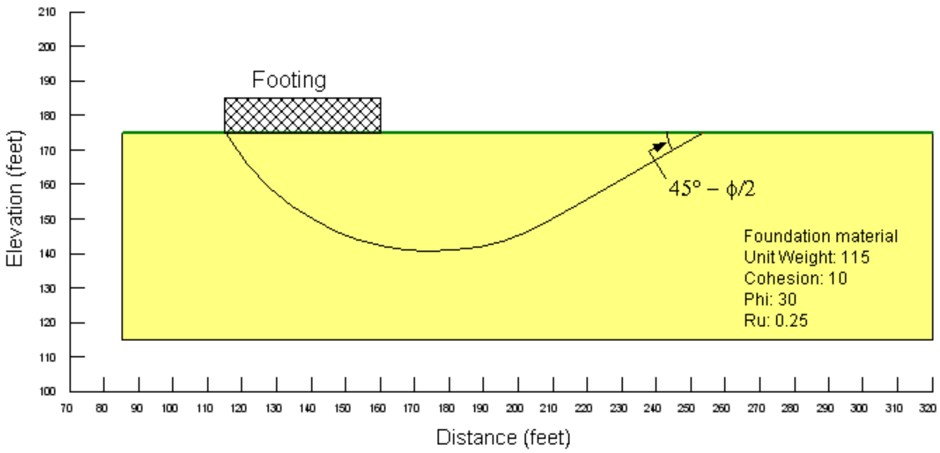

Figure 1 Schematic failure surface under a footing load

The location of the single point radius, the search grid and the pressure boundary representing the footing load are shown in Figure 2.

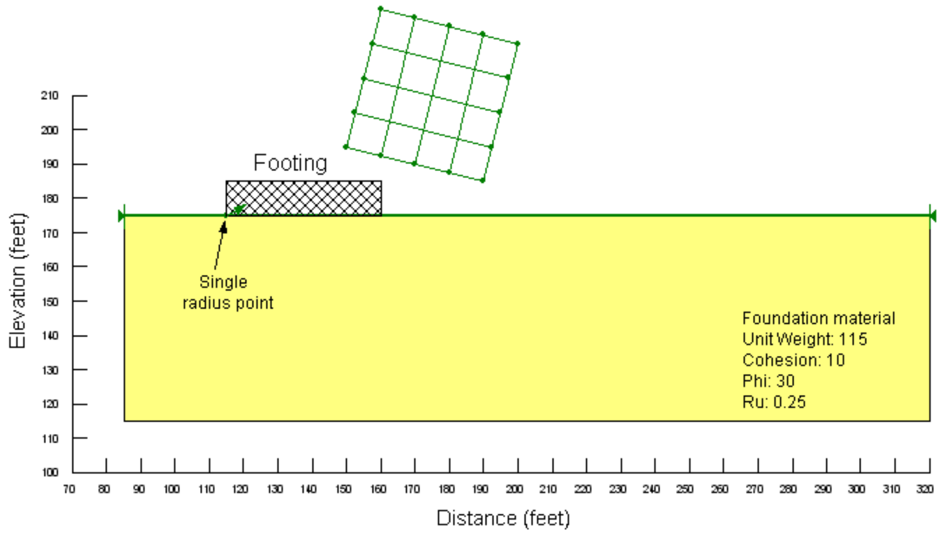

Figure 2 Location of the grid and radius

3 Critical factor of safety

The critical slip surface and factor of safety, as well as factor of safety contours, for the strip footing are presented in Figure 3.

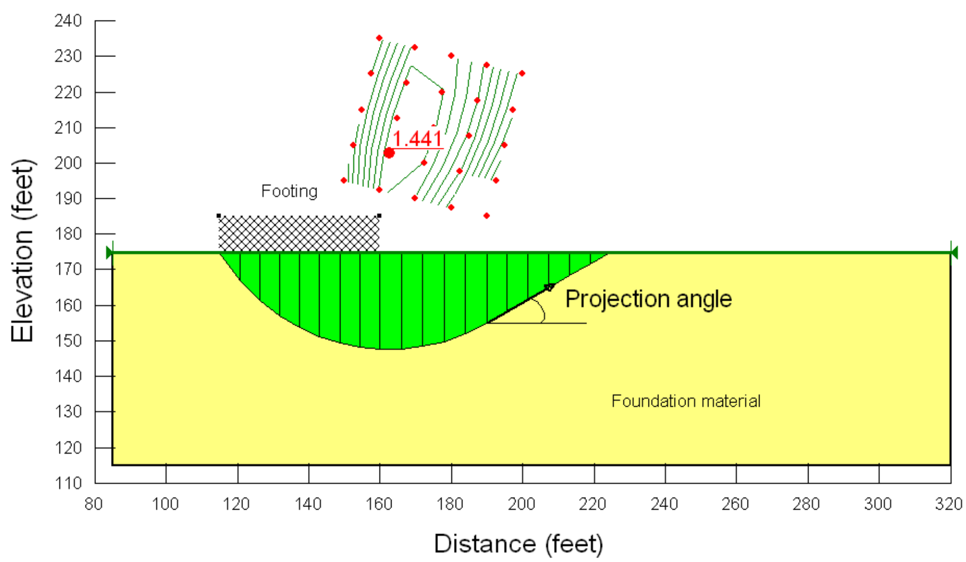

Figure 3 Location of the critical slip surface and the resulting factor of safety for a strip footing

In CONTOUR under view slice information, the base angle of the slices is reported. For this slip surface, which consists of 19 individual slices, slices 14 - 19 have base angles equal to 30°, which indicates that the defined projection angle of 30° was maintained for slices in the passive wedge.

Hand calculations can also be completed to spot check that the pressure boundary was appropriately defined. Note the presence of a line load of 56250 lbs/ft acting on the top of slice #5 shown in Figure 4.

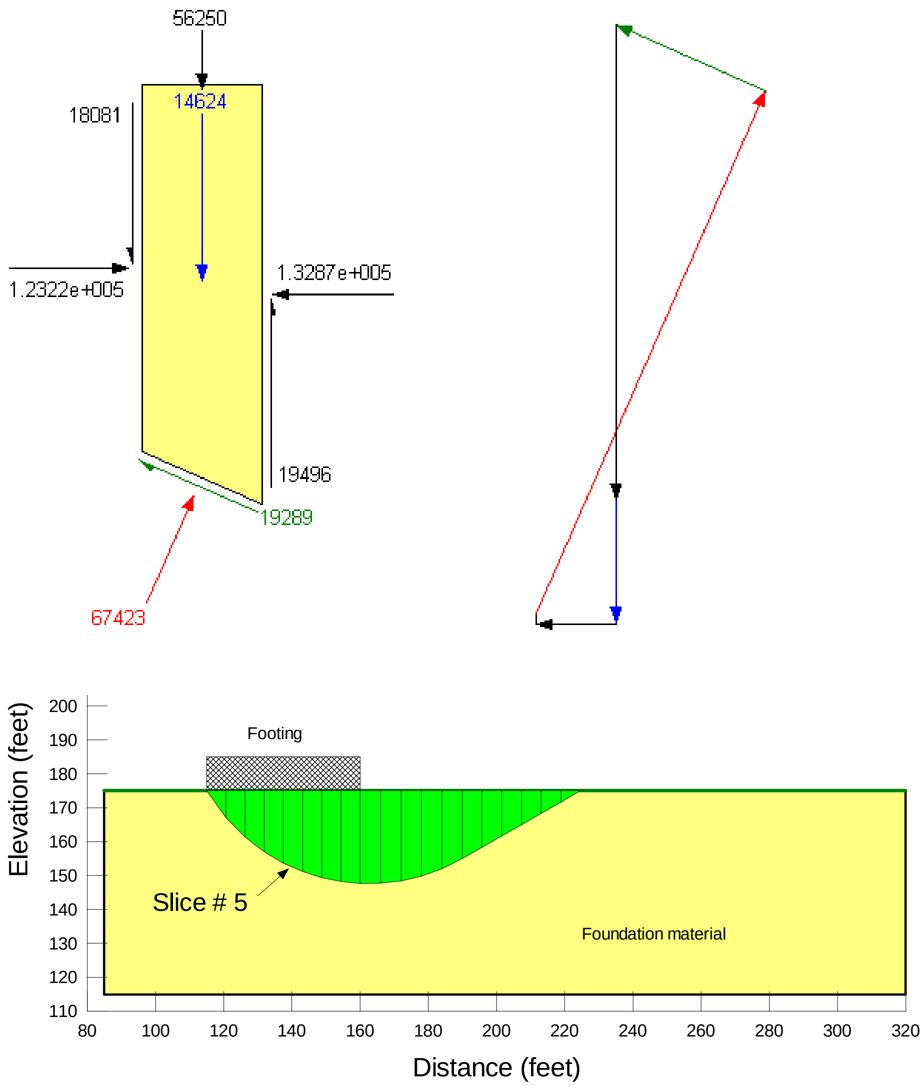

Figure 4 View slice information showing the presence of a line load on slice 5

Since the applied pressure is 1000 lbs/ft^2, the height of the pressure boundary is 10 ft and the width of slice #5 is 5.625 ft, the applied line load force is as follows:

1000 lbs/ft2 x 10 ft x 5.625 ft = 56250 lbs (per unit depth)

Similarly, for slice #5, the reported pore-water pressure acting at the base of the slice is equal to 3150 lbs/ft^2. The pore-pressure ratio R_u is a coefficient that relates the pore-pressure to the overburden stress. The total overburden stress is the sum of the applied pressure load on the slice and the soil weight of the slice divided by the width of the slice. Therefore, the pore water pressure for Slice # 5 can be calculated as:

u = R_u x Overburden_stress = 0.25 x (56250 + 14624) / 5.625 = 3150 lbs/ft^2