GeoStudio Example File
Pressure Bulb beneath a Strip Footing

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Introduction

This example computes the pressure beneath a strip footing on an elastic half space. Closed-form solutions based on the Boussinesq equations are presented in most introductory soil mechanics textbooks for this case (i.e. Bowles, 1975). Since the solutions are so readily available, and since they are so well known, this is a useful example for testing the SIGMA/W formulation.

Numerical Simulation

A 2D analysis with a vertical symmetric axis through the footing is used in this analysis because the footing is continuous in the out-of-plane direction. The footing load is applied as a Y-pressure of -100 kPa (the minus sign indicates downward). The pressure of 100 kPa is selected so that vertical stress contours represent a percentage change in the vertical stress with depth.

The material properties E and v are arbitrarily chosen, since they do affect the vertical pressure contours.

The footing width B is 4 m; the half width is 2 m.

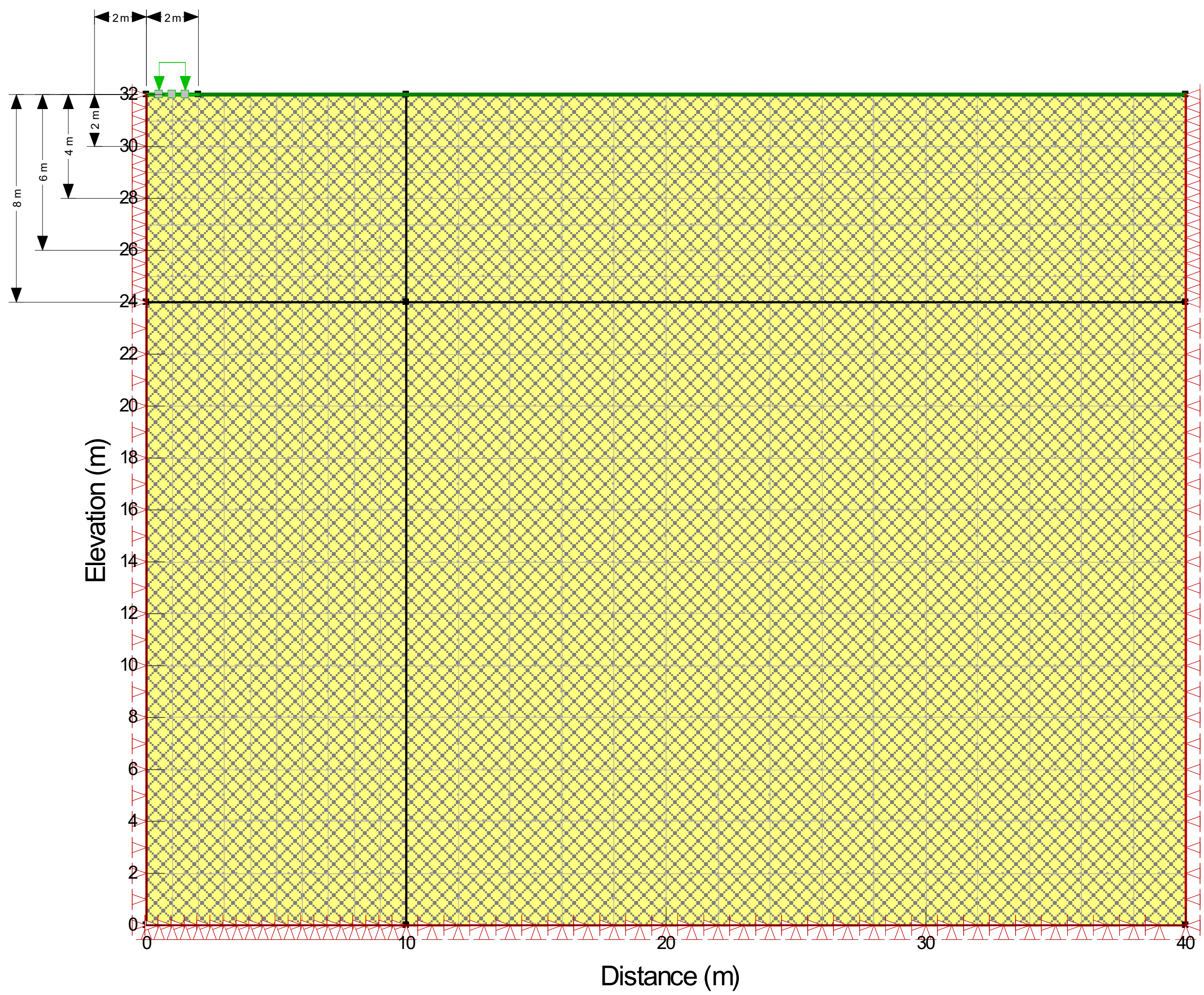

Figure 1. Problem configuration.

Results and Discussion

Figure 2 presents the SIGMA/W computed vertical stress contours that represent the typical bulbs of vertical pressure. The contour labels represent percentages of the applied pressure.

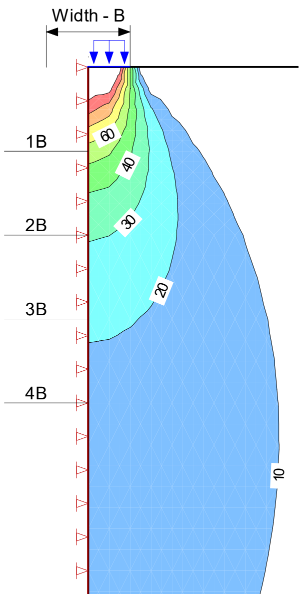

Figure 2. Resulting vertical stress contours.

Figure 3 shows the pressure isobars based on the Boussinesq equation for a footing (Bowles, 1975). The isobars on the right are for a strip (continuous) footing.

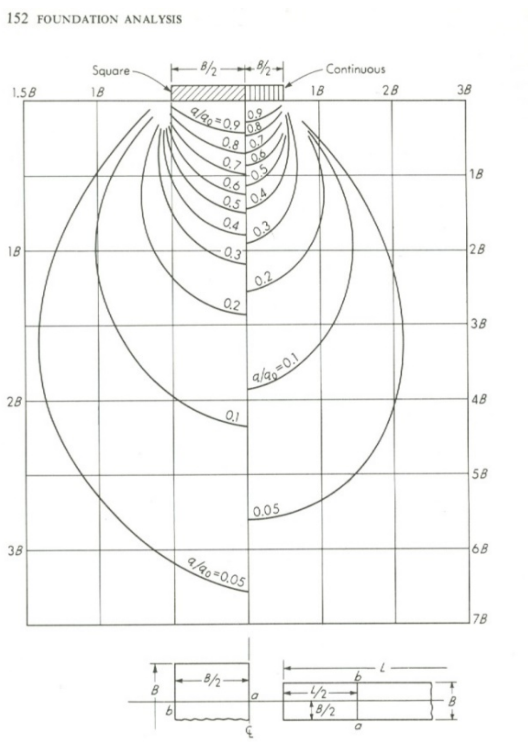

Figure 3. Vertical stress contours presented by Bowles (1975) based on the Boussinesq equation.

The SIGMA/W vertical pressure contours match the comparable isobar position under the centre of the footing reasonably well up to 20% of the applied load. The closed-form solution shows the 30% line just above 3B, while the SIGMA/W line is just below 3B. The SIGMA/W 20% line is at about 3.2B while the chart value is at about 2.6B. The SIGMA/W 10% line, however, is much deeper than the 10% chart line.

The shapes of the bulbs of pressure are consistent with closed-form solutions, but the low-stress change influence is much deeper. The difference is likely due to the simplifying assumptions necessary to apply the Boussinesq equation, which was developed for a point load, to the case of a strip footing. The mathematically more rigorous finite element formulation, based on the theory of elasticity for plane strain, is likely a better representation of the actual case.

Although there are some differences between the closed-form solutions and the SIGMA/W results, all indications are that SIGMA/W has been formulated correctly.

Summary and Conclusions

This example verified a 2D analysis by demonstrating the strip footing bearing capacity problem to the Boussinesq pressure bulb beneath the footing.

References

Bowles, J.E. 1975. Foundation Analysis and Design. McGraw-Hill Book Company, p. 152.