Example 7.3 Circular foundation subjected to eccentric loading

1 Description of the problem

Another example is considered to show the applicability of nonlinear analysis of foundations using the program *ELPLA* for simple assumption model to different foundation types. The results of nonlinear analysis for a circular raft calculated by *Teng* (1962) are compared with those obtained by the program *ELPLA*.

A circular raft of radius r = 5 [m] is considered as shown in Figure 7.7. The raft carries an eccentric load of N = 2000 [kN]. The position of the resultant N is defined by the ordinate e.

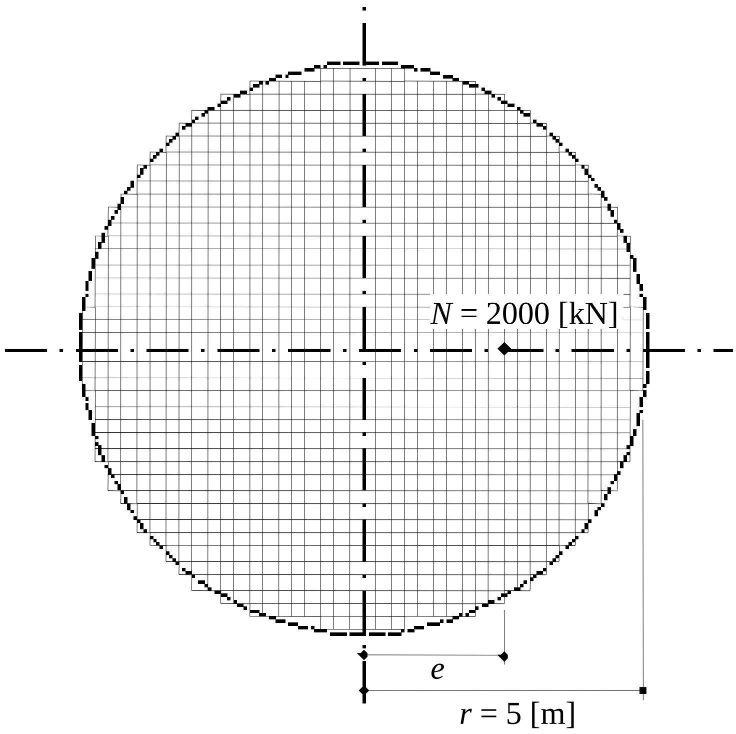

Figure 7.7 Plan of the circular raft with dimensions and FE-Net

2 Analysis
2.1 Simple assumption model

To carry out the comparison, the raft is subdivided into 1238 square elements. Each element has a side of 0.25 [m]. The contact pressures q under the middle of the raft are obtained in Figure 7.8 at different ratios e/r, which shows also the separation zones. The ratio e/r ranges from 0.25 to 0.75.

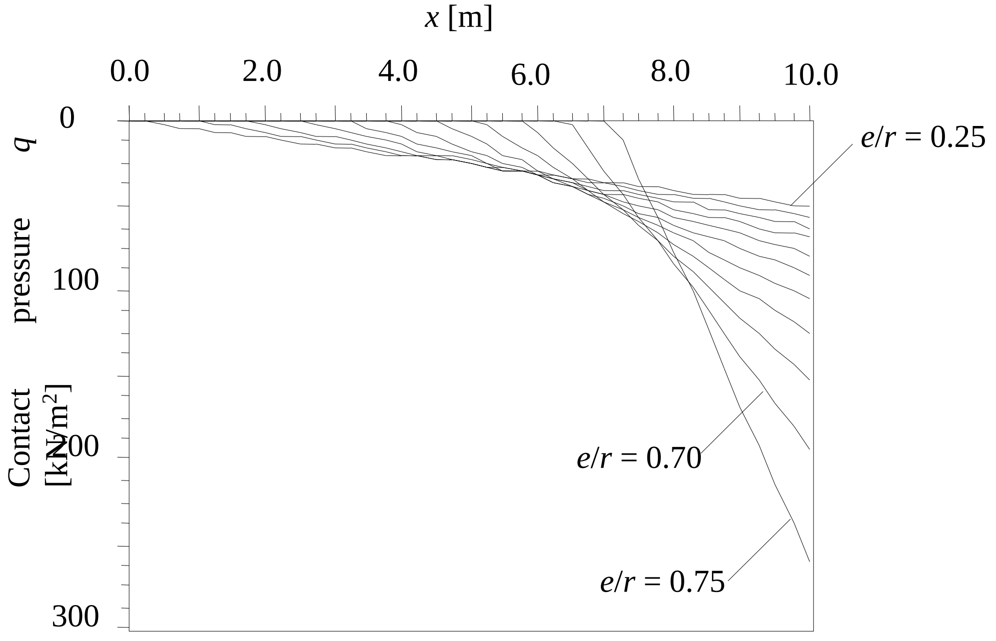

Figure 7.8 Contact pressures q [kN/m^2] under the circular raft at different values of e/r

The coefficient $k = max\ q_o\ \pi\ r^2/N$ at different ratios e/r obtained from the program *ELPLA* is plotted and compared with the results obtained by *Teng* (1962) in Figure 7.9. It can be concluded from this figure that the results of nonlinear analysis of the circular raft using the program *ELPLA* and those of *Teng* (1962) are in a good agreement.

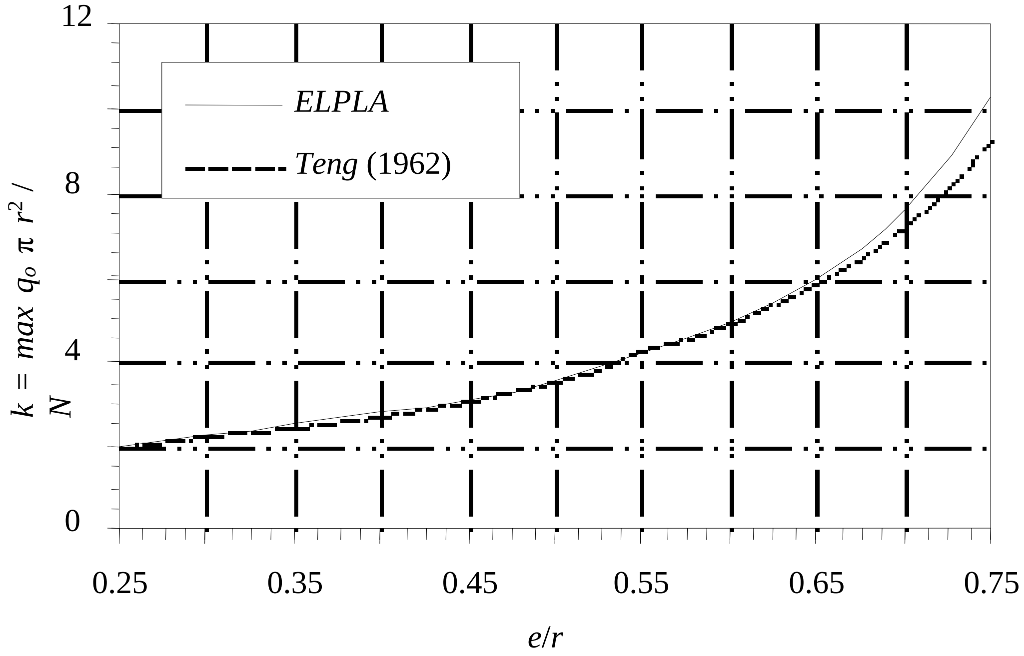

Figure 7.9 Coefficient $k = max\ q_o\ \pi\ r^2/N$ at different ratios e/r

2.2 Rigid raft on Continuum medium

Although it is easy to drive closed form equations for raft separation in case of regular rafts for simple assumption model, but it is difficult to drive such equations for circular rigid rafts. For this reason, the same circular raft is analyzed again for rigid raft on Continuum medium to show the applicability of the nonlinear analysis of foundations using the program *ELPLA* for different soil models. The subsoil under the raft is chosen to be a layer of sand, which has the following parameters:

Modulus of compressibility	E_s = 12 000	[kN/m^2]
Poisson's ratio	ν_s = 0.25	[-]
Layer depth	z = 10	[m]

The core of the circular raft, in which no separation occurs when the resultant N lies in it, takes a radius $r/4$ in case of simple assumption model, while in case of rigid raft on Continuum medium takes a radius $r/3$. Therefore, the rigid raft is analyzed for different ratios e/r from 0.35 to 0.75. Figure 7.10 shows the contact pressures q under the raft at different values of e/r, while Figure 7.11 shows the settlements s.

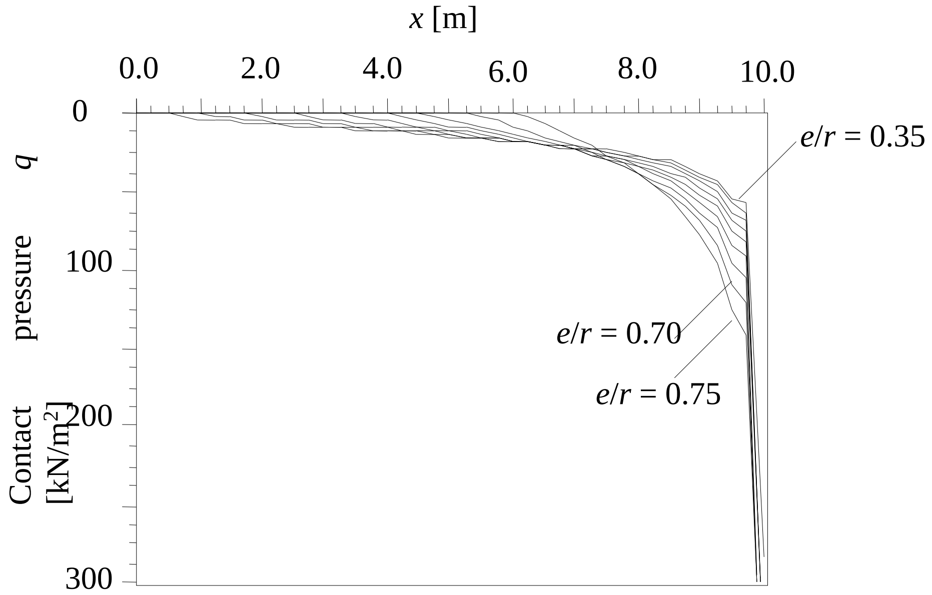

Figure 7.10 Contact pressures *q* [kN/m^2] under rigid circular raft at different values of *e*/*r*

A comparison between Figure 7.8 and Figure 7.10 shows that the effective contact area for the raft in case of simple assumption model is less than that of rigid raft on Continuum medium at the same corresponding ratio *e*/*r*. The effective contact area and effective width may be used to determine the ultimate load for the foundation, which carries eccentric loading. Figure 7.11 shows that the separation zones have upward settlements.

The effective contact width *c* for the circular raft is given in a non-dimensional form in Figure 7.12. Depending on the nature of the load eccentricity and the radius of the raft, once the magnitudes of the effective width and the effective area are determined, they can be used in Equation 7.6 to determine the ultimate load of the raft.

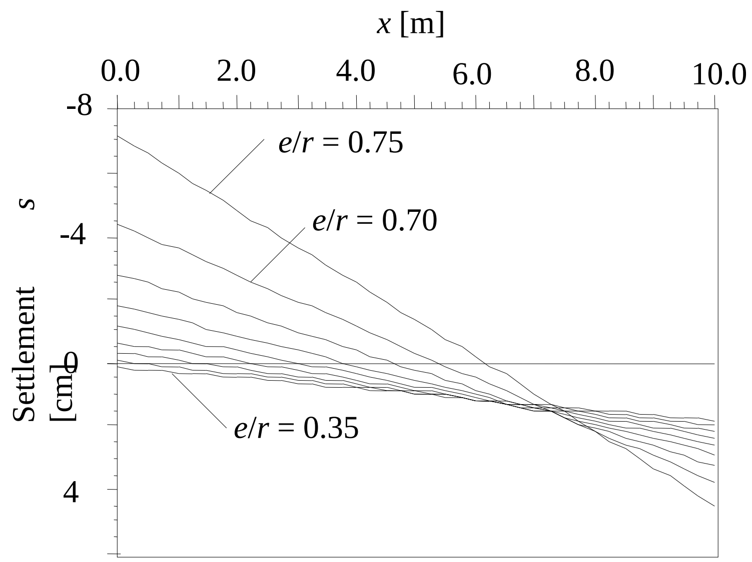

Figure 7.11 Settlements *s* [cm] under rigid circular raft at different values of *e*/*r*

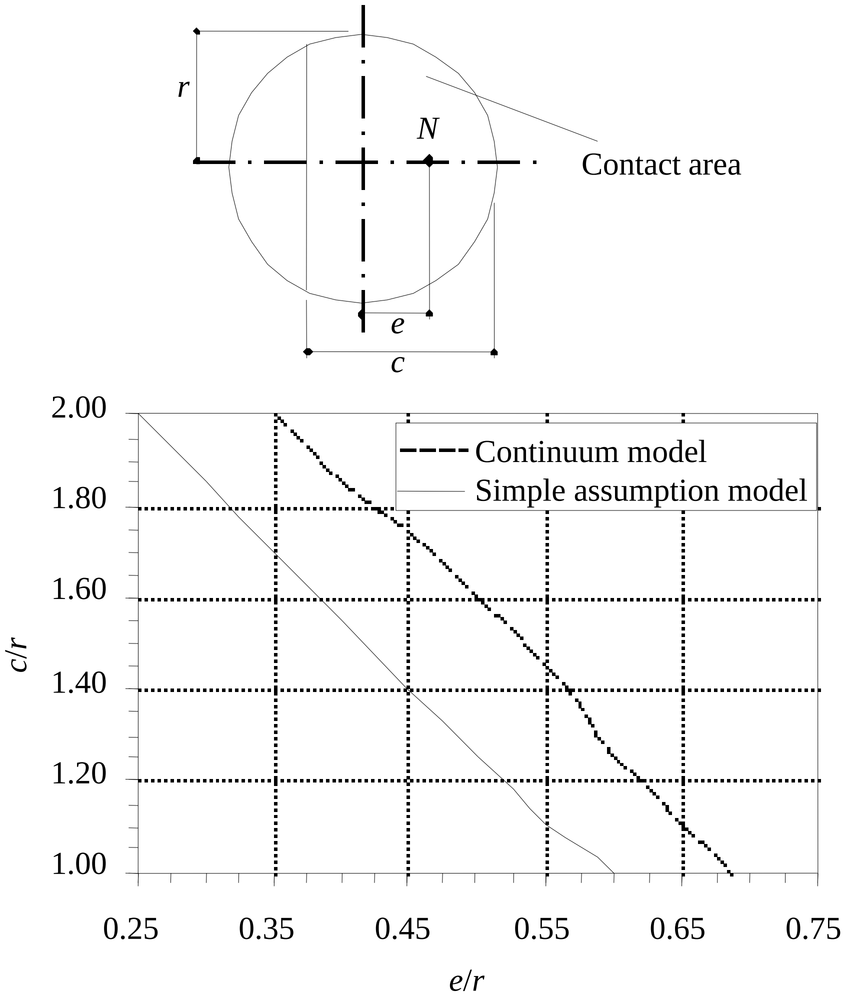

Figure 7.12 Diagram to determine the contact width *c* of the circular raft by eccentric loading