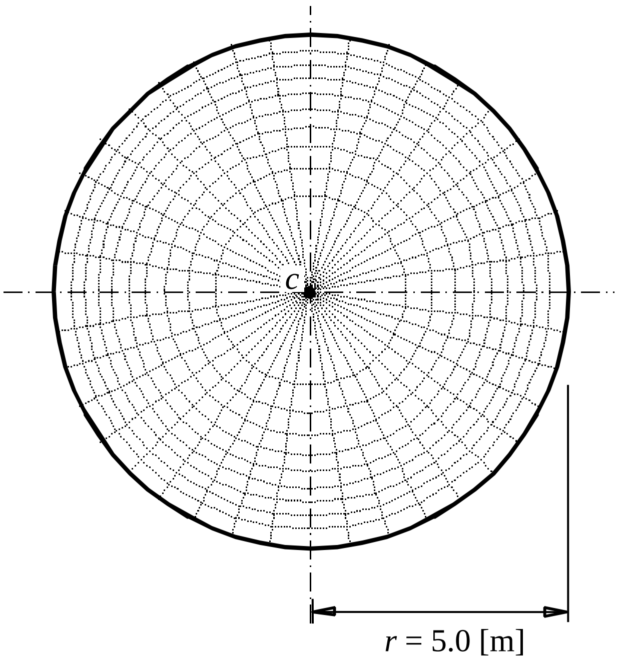
Example 2: Stress on soil under a circular loaded area

1 Description of the problem

To verify the vertical stress at point *c* below the center of a circular loaded area, the influence coefficients of stress I_z below the center of a uniformly loaded area at the surface obtained by *Scott* (1974), Table 12.2, page 287, are compared with those obtained by *ELPLA*.

Figure 2 shows a distributed load of q = 1000 [kN/m^2] that acts on a flexible circular area of radius r = 5 [m]. It is required to determine the vertical stress under the center *c* of the area at different depths *z* up to 10 [m] below the ground surface.

a)



b)

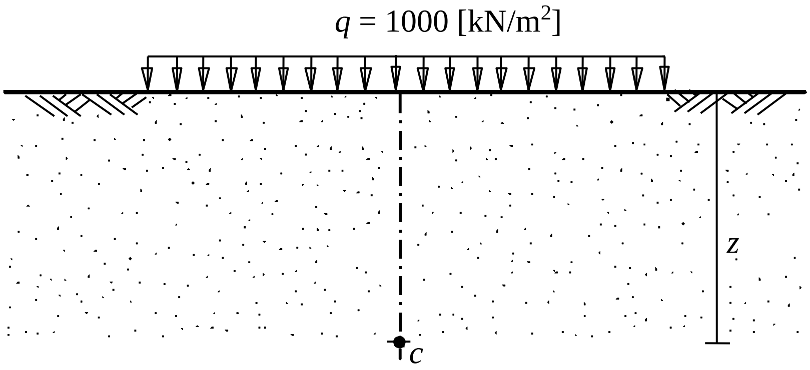


Figure 2 a) Plan of the loaded area with dimensions and FE-Net

b) Cross section through the soil under the loaded area

2 Hand calculation of stress on soil

According to *Scott* (1974), the stress on soil below the center of a uniformly loaded circular area at the surface may be determined by integrating *Boussinesq's* expressions over the relevant area. The stress σ_z [kN/m^2] at a depth z [m] under the center of a circular loaded area q [kN/m^2] of radius r [m] is given by

$$\sigma_z = q\, I_\sigma \ [\text{kN/m}^2] \qquad (3)$$

where I_σ [-] is the influence coefficient of the soil stress and is given by

$$I_\sigma = 1 - \frac{1}{\left[1 + \left(\frac{r}{z}\right)^2\right]^{3/2}}$$

3 Stress on soil by *ELPLA*

The contact pressure in this example is known and distributed uniformly on the ground surface. Therefore, the available method "Flexible foundation 9" in *ELPLA* may be used here to determine the stress on soil due to a uniformly loaded circular area at the surface. This can be carried out by choosing the option "Determination of limit depth", where the limit depth calculation requires to know the stress on soil against the depth under the foundation. The location of the stress on soil under the loaded area can be defined at any position in *ELPLA*. In this example only the stress on soil is required. Therefore, any reasonable soil data may be defined.

The influence coefficients I_σ of the soil stress below the center of a uniformly loaded circular area at the surface are shown in Table 2. From this table, it can be observed that the influence coefficients obtained by *ELPLA* under the loaded circular area at different depths below the ground surface are nearly equal to those obtained by hand calculation from Eq. 3 with maximum difference of $\Delta = 0.50$ [%].

Table 2 Influence coefficient I_σ [-] of the soil stress below the center of a uniformly loaded circular area

z/r [-]	I_σ [-]		Diff. Δ [%]	*z/r* [-]	I_σ [-]		Diff. Δ [%]
	Scott (1974)	*ELPLA*			*Scott* (1974)	*ELPLA*	
0.0	1.000	1.000	0.00	1.3	0.502	0.501	0.20
0.1	0.999	0.999	0.00	1.4	0.461	0.460	0.22
0.2	0.992	0.992	0.00	1.5	0.424	0.423	0.24
0.3	0.976	0.976	0.00	1.6	0.390	0.389	0.26
0.4	0.949	0.949	0.00	1.7	0.360	0.359	0.28
0.5	0.911	0.910	0.11	1.8	0.332	0.331	0.30
0.6	0.864	0.863	0.12	1.9	0.307	0.306	0.33
0.7	0.811	0.811	0.00	2.0	0.284	0.284	0.00
0.8	0.756	0.755	0.13	2.1	0.264	0.263	0.38
0.9	0.701	0.700	0.14	2.2	0.246	0.245	0.41
1.0	0.646	0.645	0.15	2.3	0.229	0.228	0.44
1.1	0.595	0.594	0.17	2.4	0.214	0.213	0.47
1.2	0.547	0.546	0.18	2.5	0.200	0.199	0.50