Example 20: Examination of influence of overburden pressure

1 Description of the problem

One of the advantages of *ELPLA* is that the bilinear relation of deformation for the modulus of compressibility can be taken into consideration. Therefore, an example was carried out by the Modulus of compressibility method 7 to show the influence of overburden pressure on the settlements, contact pressures and moments.

A square raft that has the dimension of 18 × 18 [m^2] under an elevated water tank is chosen as shown in Figure 36.

For comparison, *ELPLA* was used to study the influence of overburden pressure (q_v, W_v) on the values of settlements, contact pressures and moments for the following three different assumptions:

- Without taking into consideration the influence of overburden pressure, where the modulus of compressibility for reloading W_s of the soil is taken to be equal to that of loading E_s

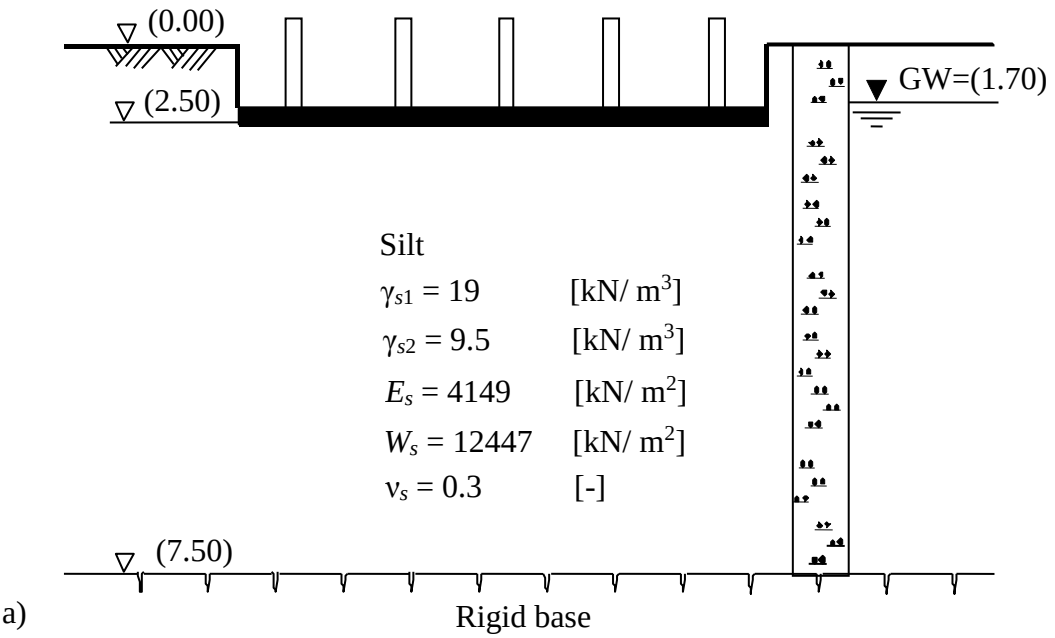
- The modulus of compressibility for reloading W_s of the soil is very great ($W_s = 9 \times 10^8$ [kN/m^2]), where the settlement due to the reloading of the soil is nearly zero

- The modulus of compressibility for reloading W_s = 12447 [kN/m^2] is three times as the modulus of compressibility for loading E_s = 4149 [kN/m^2], where the bilinear relation of deformation for the modulus of compressibility is taken into consideration

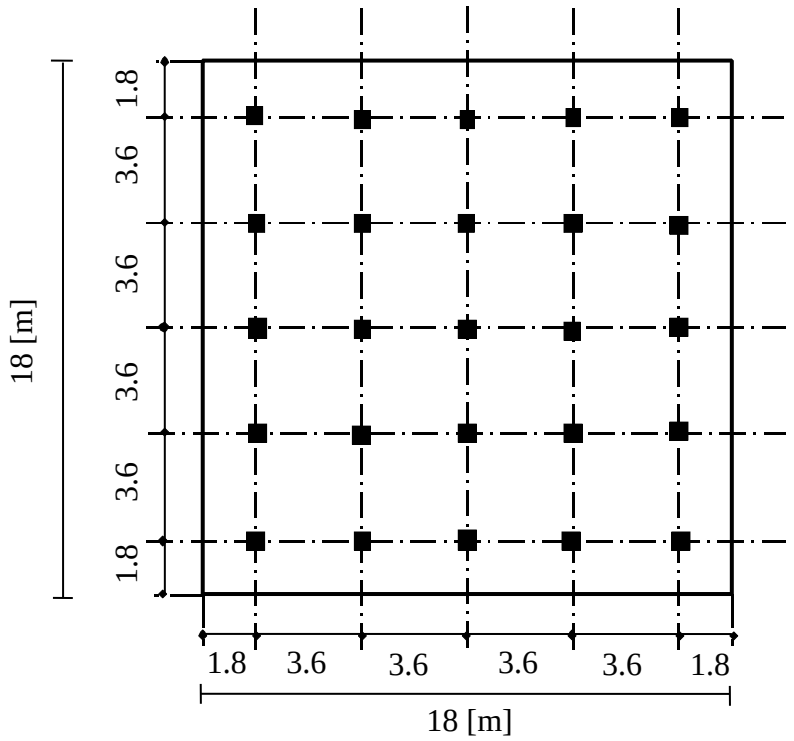
2 Raft material and thickness

The raft material and thickness are supposed to have the following parameters:

Young's modulus	E_b	$= 2 \times 10^7$	[kN/m^2]
Poisson's ratio	ν_b	= 0.25	[-]
Unit weight	γ_b	= 25	[kN/m^3]
Raft thickness	d	= 0.75	[m]



a)



b)

Figure 36 a) Section elevation in soil and raft

b) Dimensions [m] and columns (Each column load is 1685 [kN])

3 Soil properties

The subsoil under the raft is 5 [m] layer of silt resting on rigid base of rock. The layer parameters and the moduli of compressibility E_s (for loading) and W_s (for reloading) are given in the soil profile, Figure 36a. The level of water table under the ground surface is GW = 1.7 [m]. The level of foundation is d_f = 2.5 [m].

The silt has the following parameters:

Unit weight above the water table	γ_{s1}	= 19	[kN/m^3]
Unit weight under the water table	γ_{s2}	= 9.5	[kN/m^3]
Modulus of compressibility for loading	E_s	= 4149	[kN/m^2]
Modulus of compressibility for reloading	W_s	= 12447	[kN/m^2]
Poisson's ratio	ν_s	= 0.3	[-]

4 Loads

The raft transmits equal loads for all 25 columns, each of 1685 [kN]. The loads give average contact pressure on soil q_{av} = 130 [kN/m^2]. Columns are equally spaced, 3.6 [m] apart, in each direction as shown in Figure 36b.

5 Analysis of the raft

Taking advantage of the symmetry in shape and load geometry about *x*- and *y*-axes, the analysis was carried out by considering only a quarter of the raft, Figure 37. A net of equal square elements is chosen. Each element has a side of 1.8 [m]. There is a total of only 36 nodal points, each with three unknown displacements, so the total number of equations is reduced to 108.

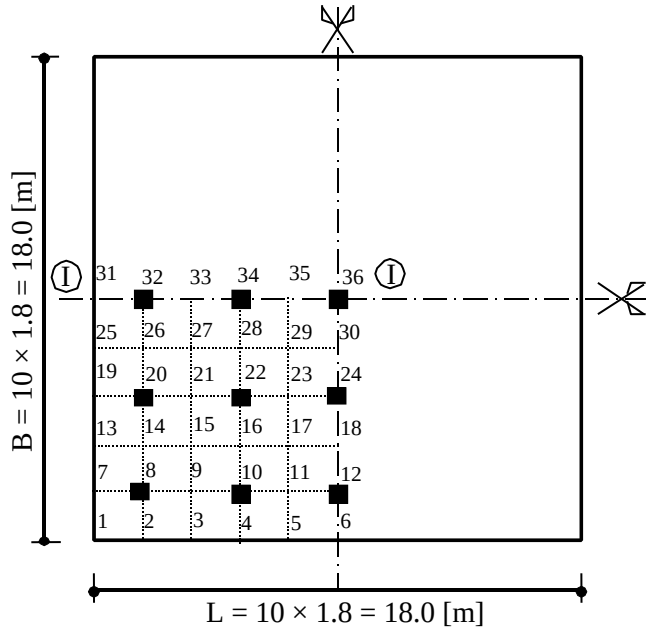


Figure 37 FE-Net of the raft with node numbering

6 Results and evaluation

Figure 38 to Figure 40 show the expected settlement *s*, contact pressure distribution *q* and moment m_x at the middle section I-I of the raft for the three cases of analysis. The results of the analysis with and without taking into consideration the influence of overburden pressure show that the settlement has great difference while the contact pressure and moment have practically no difference. On the other hand a great difference is remarkable for the settlements (Figure 38).

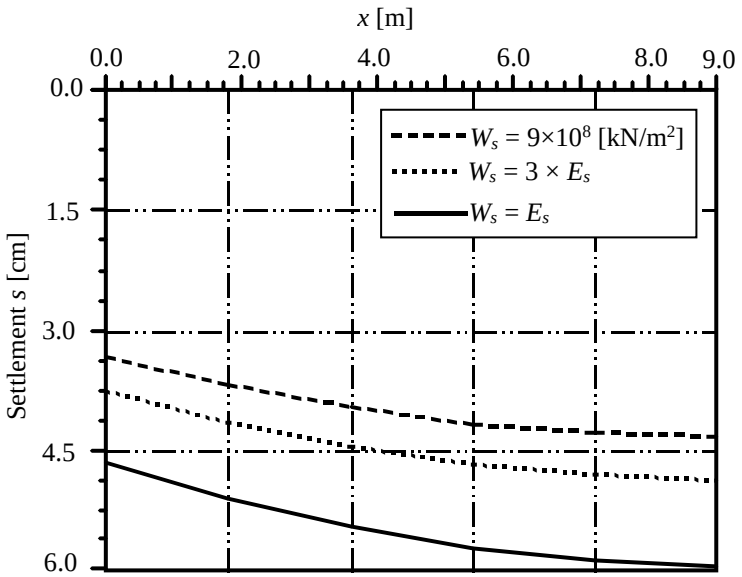


Figure 38 Settlement *s* [cm] at the middle section of the raft

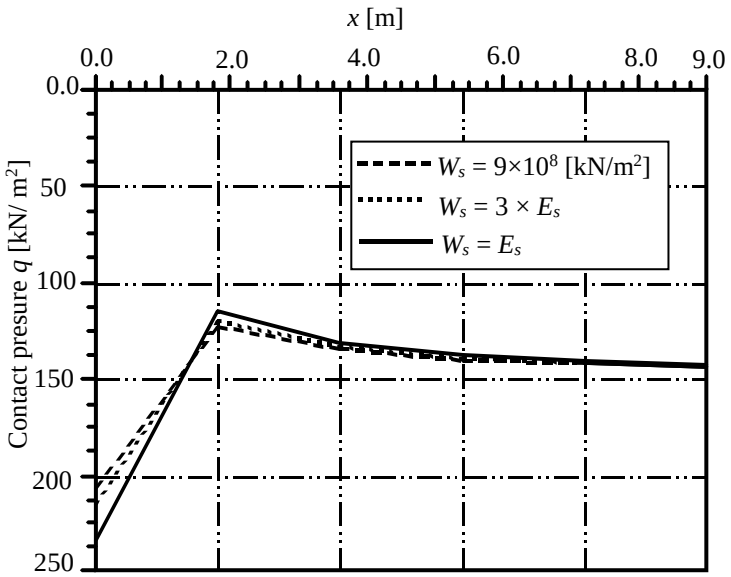


Figure 39 Contact pressure *q* [kN/m^2] at the middle section of the raft

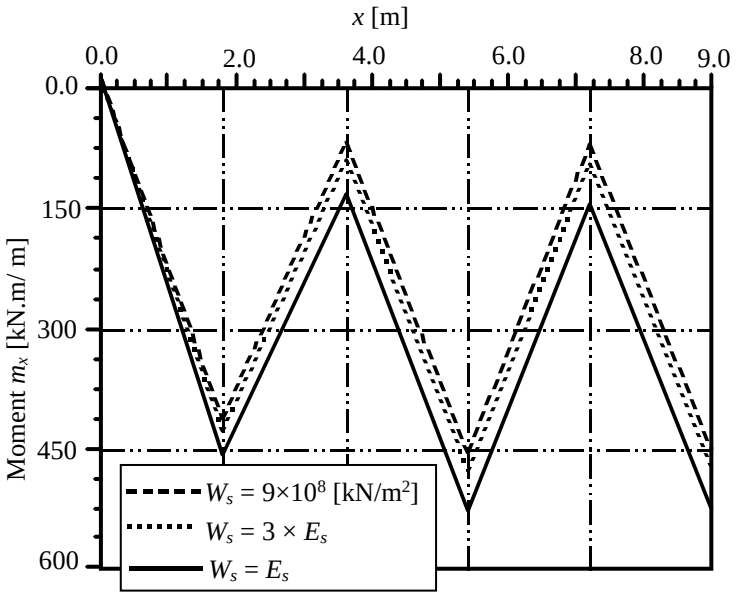


Figure 40 Moment m_x [kN.m/m] at the middle section of the raft