Example 23: Settlement calculation for a rigid raft subjected to an eccentric load

1 Description of the problem

In many cases, it is required to determine the settlement under an abutment, a bridge pier, a building core or a raft of thick thickness. In these cases, the foundation will be assumed as rigid foundation.

As an example for rigid rafts, consider the rectangular raft of a core from concrete walls shown in Figure 56 as a part of 93.0 [m] structure. The length of the raft is L = 28.0 [m], while the width is B = 25.0 [m]. Due to the lateral applied wind pressure, the raft is subjected to an eccentric vertical load of P = 142000 [kN]. Figure 56 shows section elevation through the raft and subsoil, while Figure 57 shows a plan of the raft, load, dimensions and mesh. It is required to estimate the expected settlement if the raft is considered as perfectly rigid.

2 Soil properties

The raft rests on four different soil layers of stiff plastic clay, middle hard clay, sand and limestone, overlying a rigid base as shown in Figure 56 and Table 33. *Poisson's* ratio is constant for all soil layers and is taken ν_s = 0.0 [-], while unit weight of the soil is γ_s = 13.6 [kN/m^3]. The foundation level of the raft is 11.0 [m] under the ground surface. The level of ground water is 11.0 [m] under the ground surface equal to the foundation level. Therefore, there is no effect for uplift pressure on the raft.

Table 33 Soil properties

Layer No.	Type of soil	Depth of layer under ground surface z [m]	Modulus of compressibility for	
			Loading E_s [kN/ m^2]	Reloading W_s [kN/ m^2]
1	Stiff plastic clay	13	25200	85800
2	Middle hard clay	16	27500	104100
3	Sand	21	31400	133200
4	Limestone	41	44400	209200

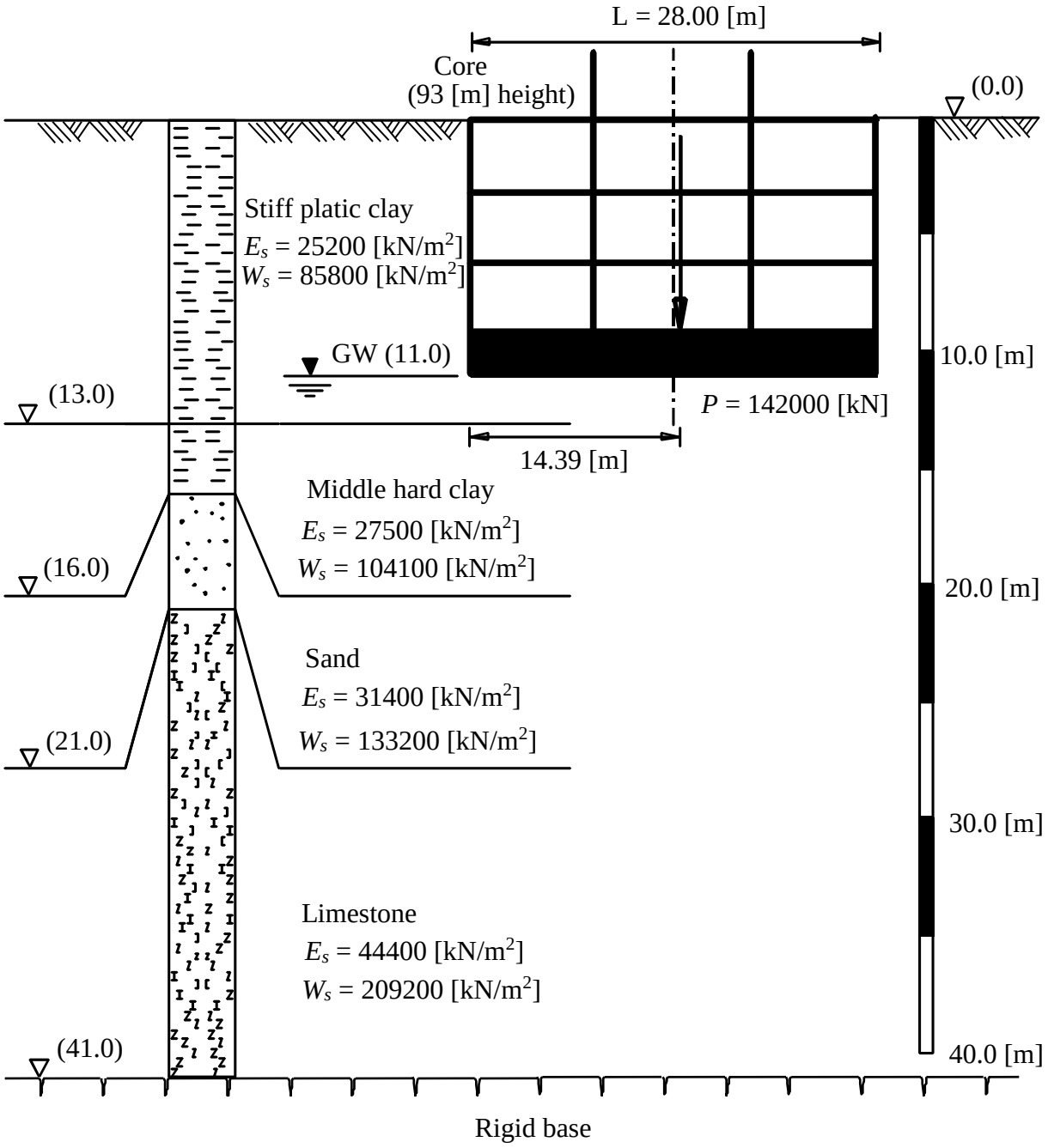


Figure 56 Section elevation through the raft and subsoil

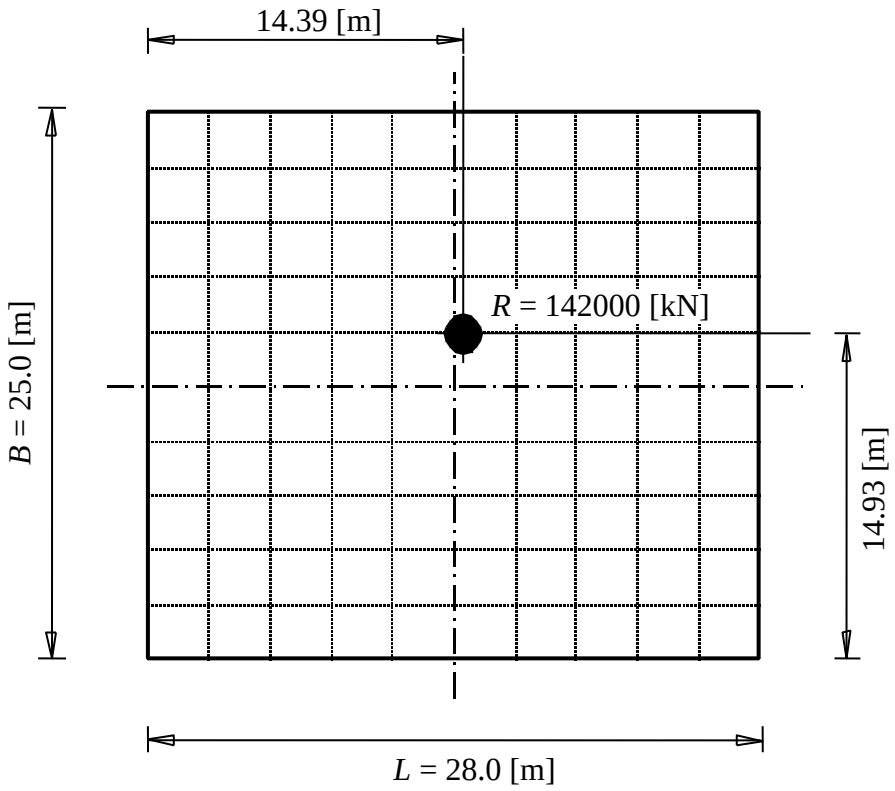


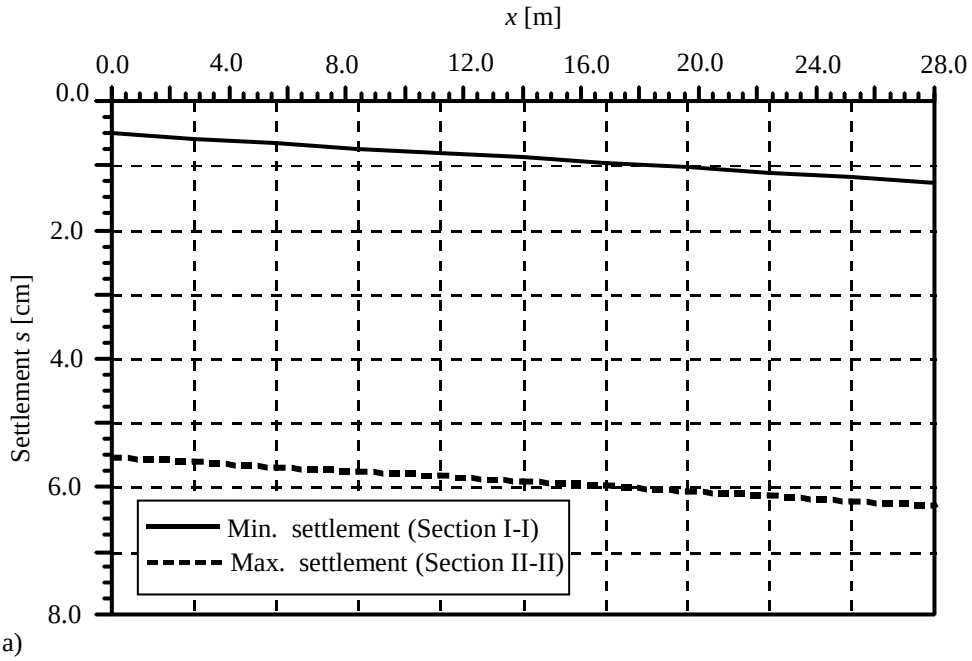
Figure 57 Raft dimensions, load and FE-Net

3 Analysis of the raft

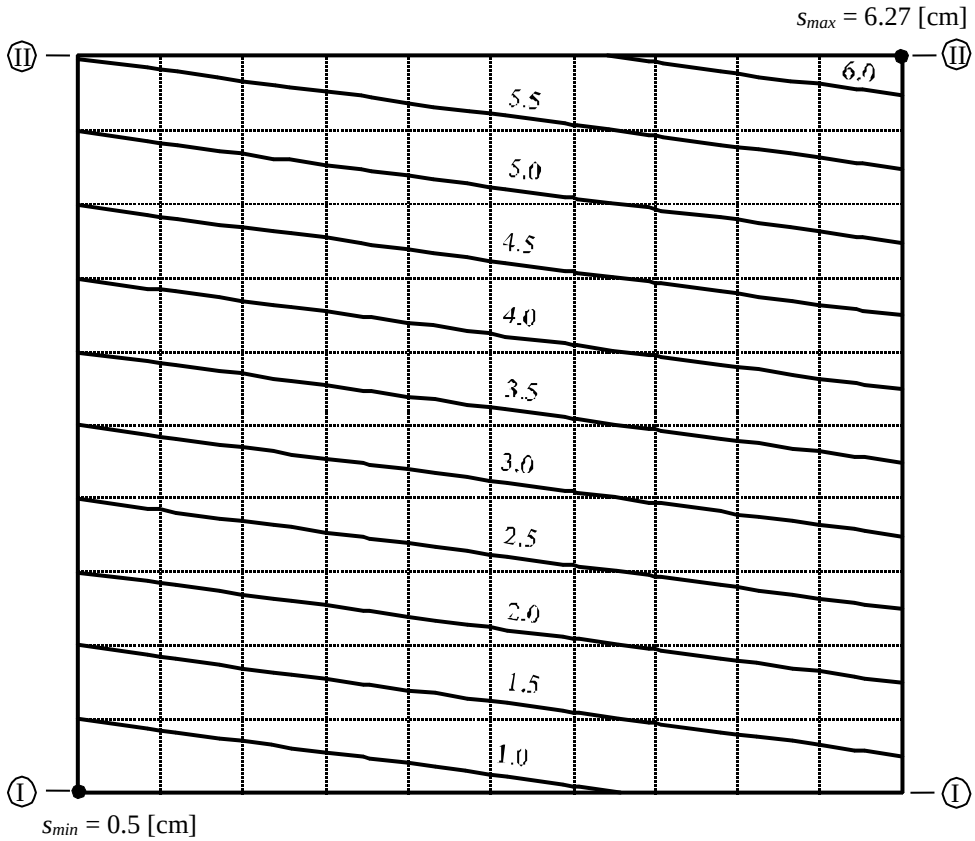
If the raft is perfectly rigid and subjected to an eccentric vertical load, the settlement will be distributed linearly on the bottom of the raft. To carry out the settlement calculation of perfectly rigid raft, the available calculation method "Rigid slab 8" in *ELPLA* is used to analyze the raft. In the analysis of rigid raft, only the settlement is required. Therefore, a coarse finite element net may be used. Here, a coarse net of rectangular elements is chosen. Each element has dimensions of 2.5 [m] × 2.8 [m] as shown in Figure 57.

4 Results

Figure 57b shows the contour lines of settlement under the raft, while Figure 58a shows minimum and maximum settlement curves. From these figures, it can be concluded that the maximum settlement is s_{max} = 6.27 [cm] at the right up corner of the raft, while the minimum settlement is s_{min} = 0.50 [cm] at the left down corner. The settlement difference is Δs = 5.77 [cm], which gives 92 [%] from the maximum settlement.



a)



b)

Figure 58 a) Min./ Max. settlement *s* [cm] at section I and II

b) Contour lines of settlement *s* [cm]