Example 22: Settlement calculation under flexible foundation of an ore heap

1 Description of the problem

In many cases, it is required to determine the settlement under an embankment, a metal plate foundation of a liquid tank, loads on small isolated plates or a raft of thin thickness. In these cases, the foundation will be assumed as flexible foundation.

Figure 53 shows an ore heap on thin concrete pavement slabs. The pavement slabs are connected with each other by movable joints. Consequently, the pavement slabs are considered as completely flexible foundation. The unit weight of the ore material is $\gamma = 30$ [kN/m^3].

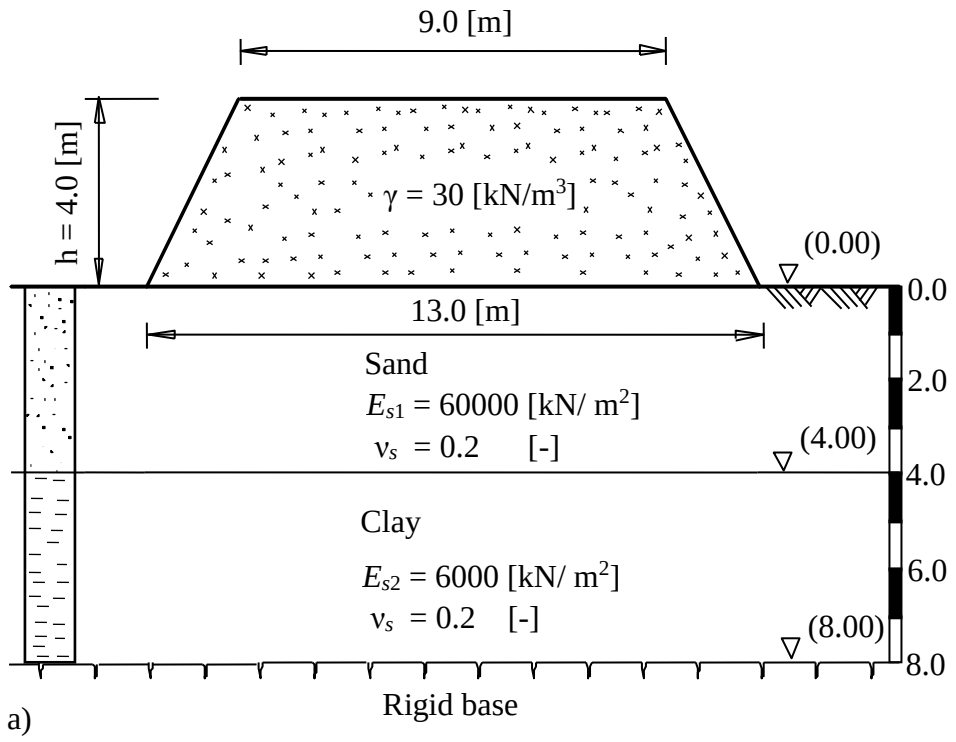
The foundation base under the ore heap has the dimensions of 13 × 13 [m^2], while the top area of the ore heap has the dimensions of 9 × 9 [m^2]. The height of the ore heap is 4.0 [m] (Figure 53a). It is required to determine the expected settlement due to the ore heap.

2 Soil properties

The pavement slabs rest on two different soil layers of sand and clay as shown in Figure 53b. The modulus of compressibility of the sand is E_{s1} = 60 000 [kN/m^2], while for the clay is E_{s2} = 6000 [kN/m^2]. *Poisson's* ratio of the soil is taken to be $\nu_s = 0.2$ [-].

3 Loads

In the analysis, the pressure on the foundation is estimated as a uniform pressure at the foundation middle and four areas of irregular distributed pressures near the foundation sides as shown in Figure 54. The middle pressure is $p = \gamma\, h = 30 \times 4.0 = 120$ [kN/m^2].



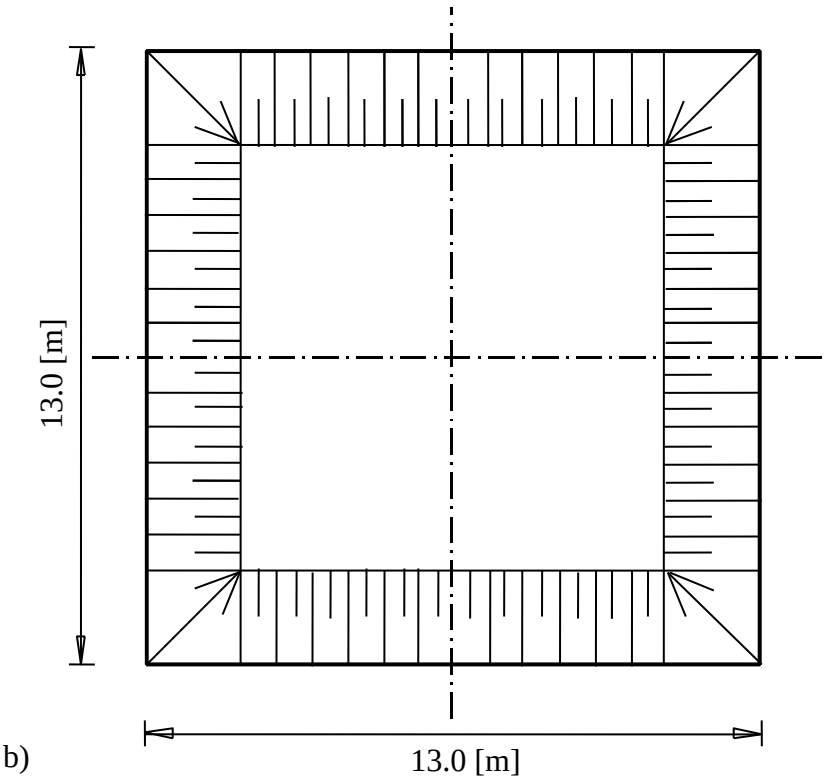
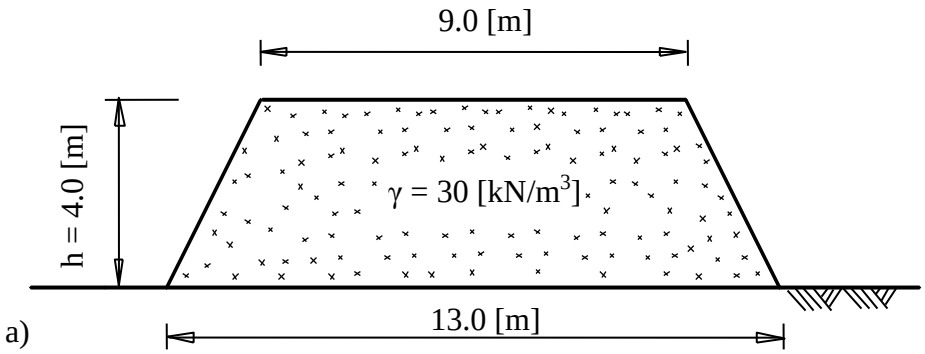
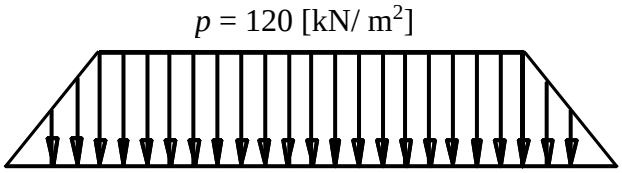


Figure 53 a) Section elevation in soil and the ore heap
b) Plan of the ore heap



a)



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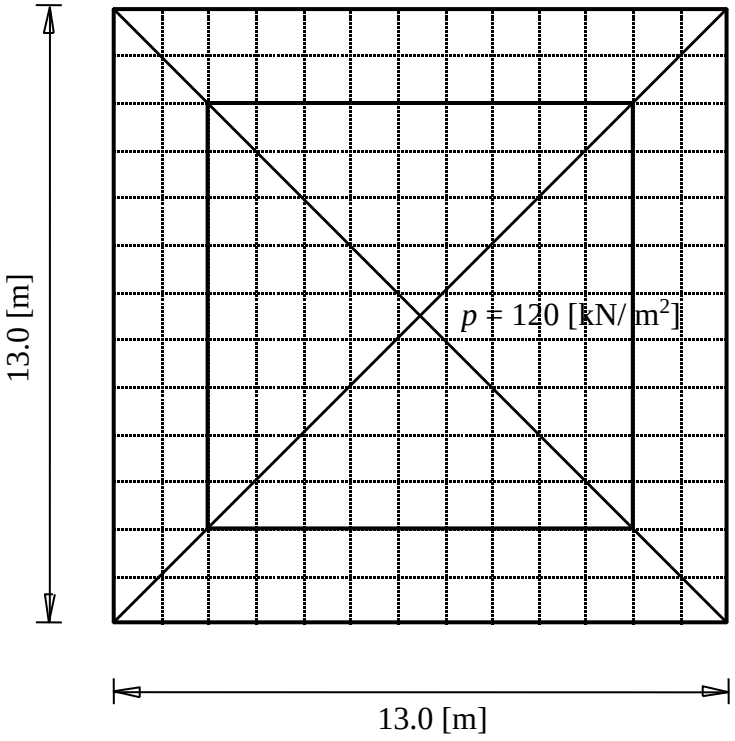


c)

Figure 54 a) Equivalent ore heap mass

b) Pressures on foundation

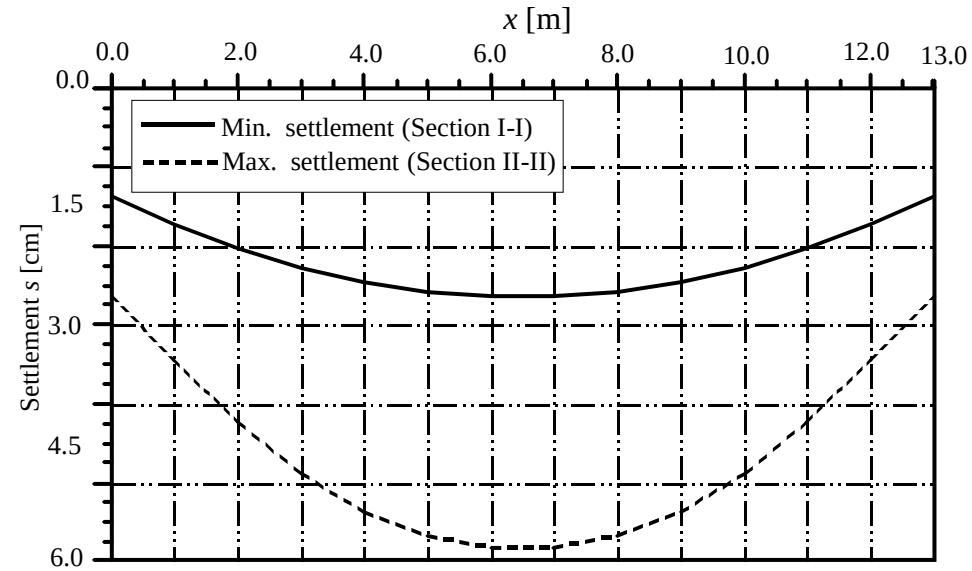
c) FE-Net

4 Analysis of the foundation

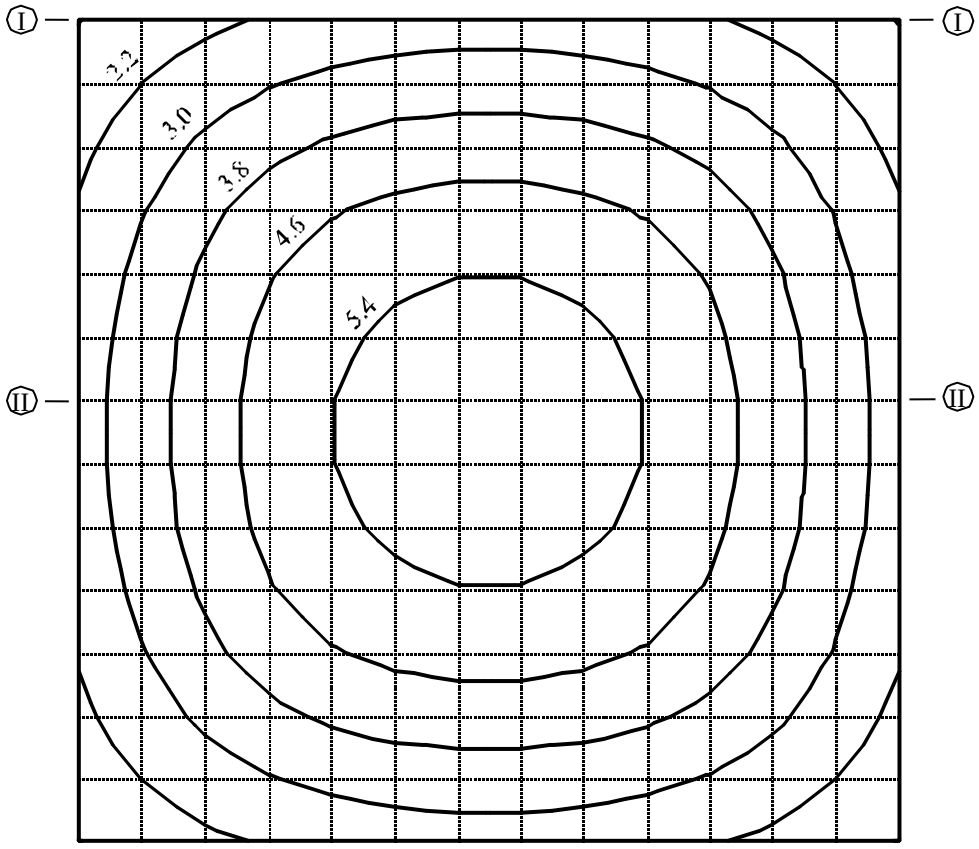
If the foundation is perfectly flexible such as in this example, then the contact stress will be equal to the gravity stress exerted by the foundation on the underlying soil. To carry out the settlement calculation of flexible foundation, the available calculation method "Flexible foundation 9" in *ELPLA* is used to analyze the foundation. A net of equal square elements is chosen. Each element has a side of 1.0 [m] as shown in Figure 54c.

5 Results

Figure 55b shows the contour lines of settlement under the ore heap, while Figure 55a shows minimum and maximum settlement curves. From these figures, it can be concluded that the maximum settlement is s_{max} = 5.78 [cm] at the center of the ore heap while the minimum settlement is s_{min} = 1.25 [cm] at the corners. The settlement difference is Δs = 4.53 [cm], which gives 78 [%] from the maximum settlement.



a)



b)

Figure 55 a) Min./ Max. settlement *s* [cm] at section I and II

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