Example 5.2 Rigidity of irregular raft on irregular subsoil

1 Description of problem

A general numerical example is carried out to show the applicability of system rigidity analysis, proposed by *El Gendy* (1998), to find the rigid thickness of rafts of any shape considering re-entrant corner and opening within the rafts.

In one case the raft carries many types of external loads; concentrated loads, distributed load, line load and moments in *x*- and *y*-direction as shown in Figure 5.9. The raft parameters are *Young*'s modulus E_b = 2 × 107 [kN/m2] and *Poisson*'s ratio ν_b = 0.25. Level of foundation is d_f = 2.7 [m].

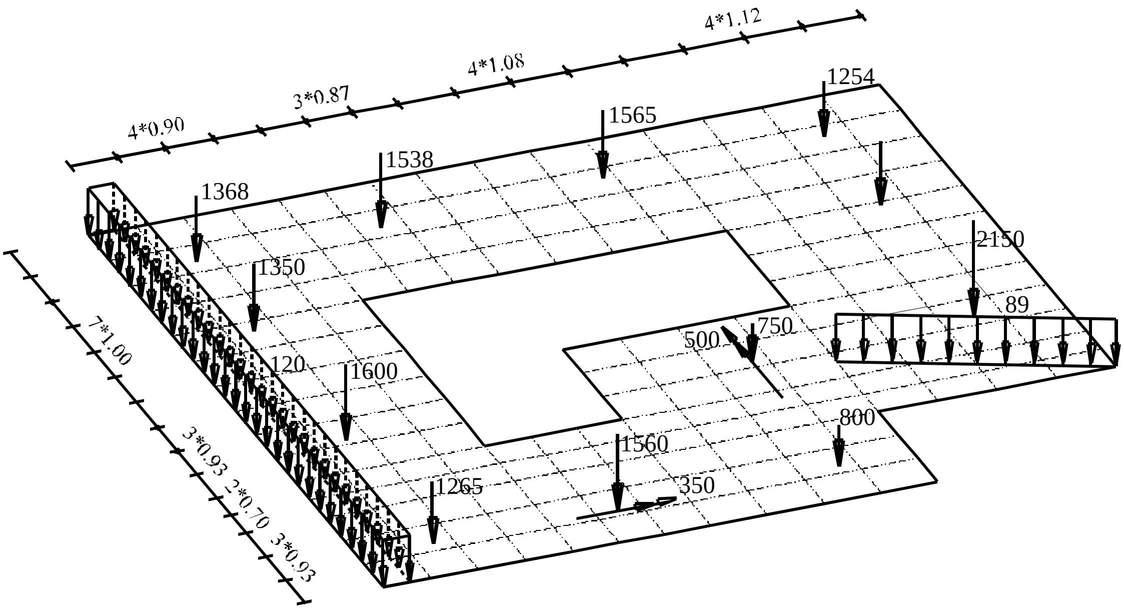

Figure 5.9 Raft dimensions, loads

The subsoil under the raft is characterized by three boring logs. Each has three layers with different materials. The moduli of compressibility of the three layers for loading are E_{s1} = 9500 [kN/m^2], E_{s2} = 22000 [kN/m^2] and E_{s3} = 120000 [kN/m^2] while for reloading are W_{s1} = 26000 [kN/m^2], W_{s2} = 52000 [kN/m^2] and W_{s3} = 220000 [kN/m^2]. *Poisson*'s ratio is assumed 0.3 and constant for all soil layers. The effect of reloading and water pressure is taken into account. Boring logs and locations are shown in Figure 5.10.

2 Analysis and discussion

The available solution from *Kany*/ *El Gendy* (1995) for the analysis of raft foundations on three-dimensional subsoil model using interpolation method is used here in the analysis of this general example. Four points on the raft are chosen to estimate the parameter k_r, which represent the whole foundation rigidity as shown in Figure 5.10a. Figure 5.11 shows the parameter k_r for these points. It can be seen that the raft is considered rigid for a thickness more than 1.01 [m].

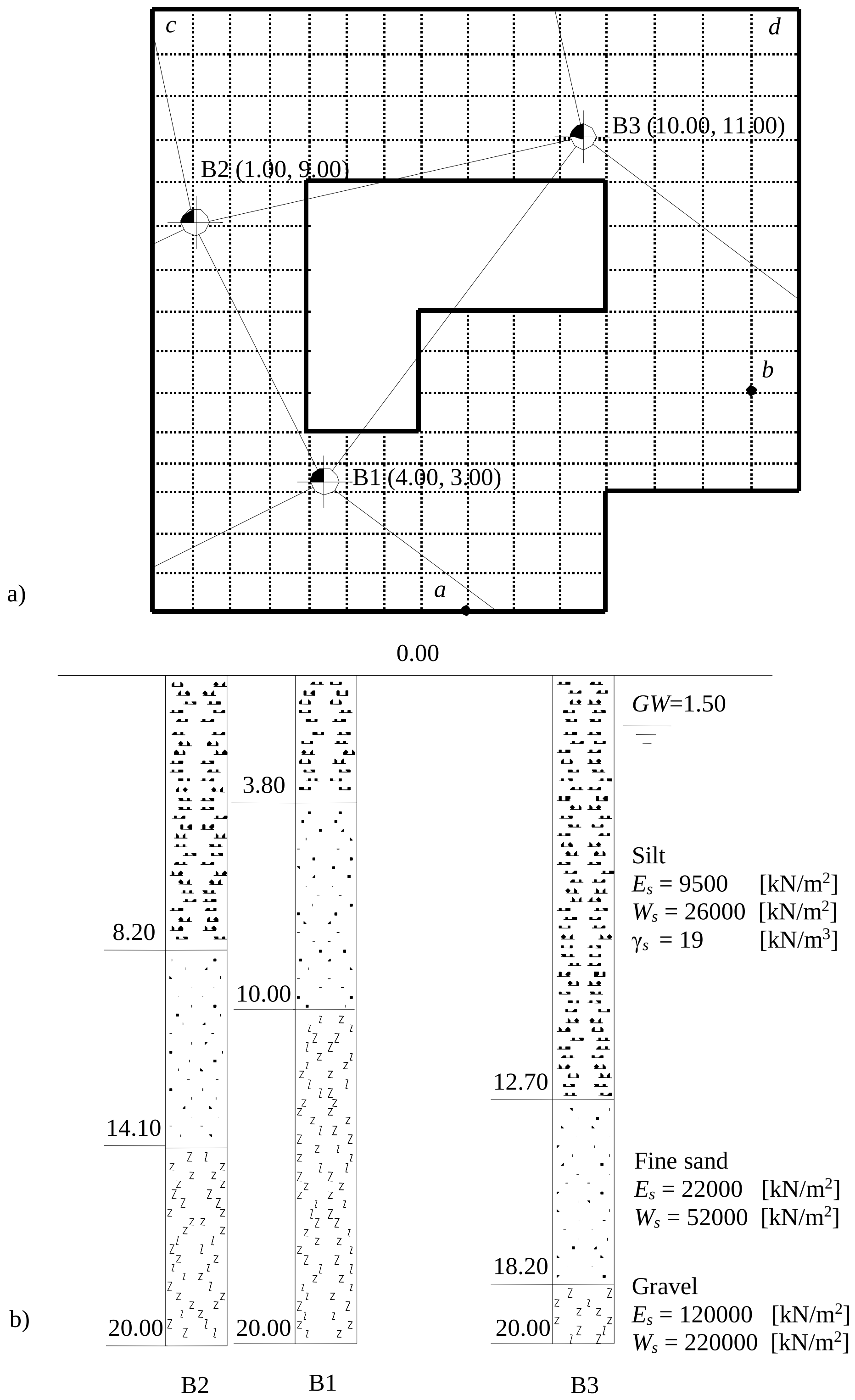

Figure 5.10 a) Boring locations and interpolation regions
b) Boring logs B1 to B3

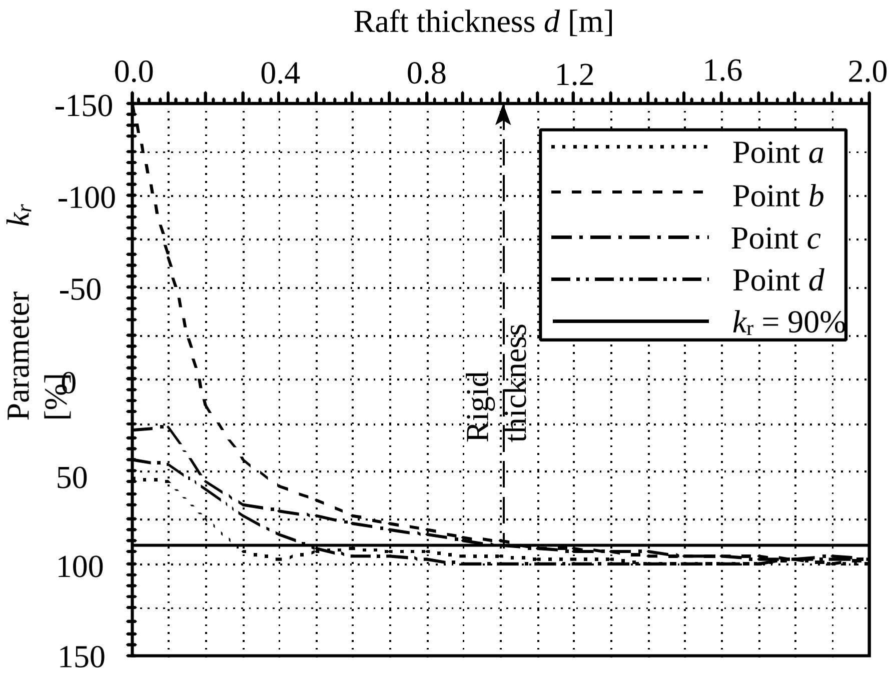

Figure 5.11 Parameter k_r for the characteristic points *a*, *b*, *c* and *d*

Another parameter k'_r similar to k_r is obtained from the contact pressure shape. This parameter is plotted against raft thickness and for the 4 points in Figure 5.12. In which k'_r is given by

$$k'_r = \left(1 - \frac{\Delta q_i}{g_i}\right) \times 100 \qquad (٥,١)$$

where:

q_i Contact pressure from elastic analysis at point *i*

g_i Contact pressure from rigid analysis at point *i*

Δq_i Absolute difference between q_i and g_i at that point *i*

Although Figure 5.12 gives a rigid thickness more than 1.05 [m] nearly as the same as that of Figure 5.11, but it is recommended to use k_r in which the rigid movement plane can be described only by three points.

To check the validity of the analysis for this example, the moments m_x and m_y at point *b* are plotted against raft thickness in Figure 5.13. The moments at a raft thickness of 1.01 [m] are compared with the maximum moments that may occur at that point. It is found that both moments m_x and m_y check closely, where the value of m_x is 92 [%] from maximum m_x while the value of m_y is equal to 95 [%] at the same point.

Although the raft in this example has a constant thickness, but it can determine the foundation rigidity when the thickness is variable. In this case, the rigidity of the foundation may be determined through plotting the parameter k_r against *Young*'s modulus of elasticity of the raft material E_b at several values of E_b.

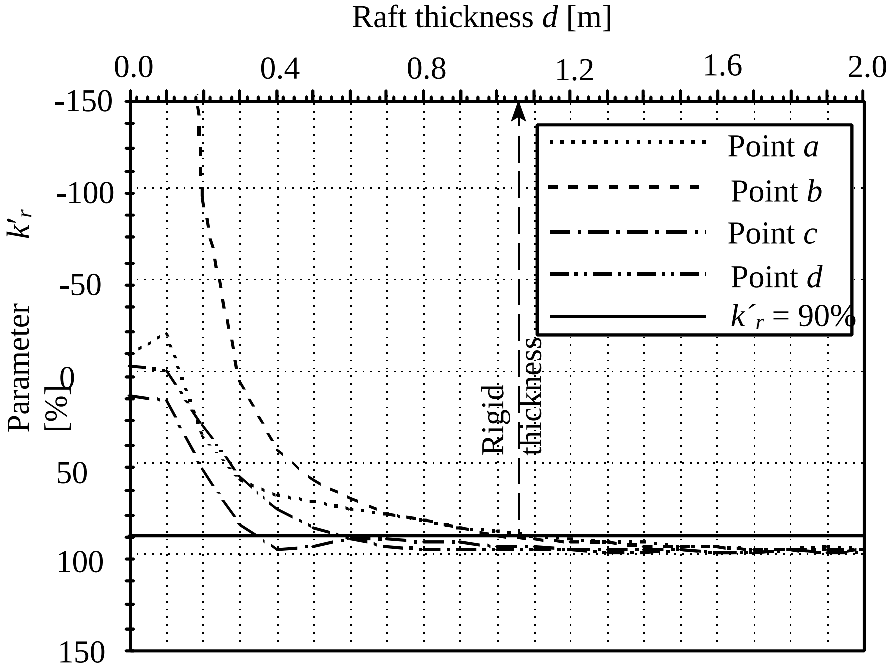

Figure 5.12 Parameter k'_r for the characteristic points *a*, *b*, *c* and *d*

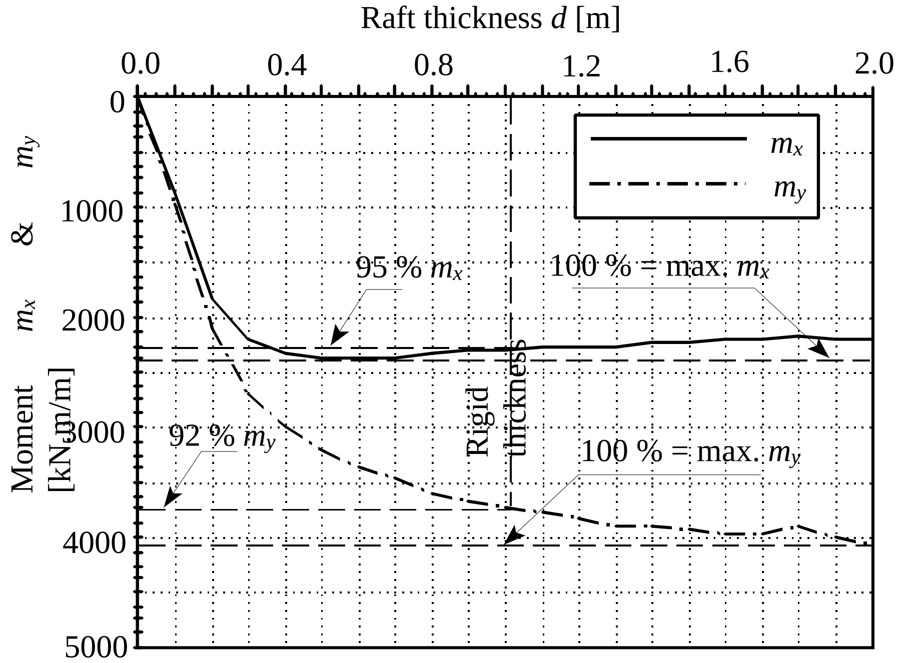

Figure 5.13 Moment m_x and m_y at characteristic point *b*