Example 4.2 Settlement behavior of four containers

1 Description of the problem

To verify the iterative procedure of *Kany*/ *El Gendy* (1997) and evaluate its accuracy for interactive large system of rigid rafts, consider the example 2 in the User's Guide of program *STAPLA* (*Kany* (1976)). The computed settlements obtained from the iterative procedure are compared with those of program *STAPLA* (*Kany* (1976)).

For a sewerage station, two isolated containers A and B were constructed simultaneously. Then, lately to extend the station another two isolated containers C and D would be constructed at the same area. Those two external C and D containers would provide an additional settlement on containers A and B.

It is required to assess the tilting of each container and the settlement considering the interaction between the containers through the subsoil at the end of construction. The tilting and settlement of the containers are main factors for designing the pipe connections.

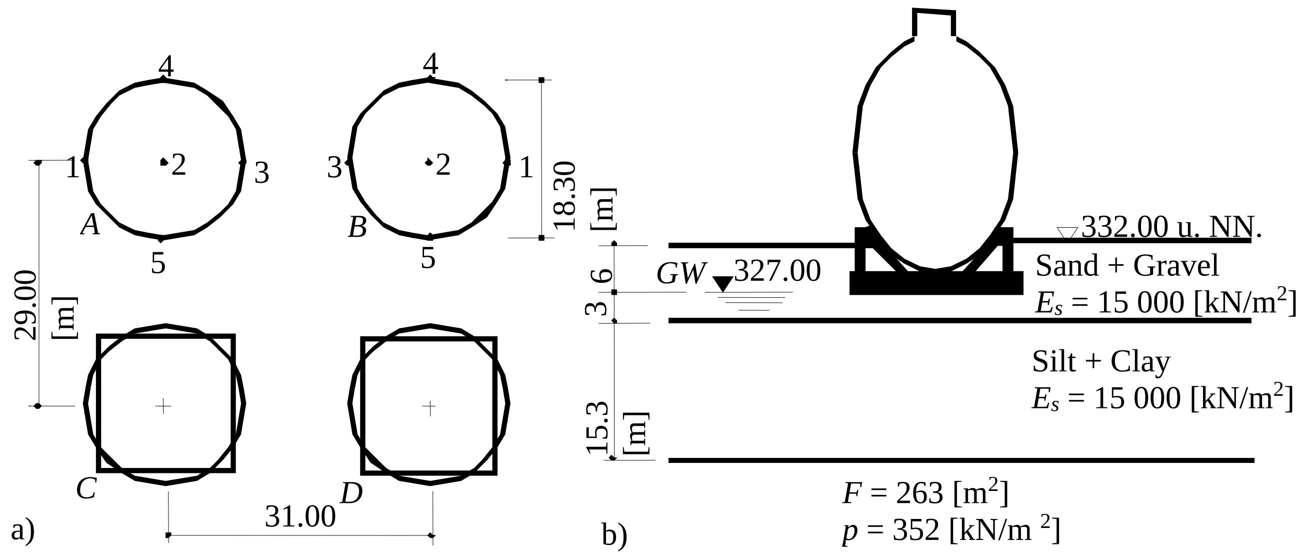

Figure 4.7 a) Location of containers to each other
b) Soil properties under the containers (*STAPLA*, *Kany* (1976))

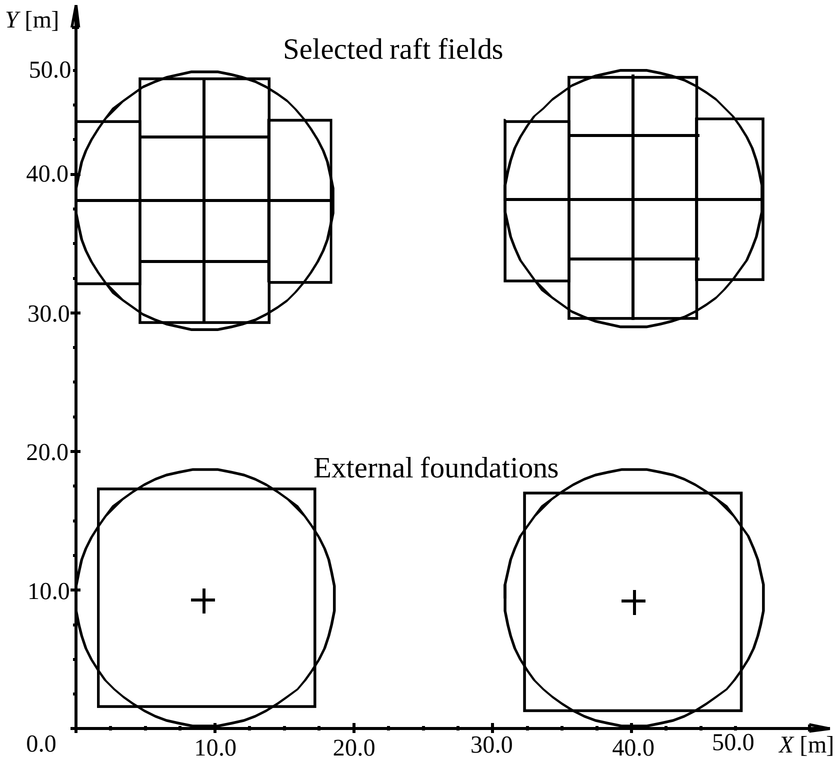

Figure 4.8 Division of the four circular rafts together into 26 fields (*STAPLA*)

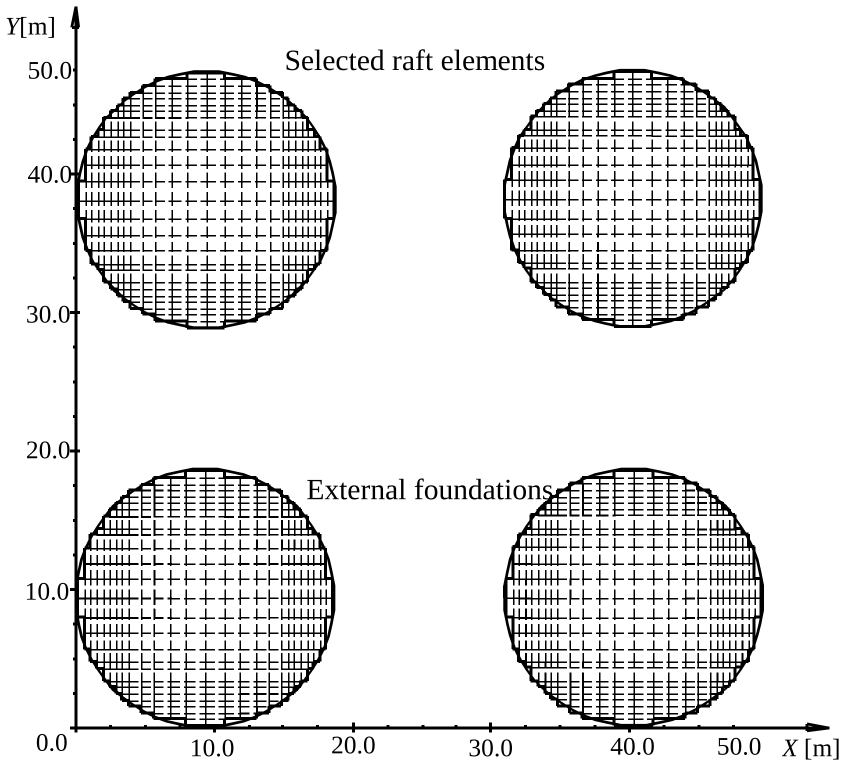

Figure 4.9 Division of the four circular rafts together into 1828 nodes (*ELPLA*)

2 Analysis

Due to the big rigidity of the concrete containers, the containers may be treated as full rigid bodies. Therefore, the foundations are assumed rigid circular rafts. To assess the tilting of the circular rafts by the Program *STAPLA* (*Kany* (1976)), the circular rafts were subdivided into a coarse mesh of rectangular fields. The total number of the fields of the four circular rafts is 26 fields as shown in Figure 4.8. The analysis is carried out to represent the final stage of construction (four containers). To reduce the computation time by the program *STAPLA* (*Kany* (1976)), the advantage of symmetry of the system of rafts about the *y-y* axis was considered in the analysis. In addition, equivalent square rafts were chosen instead of the two external circular rafts that would be constructed lately (containers C and D in Figure 4.7).

By the iterative procedure of *Kany*/ *El Gendy* (1999), dividing the same system of rafts into many elements is possible. In the example, the circular rafts were subdivided into a finer mesh of rectangular elements. The total number of nodes was 1828 nodes for the four rafts as shown in Figure 4.9.

3 Results and evaluation

To evaluate the iterative procedure, the results of settlements at five selected points as shown in Figure 4.7 were compared in Table 4.1 with those obtained from the program *STAPLA* (*Kany* (1976)). The results were considered for the final stage of construction (four containers).

It can be noticed from the comparison that there is relative difference between the results obtained by the iterative procedure and those obtained by the program *STAPLA* (*Kany* (1976)) for the five selected points. Through this comparison, it can be recognized that the settlements at a coarse fine subdivision of the raft exceed those at a fine subdivision of the raft by 4.1 [%] to 6.4 [%]. On the other hand, subdividing the circular raft into many square elements could bitterly represent its dimension. The analysis of system of rigid rafts shown in Figure 4.7 was carried out by a personal computer (300 MHZ, 4.5 GB capacity, Win 95). The iteration process needed fewer than 2 Min. at accuracy 0.0012 cm after three cycles.

Table 4.1 Comparison between settlements *s* [cm] obtained by *STAPLA* (*Kany* (1976)) and that by *ELPLA*

Point	Settlement *s* [cm]		Relative difference [%]
	STAPLA	New calculation	
1	14.51	13.74	5.6
2	14.91	14.17	5.2
3	15.31	14.61	4.8
4	14.44	13.57	6.4
5	15.38	14.78	4.1