## Example 4.1 Interaction of two circular rafts

### 1 Description of the problem

To illustrate the application of the iterative procedure of *Kany*/ *El Gendy* (1997) for the interactive system of foundations, consider the system of two equal large circular rafts shown in Figure 4.3. The rafts rest on a soil layer of 5 [m] thickness. Each raft has a diameter of 22 [m] and 0.65 [m] thickness. Loading on each raft consists of 24 column loads in which 16 columns loads have $P_1$ = 1250 [kN] and 8 column loads have $P_2$ = 1000 [kN]. The *Young*'s modulus of the raft material is $E_b$ = 2.6 × 107 [kN/m$^2$] and *Poisson*'s ratio is $\nu_b$ = 0.15 [-], while the soil values are $E_s$ = 9500 [kN/m$^2$] and $\nu_s$ = 0.0 [-].

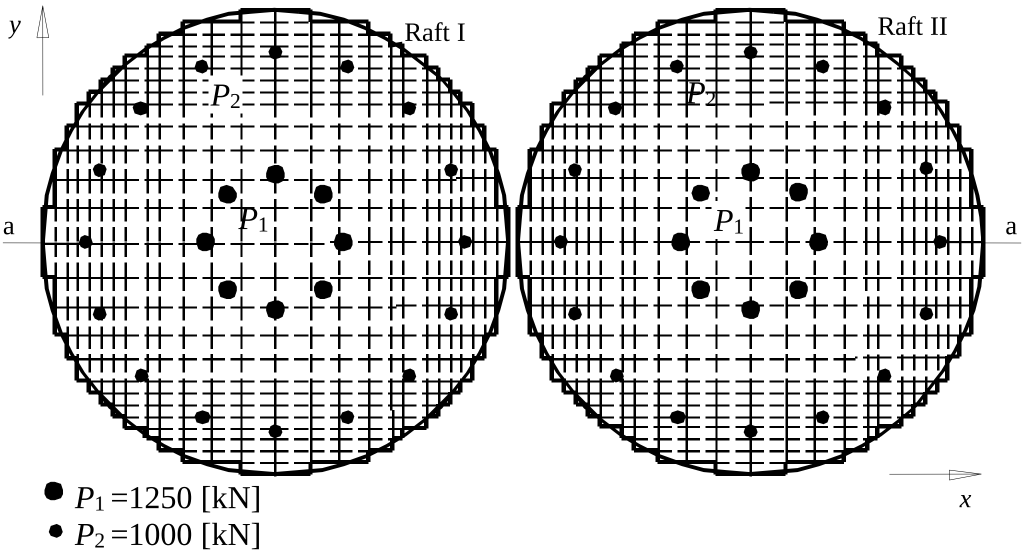


Figure 4.3 System of two circular rafts

### 2 Analysis

The analysis of the two rafts is carried out for two cases:

i) without interaction between rafts

ii) with interaction where the two rafts are constructed simultaneously

Each raft is divided into 404 elements yielding 914 and 457 nodal points, for the calculations based on system of two rafts and the isolated raft, respectively. This generates 2742 and 1371 simultaneous equations for the two calculation cases, respectively.

To analyze the rafts as system of foundations, data of the two rafts are put in two separate files (Files ha1 and ha2). Besides, a third file contains information about the system of foundations (File h12). Data of the two rafts are quite similar except the origin coordinates, which are chosen ($x_o$, $y_o$) = (0.0, 0.0) and (22.5, 0.0) for rafts I and II respectively.
The maximum difference between the soil settlement *s* [cm] and the raft deflection *w* [cm] is considered as an accuracy number. In this example, the accuracy is chosen 0.01 [cm]. The results are obtained by using the iterative procedure of *Kany*/ *El Gendy* (1997) after only four cycles for both cases with and without interaction (only isolated raft).

To show the speed of convergence of the iterative procedure of *Kany*/ *El Gendy* (1997), a comparison of it with modification of subgrade reaction by iteration method (*Ahrens*/ *Winselmann* (1984)) and that of *El Gendy* (1994) is carried out. The accuracy of computation is plotted against the iterative cycle number in Figure 4.4, for the three iteration methods where the analysis is carried out for an isolated raft. Figure 4.4 shows that the iterative procedure of *Kany*/ *El Gendy* (1997) converges more rapidly.

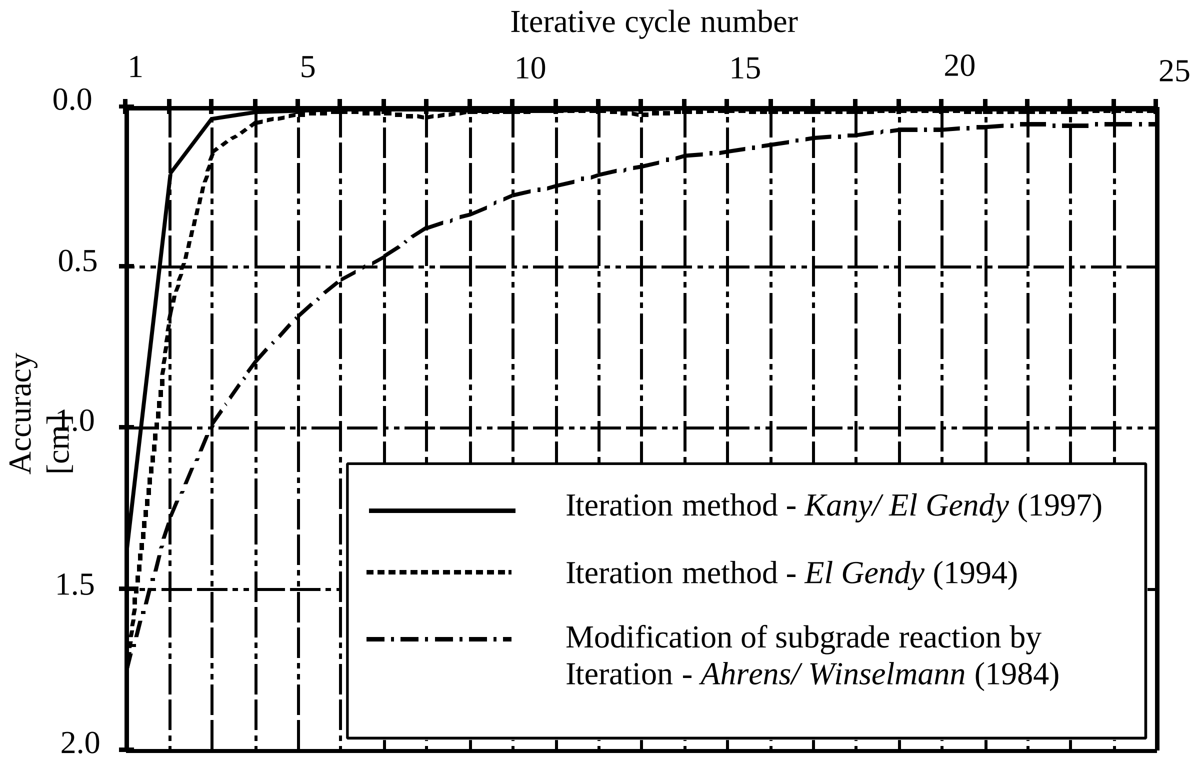


Figure 4.4 Accuracy against the iterative cycle number for the three iteration methods

## 3 Results and evaluation

Figure 4.5 on the left shows the contour lines of settlements under the raft I without interaction of two rafts. As it is expected, the settlements are distributed symmetrically, because the raft was analyzed under the assumption that the loads are symmetrically applied. Figure 4.5 on the right shows the contour lines of settlements under the raft II considering the interaction of two rafts. It is recognized through comparison that considerable differences occurred in settlements under the raft II. The settlements of the raft II became greater at the edge between two rafts.

Figure 4.6 shows the settlements *s*, contact pressures *q* and moments $m_x$ at the middle of raft II for both two cases with and without interaction.

From the results, it is recognized furthermore, that the settlements of the edge nodes of the raft II near raft I increase strongly (Figure 4.6a). Therefore, the settlement increased from 5.12 [cm] to 7.75 [cm] at the middle of the raft.

Figure (4.6b) shows that the contact pressure at the edge of the raft II near the raft I decreased from 70 [kN/m$^2$] to 240 [kN/m$^2$]. The contact pressures became smaller at the edge between two rafts due to the additional settlements from the interaction of them. From equilibrium of the vertical forces, the contact pressures became larger at the middle of the raft. Naturally, the change in contact pressure distribution under the raft will cause also changing and shifting in the stress of the raft. Accordingly, the moments of the raft will be affected.

The interaction of the two rafts is clearly noticeable in moments $m_x$ (Figure 4.6c). The field moment $m_x$ near the raft I decreased from 87 [kN.m/m] to 7 [kN.m/m] while the field moment at the center of the raft decreased from 437 [kN.m/m] to 370 [kN.m/m].

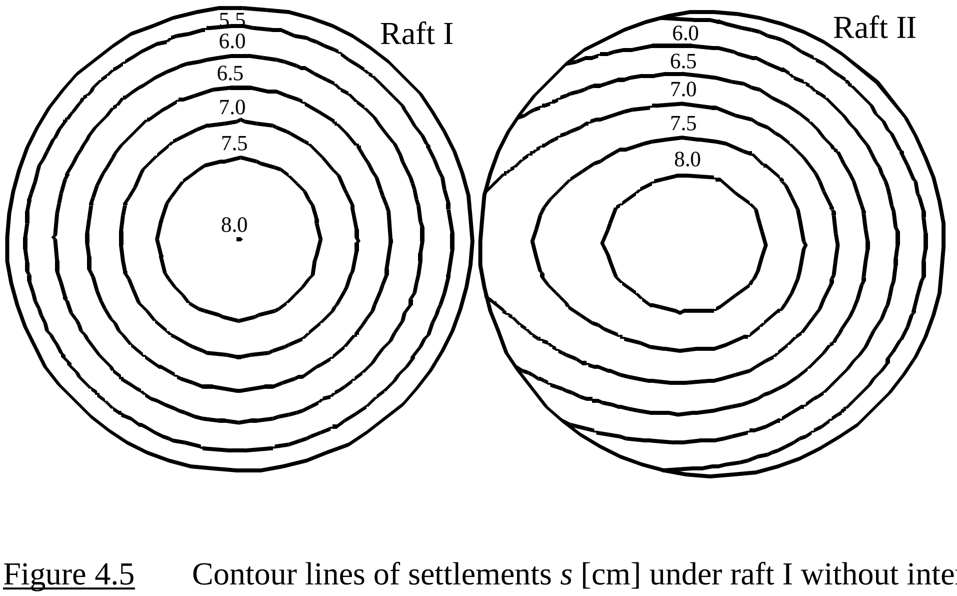


Figure 4.5 Contour lines of settlements *s* [cm] under raft I without interaction and under raft II without interaction of two rafts

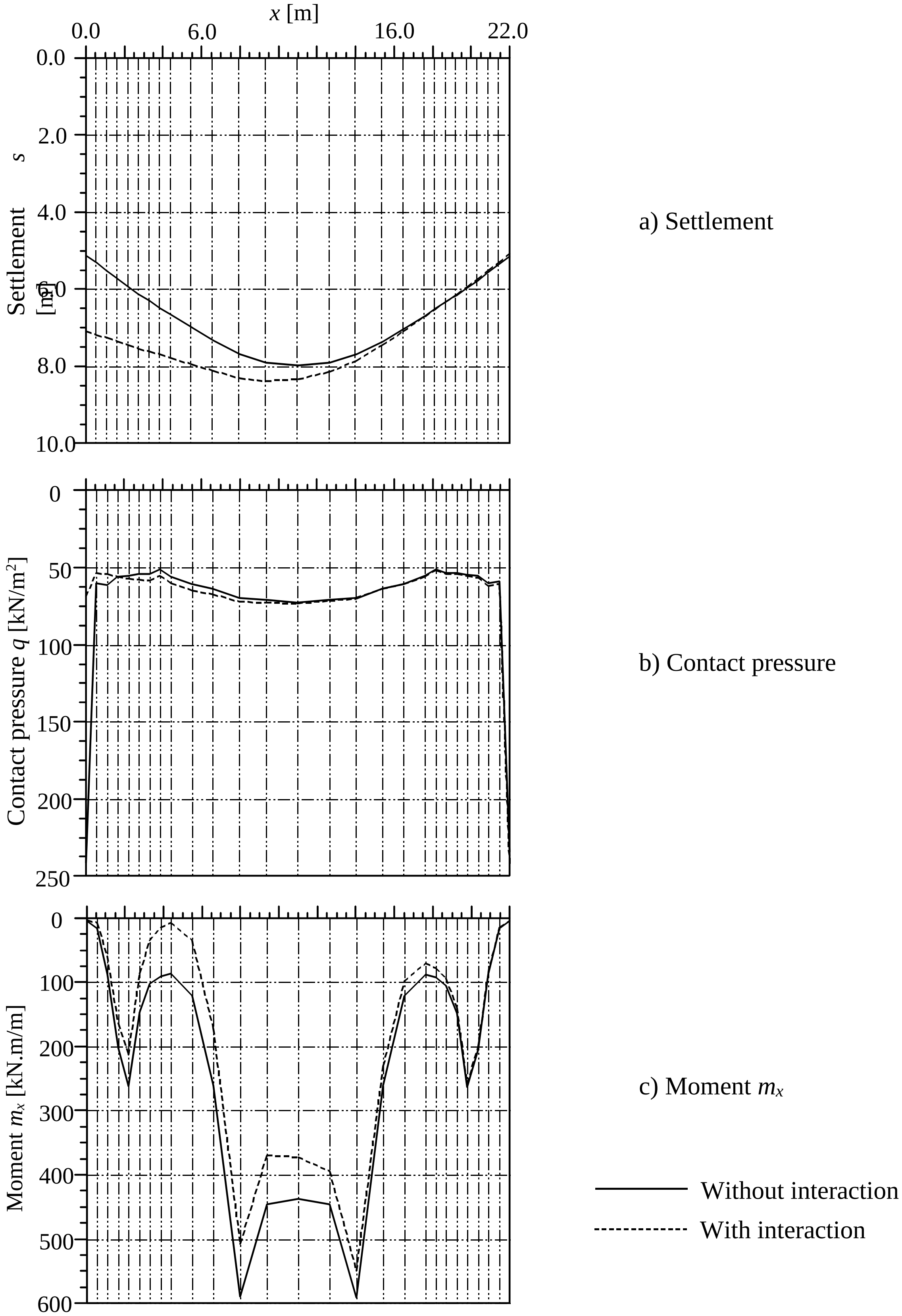


Figure 4.6 Settlements, contact pressures and moments at the middle of raft II