Example 8: Rigid square raft on Isotropic elastic half-space medium

1 Description of the problem

To verify the mathematical model of *ELPLA* for rigid square raft, the results of a rigid square raft obtained by other analytical solutions from *Kany* (1974), *Fraser/ Wardle* (1976), *Chow* (1987), *Li/ Dempsey* (1988) and *Stark* (1990), Section 5.4, page 114, are compared with those obtained by *ELPLA*.

The vertical displacement *w* [m] of a rigid square raft on Isotropic elastic half-space medium may be evaluated by

$$\mathbf{w} = \frac{\mathbf{pB}\left(1 - \mathrm{ny}_s^2\right)}{\mathbf{E_s}}\mathbf{I} \qquad (12)$$

where:

ν_s	*Poisson's* ratio of the soil [-]
E_s	*Young's* modulus of the soil [kN/m^2]
B	Raft side [m]
I	Displacement influence factor [-]
p	Load intensity on the raft [kN/m^2]

A square raft on Isotropic elastic half-space soil medium is chosen and subdivided to different nets. The nets range from 2 × 2 to 48 × 48 elements. Load on the raft, raft side and the elastic properties of the soil are chosen to make the first term from Eq. 13 equal to unit, hence:

Raft side	B	= 10	[m]
Uniform load on the raft	p	= 500	[kN/m^2]
Modulus of compressibility	E_s	= 5000	[kN/m^2]
Poisson's ratio of the soil	ν_s	= 0.0	[-]

2 Analysis of the raft

The available method "Rigid raft 8" in *ELPLA* is used here to determine the vertical displacement of the raft on Isotropic elastic half-space medium. Taking advantage of the symmetry in shape, soil and load geometry about both *x*- and *y*-axes, the analysis is carried out by considering only a quarter of the raft. Figure 10 shows a quarter of the raft with a net of total 16 × 16 elements.

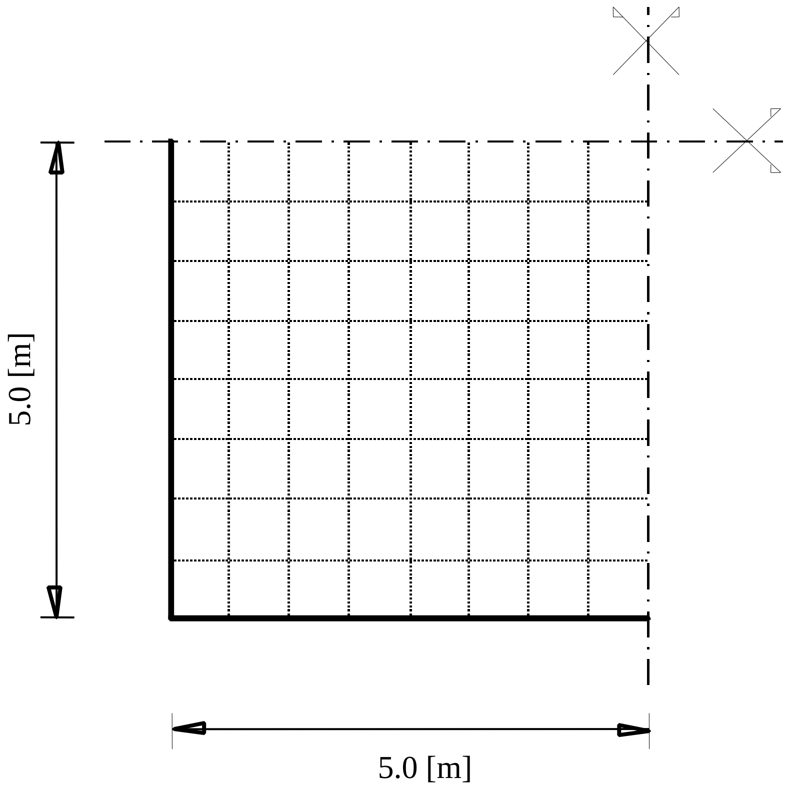

Figure 10 Quarter of rigid square raft with dimensions and FE-Net

3 Results

Table 9 shows the comparison of the displacement influence factor *I* obtained by *ELPLA* with those obtained by other published solutions from *Fraser*/ *Wardle* (1976), *Chow* (1987), *Li*/ *Dempsey* (1988) and *Stark* (1990) for a net of 16 × 16 elements. In addition, the displacement influence factor *I* is obtained by using *Kany's* charts (1974) through the conventional solution of a rigid raft.

Table 9 Comparison of displacement influence factor *I* obtained by *ELPLA* with those obtained by other authors for a net of 16 × 16 elements

Displacement influence factor *I* [-]					
Kany (1974)	*Fraser*/ *Wardle* (1976)	*Chow* (1987)	*Li*/ *Dempsey* (1988)	*Stark* (1990)	*ELPLA*
0.85	0.835	0.8675	0.8678	0.8581	0.8497

Table 10 shows the convergence of solution for the displacement influence factor *I* obtained by *ELPLA* with those obtained by *Stark* (1990) for different nets. Under the assumption of *Li*/ *Dempsey* (1988), the convergence of the solution occurs when the displacement influence factor I = 0.867783 while using *Kany's* charts (1974) gives I = 0.85 for the ratio z/B =100. *Fraser*/ *Wardle* (1976) give I = 0.87 based on an extrapolation technique, *Gorbunov-Possadov*/ *Serebrjanyi* (1961) give I = 0.88 and *Absi* (1970) gives I = 0.87. In general, the displacement influence factor *I* in this example ranges between I = 0.85 and I = 0.88. Table 10 shows that a net of 16 × 16 elements gives a good result for a rigid square raft in this example by *ELPLA*. The convergence of the solutions is in a good agreement with that of *Stark* (1990) for all chosen nets.

Table 10 Convergence of solution for displacement influence factor *I* obtained by *ELPLA* with those obtained by *Stark* (1990) for different nets

Net	Displacement influence factor *I* [-]	
	Stark (1990)	*ELPLA*
2 × 2	0.8501	0.7851
4 × 4	0.8477	0.8143
6 × 6	0.8498	0.8281
8 × 8	0.8525	0.8360
12 × 12	0.8559	0.8449
16 × 16	0.8581	0.8497
20 × 20	0.8597	0.8528
24 × 24	0.8601	0.8550
32 × 32	0.8626	0.8578
48 × 48	0.8647	0.8609