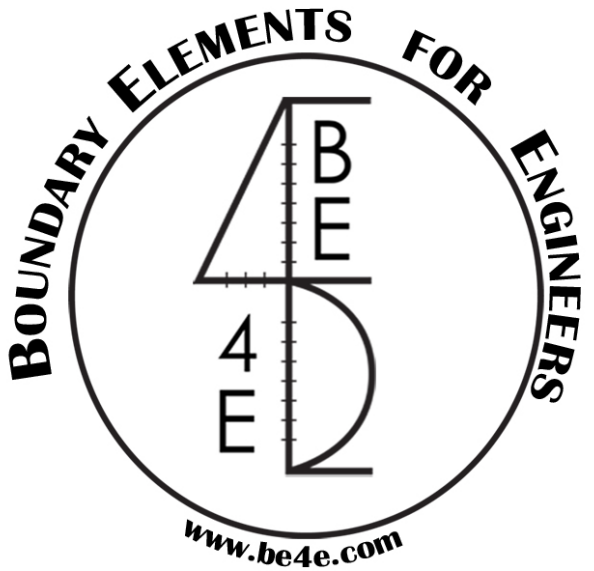

The PLPAK™

The Pile-Pile/Soil interactions (P-PPAK)

MANUAL

PLPAK™ Version 2.00

The Advanced Single-Floor (Foundation) Package

E-mail: plpak@be4e.com

Disclaimer

Considerable time, effort and expense have gone into the development and documentation of the PLPAK™ software. The PLPAK™ software has been thoroughly tested and used. The PLPAK™ software should be used by engineers with good understanding of concrete behavior, pre-stressing and structural mechanics. The user accepts and understands that no warranty is expressed or implied by the developers or the distributors on the accuracy or the reliability of the PLPAK™ software. The user must explicitly understand the assumptions of the PLPAK™ software and must independently verify the results produced by the PLPAK™ software.

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The P-PPAK is an add-in tool to the PLPAK that allows simulation of pile-pile/soil interactions effects underneath piled rafts.

P-PPAK consider three types of interaction effects:

	Piles DOFs	**Soil DOFs**
Piles DOFs	P-P interactions (1)	P-S interactions (3)
Soil DOFs	S-P interactions (3)	S-S interactions (2)

1- Consider Pile-pile interaction effects (P-P). These interaction effects could be considered using elastic approach, load transfer approach or user field measurements interaction factors. In case of multi-layered soil, these interactions are considered using three different approach:

a- Average soil young's modulus (E_{avg}) between two points each has its layer's young's modulus E.

b- Equivalent soil young's modulus (E_{equ}) for all layers.

c- Modified soil young's modulus (E_{mod}) using Poulos and LEE modifications.

2- Consider soil-soil interaction effects (S-S). These interaction effects could be considered using EHSPAK.

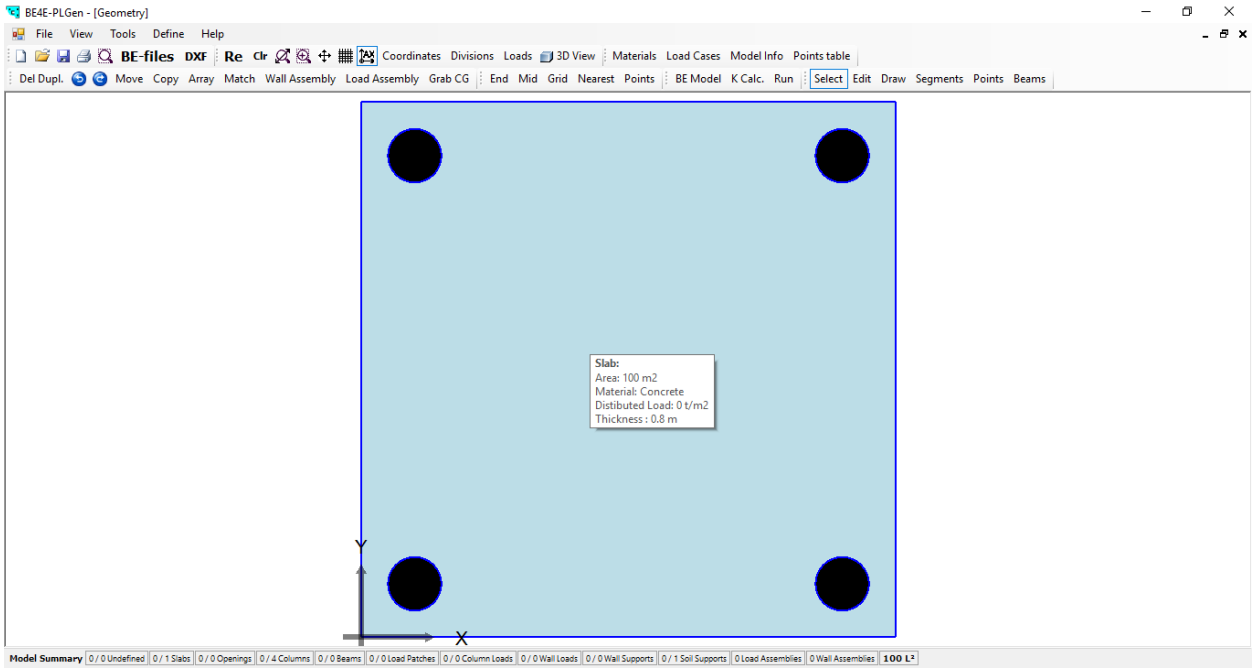
3- Consider Pile-soil interaction effects (P-S). These interaction effects could be considered using Mindlin's solution. Also, in case of multi-layered soil, the same three approaches in (1) are used.

For more clarification, The P-PPAK is described using simple two examples. For different input files structures see appendix 2.

<u>Problem 1:</u>

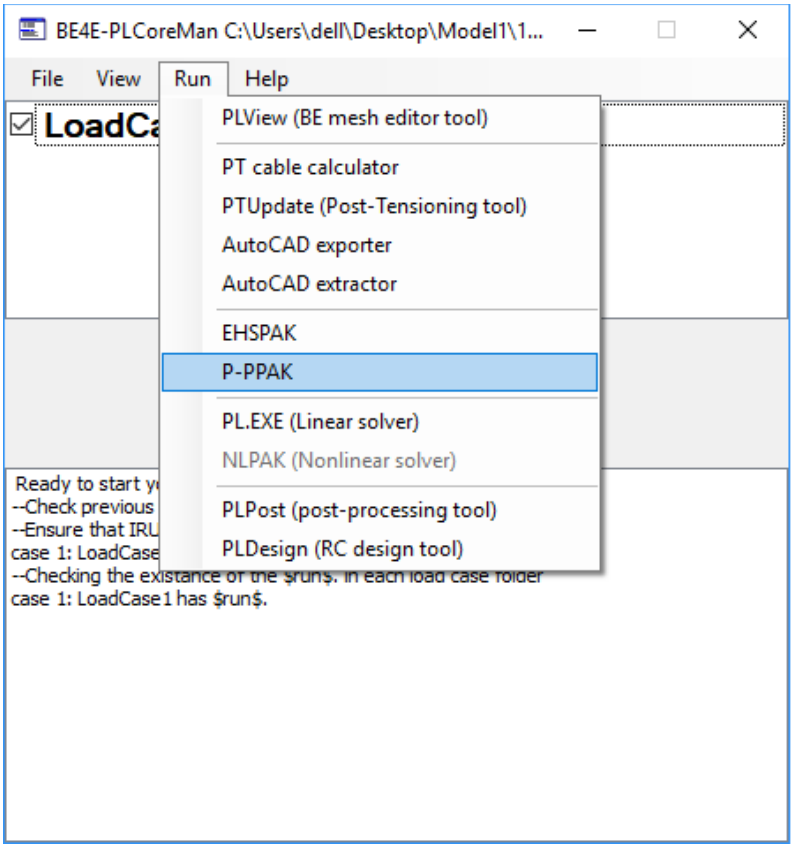
This problem is 10 × 10 m piled raft with thickness 0.8 m supported on four piles each 0.5 m radius subjected to its own weight.

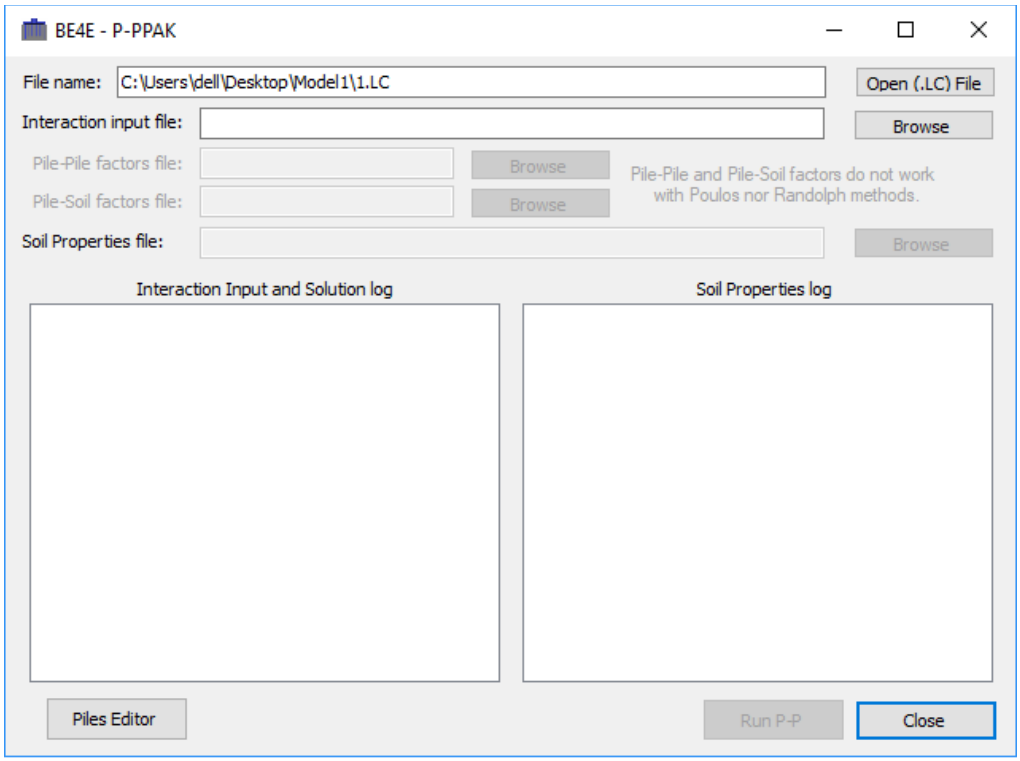
1- Generate Gen model.



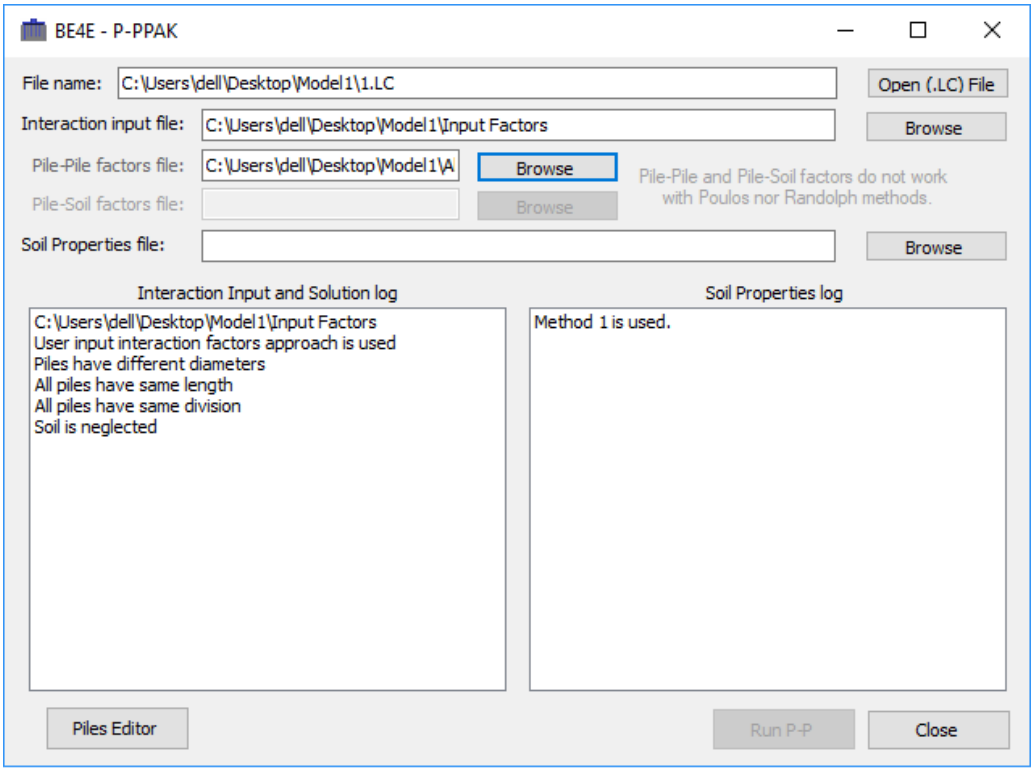
2- Run the problem from PLGen or load it from PLCoreMan.

3- From PLCoreMan run P-PPAK to extract pile-pile stiffness in (PL$MATK$.-4).

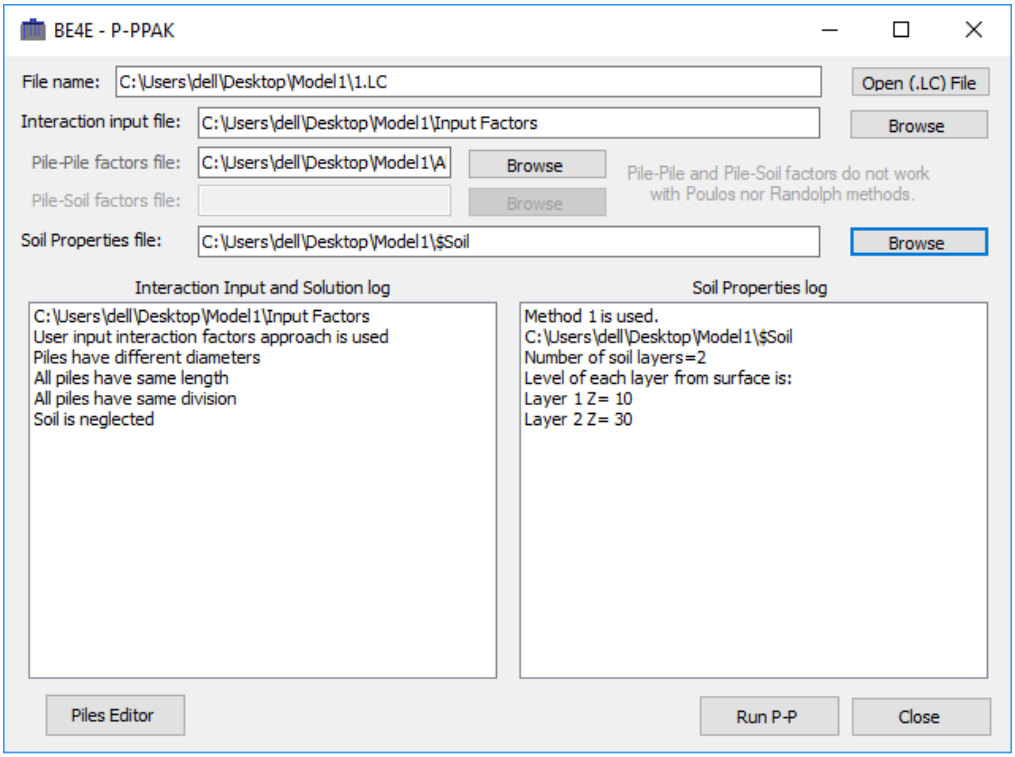




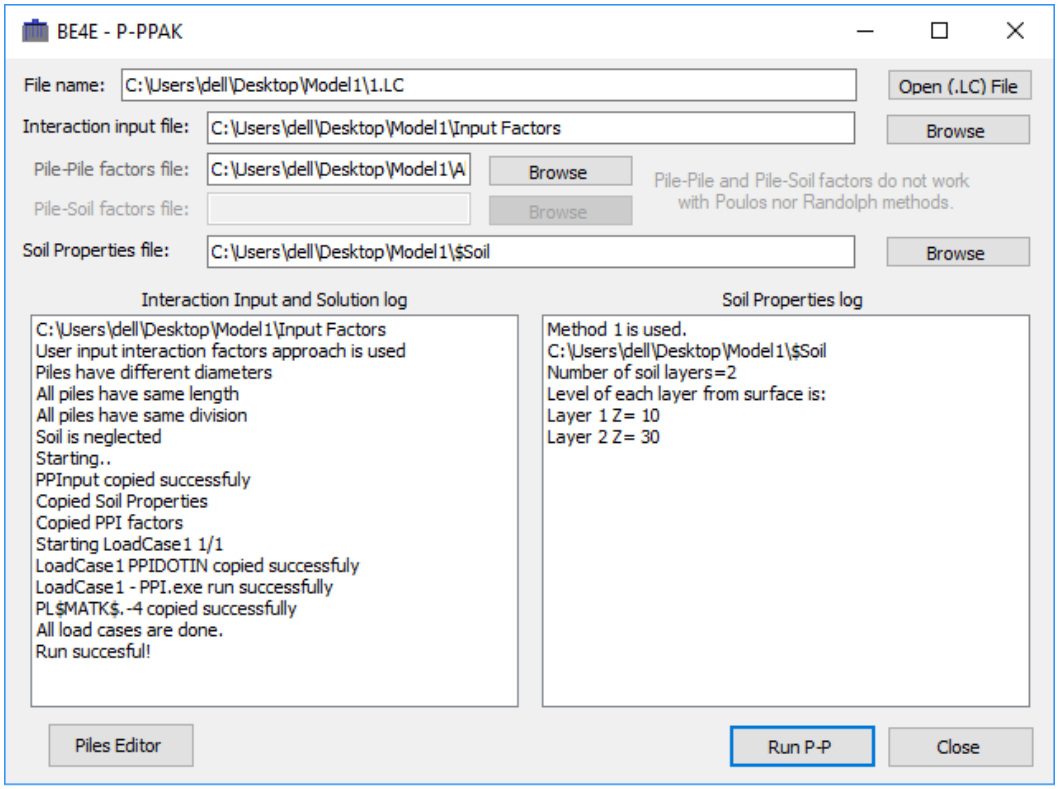
a. Load interaction input file of the problem (File different structures see appendix 1).



b. Load soil properties file (File format see appendix 1).

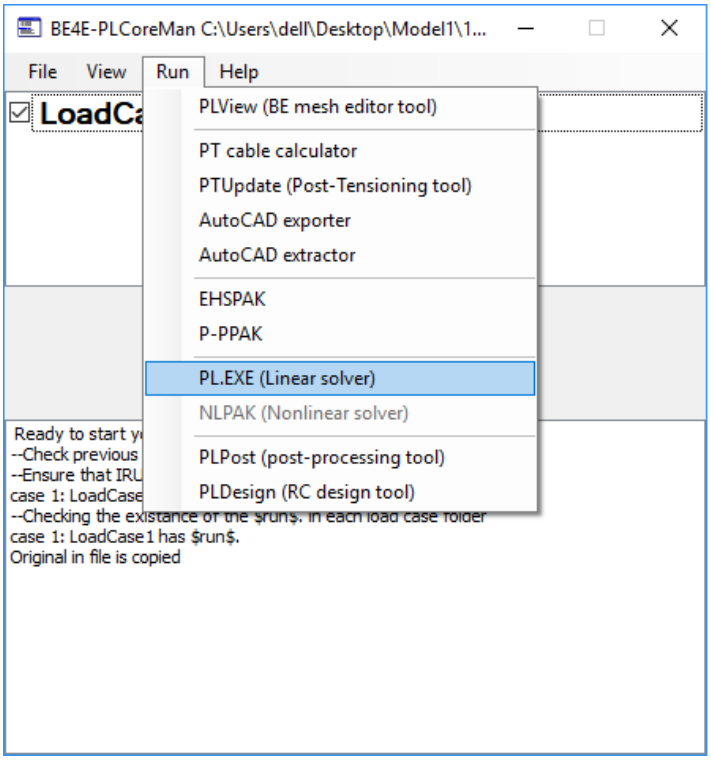


c. Press button Run P-P

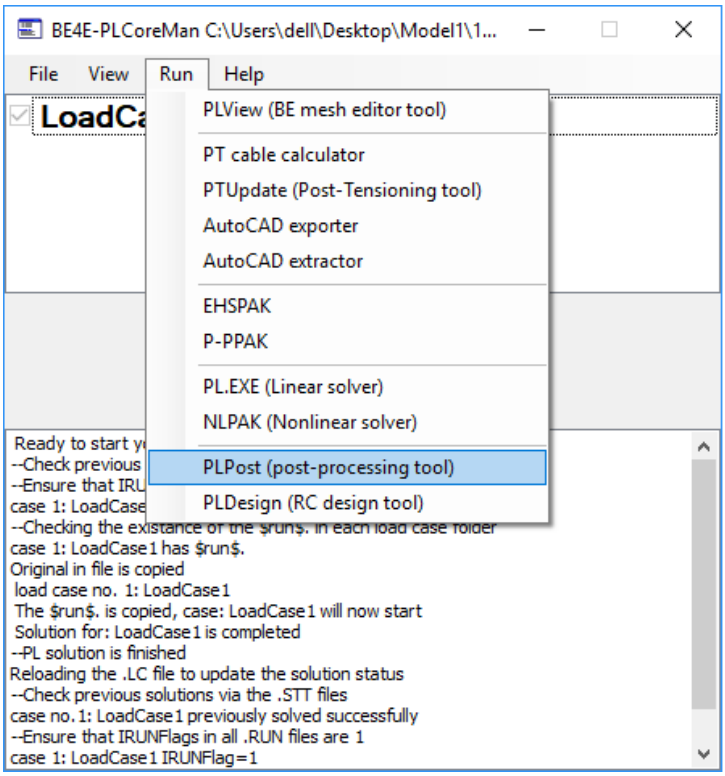


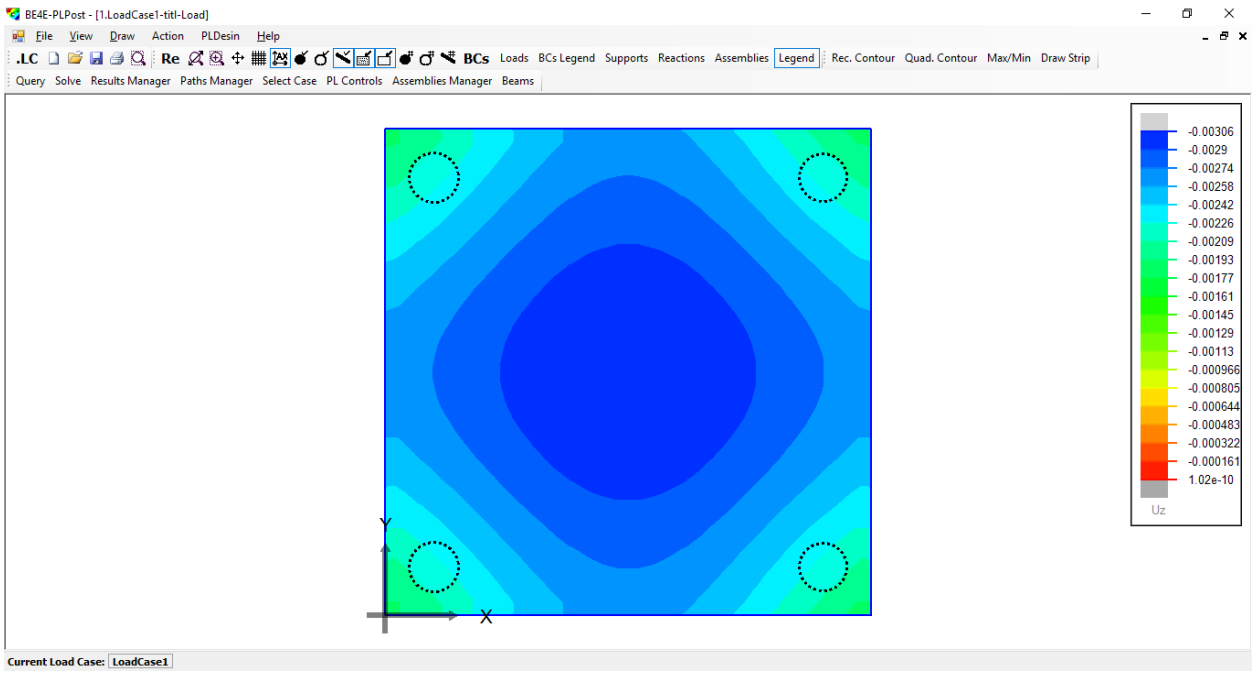
4- Close P-PPAK and go back to PLCoreMan.

5- Run PL.exe (Linear solver).



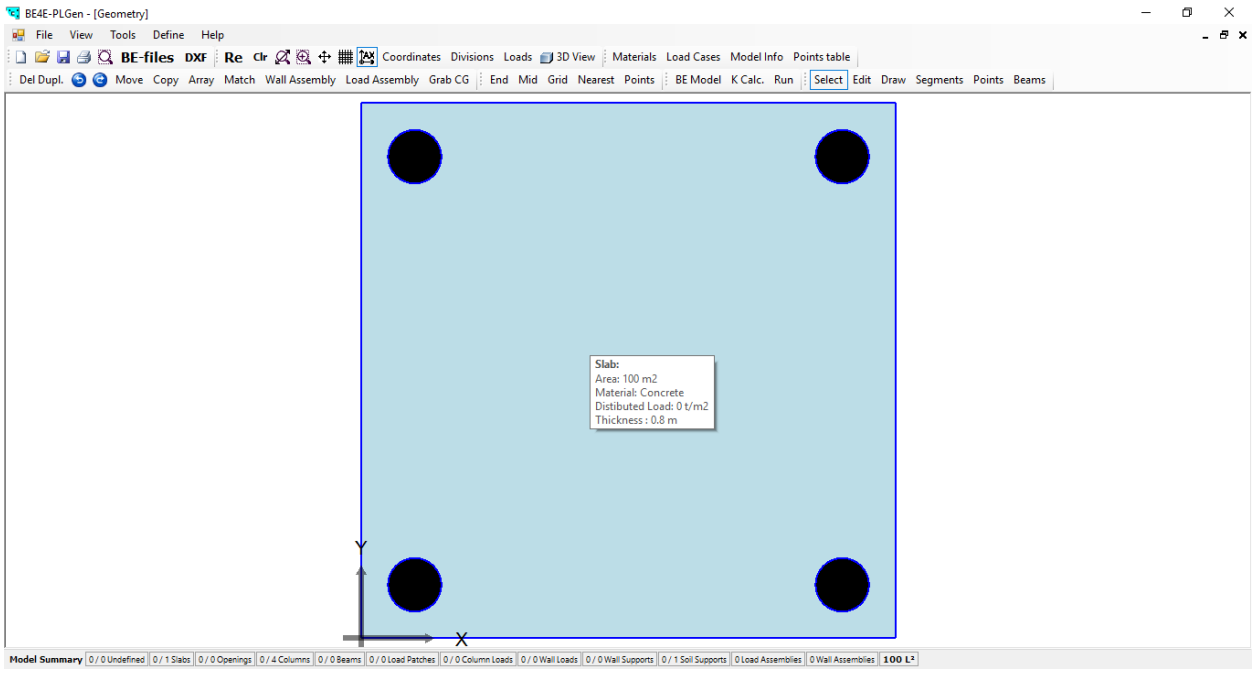
6- Show results on PLPost.



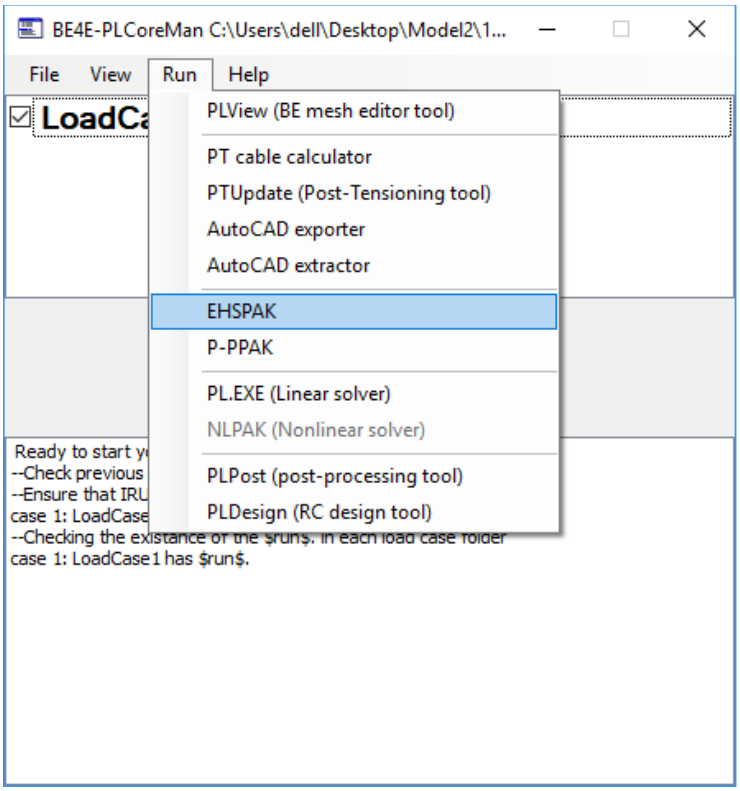


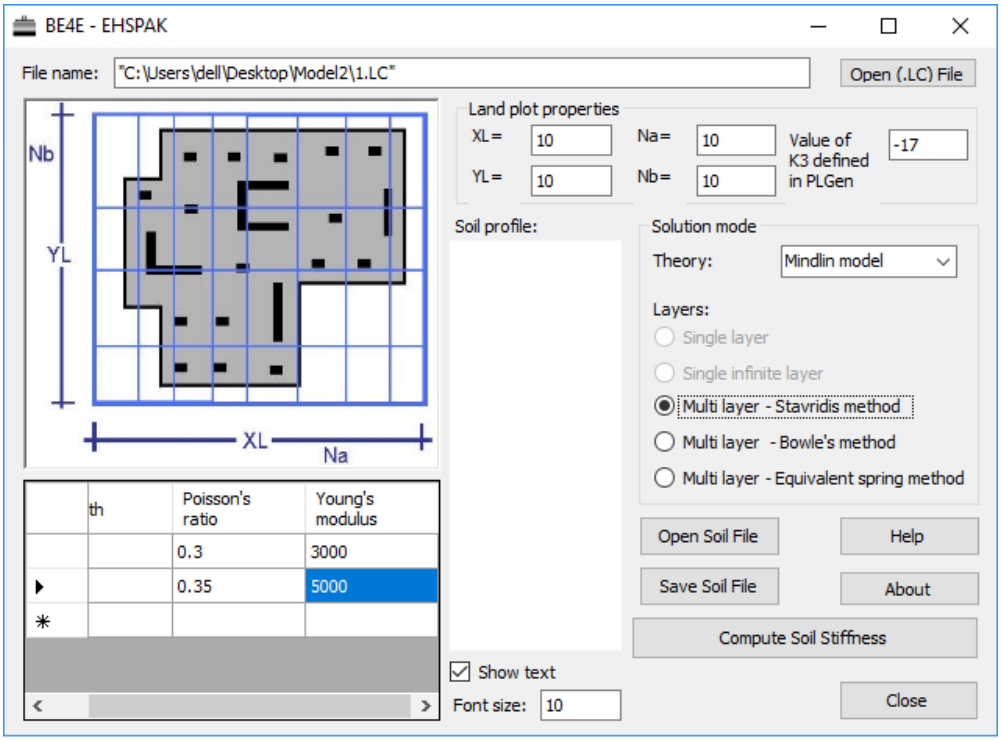
Problem 2: This problem is 10 × 10 m piled raft with thickness 0.8 m supported on four piles each 0.5 m radius and two-layered elastic half space subjected to its own weight.

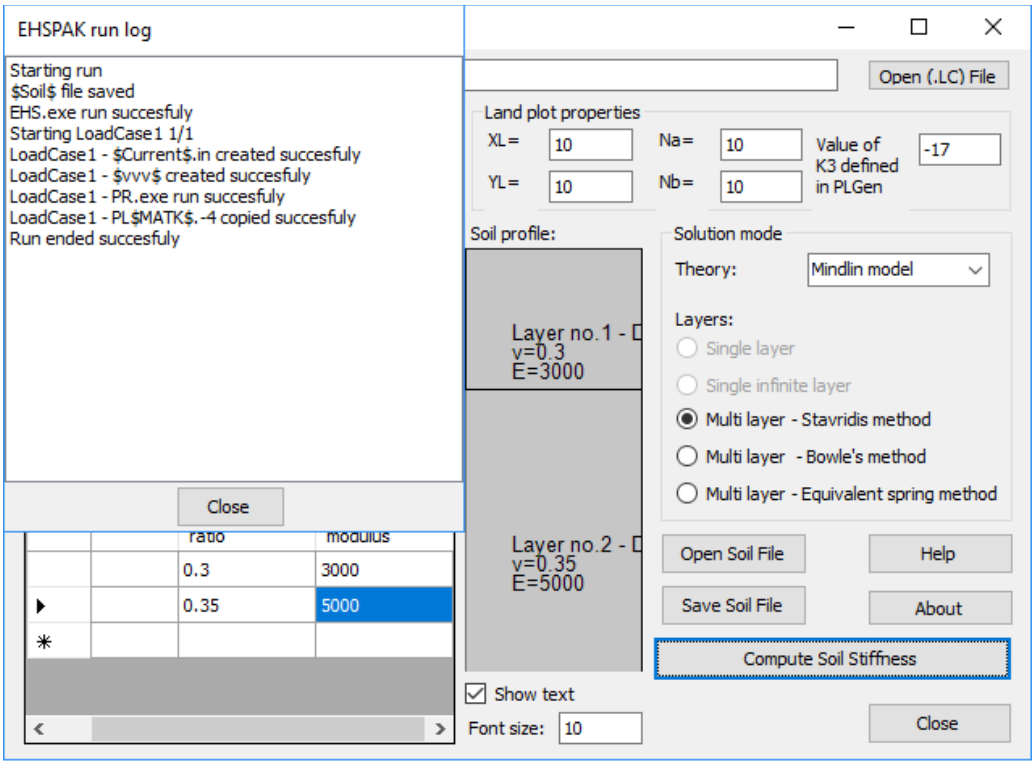
1- Generate Gen model.



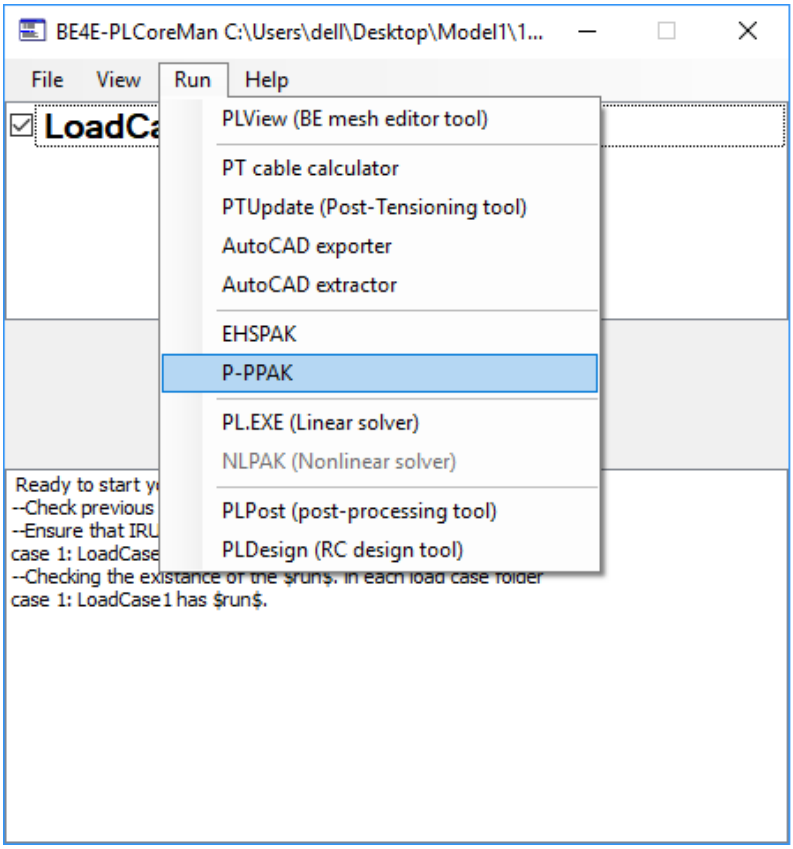
2- Run the problem from PLGen or load it from PLCoreMan.
3- From PLCoreMan run EHSPAK to extract soil-soil stiffness in (PL$MATK$.-4).

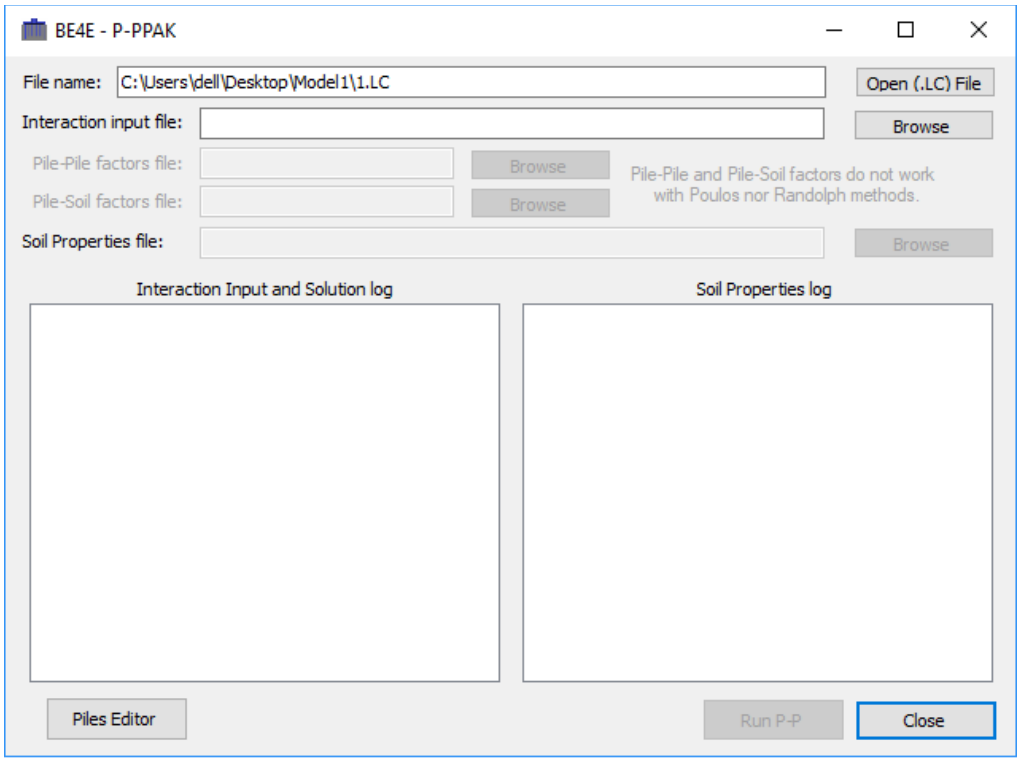

BE4E-PLCoreMan C:\Users\dell\Desktop\Model2\1...
File
View
Run
Help
LoadCa
PLView (BE mesh editor tool)
PT cable calculator
PTUpdate (Post-Tensioning tool)
AutoCAD exporter
AutoCAD extractor
EHSPAK
P-PPAK
PL.EXE (Linear solver)
NLPAK (Nonlinear solver)
PLPost (post-processing tool)
PLDesign (RC design tool)
Ready to start y
--Check previous
--Ensure that IRU
case 1: LoadCase
--Checking the existance of the run. in each load case folder
case 1: LoadCase1 has run.


BE4E - EHSPAK
File name:
"C:\Users\dell\Desktop\Model2\1.LC"
Open (.LC) File
Nb
YL
XL
Na
Land plot properties
XL=
10
Na=
10
Value of K3 defined in PLGen
-17
YL=
10
Nb=
10
Soil profile:
Solution mode
Theory:
Mindlin model
Layers:
Single layer
Single infinite layer
Multi layer - Stavridis method
Multi layer - Bowle's method
Multi layer - Equivalent spring method
th
Poisson's ratio
Young's modulus
0.3
3000
0.35
5000
Open Soil File
Help
Save Soil File
About
Compute Soil Stiffness
Show text
Font size:
10
Close

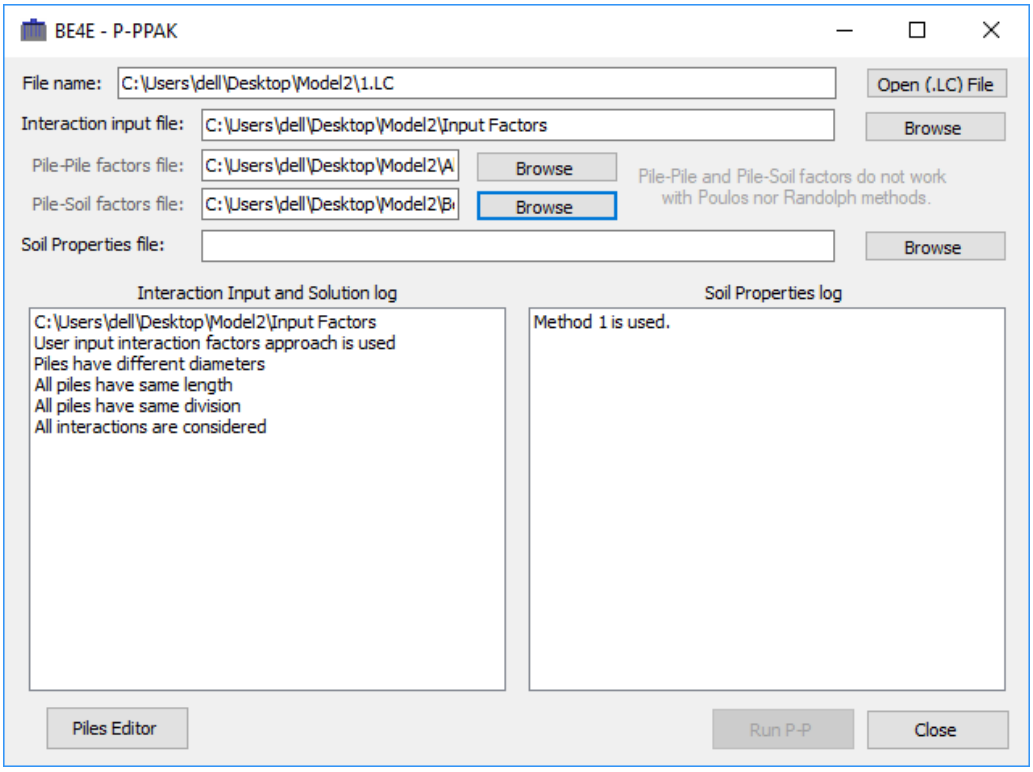


4- From PLCoreMan run P-PPAK to extract pile-pile/soil stiffness in (PL$MATK$.-4).

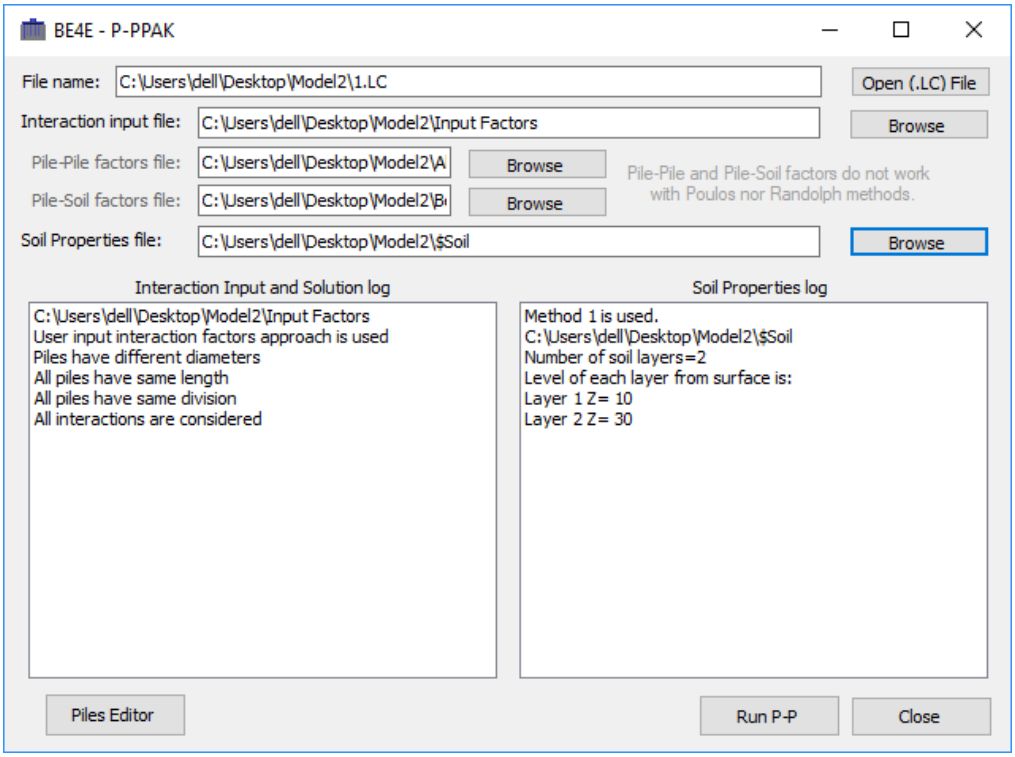




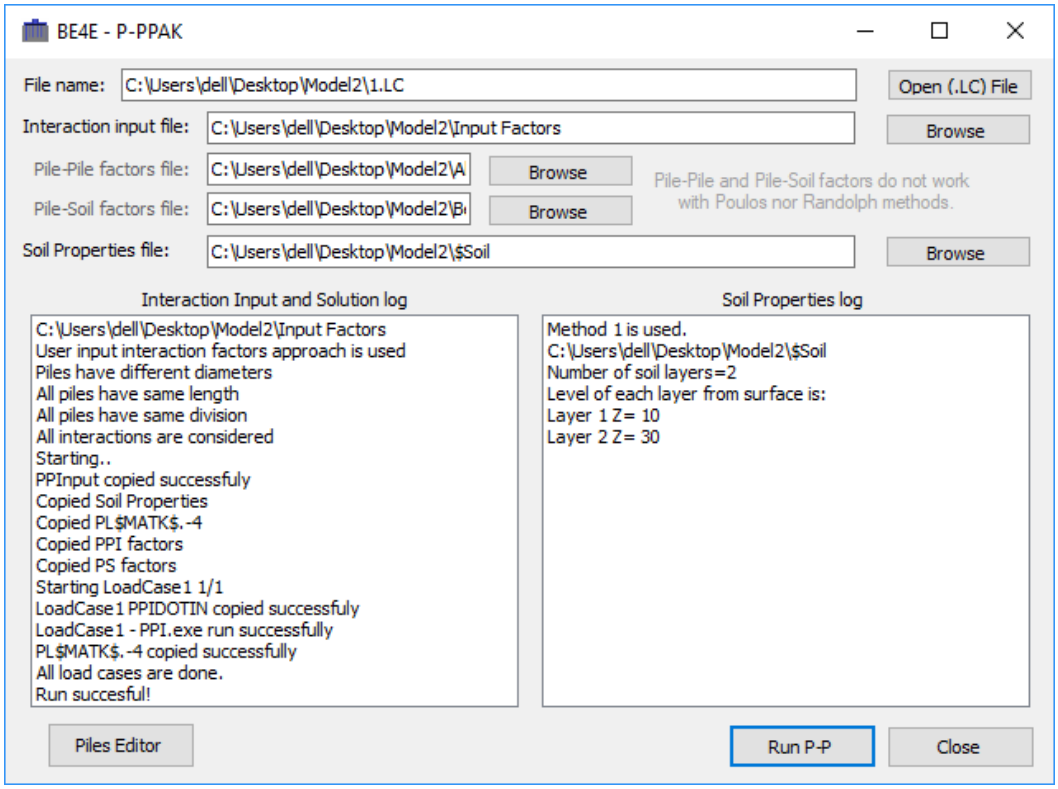
a. Load interaction input file of the problem (File different structures see appendix 1).



b. Load soil properties file (File format see appendix 1).

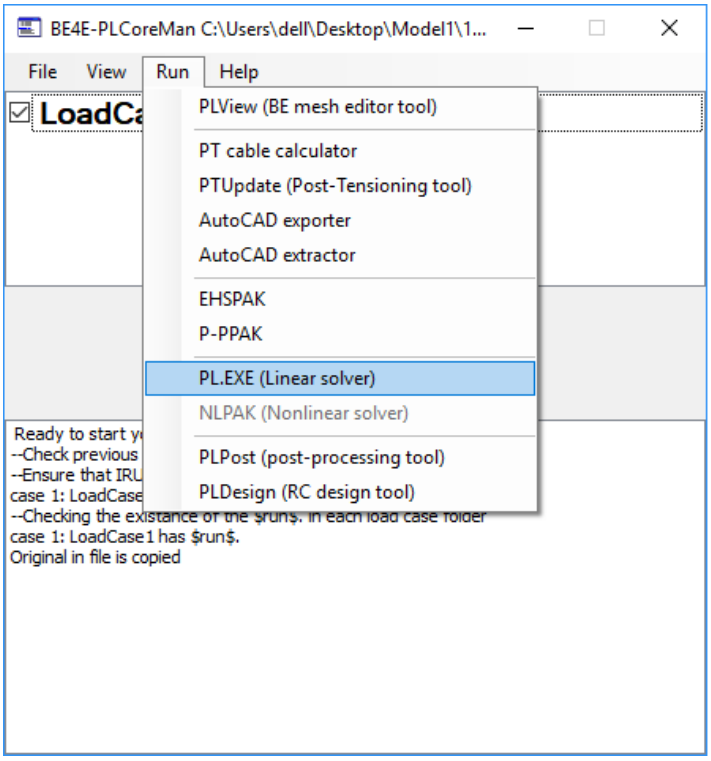


c. Press button Run P-P

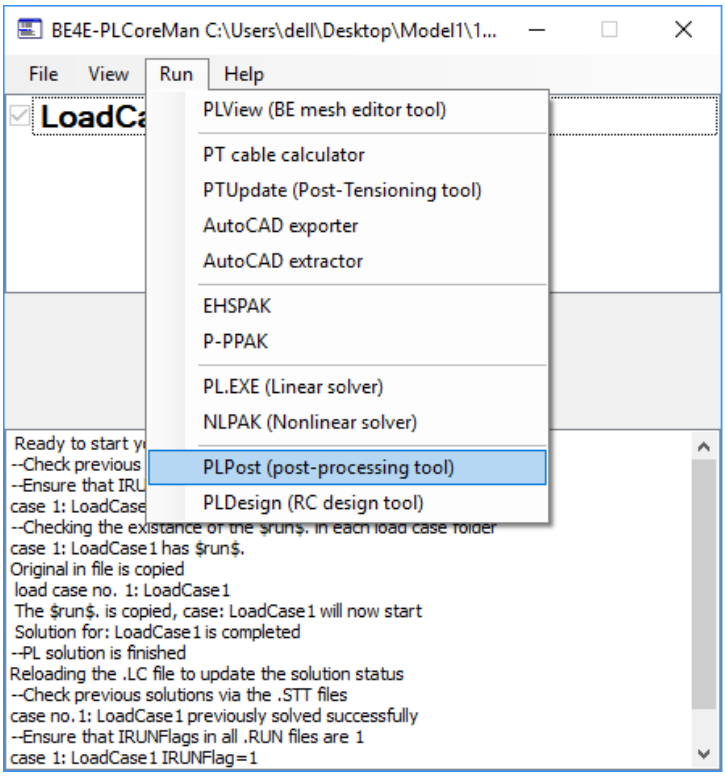


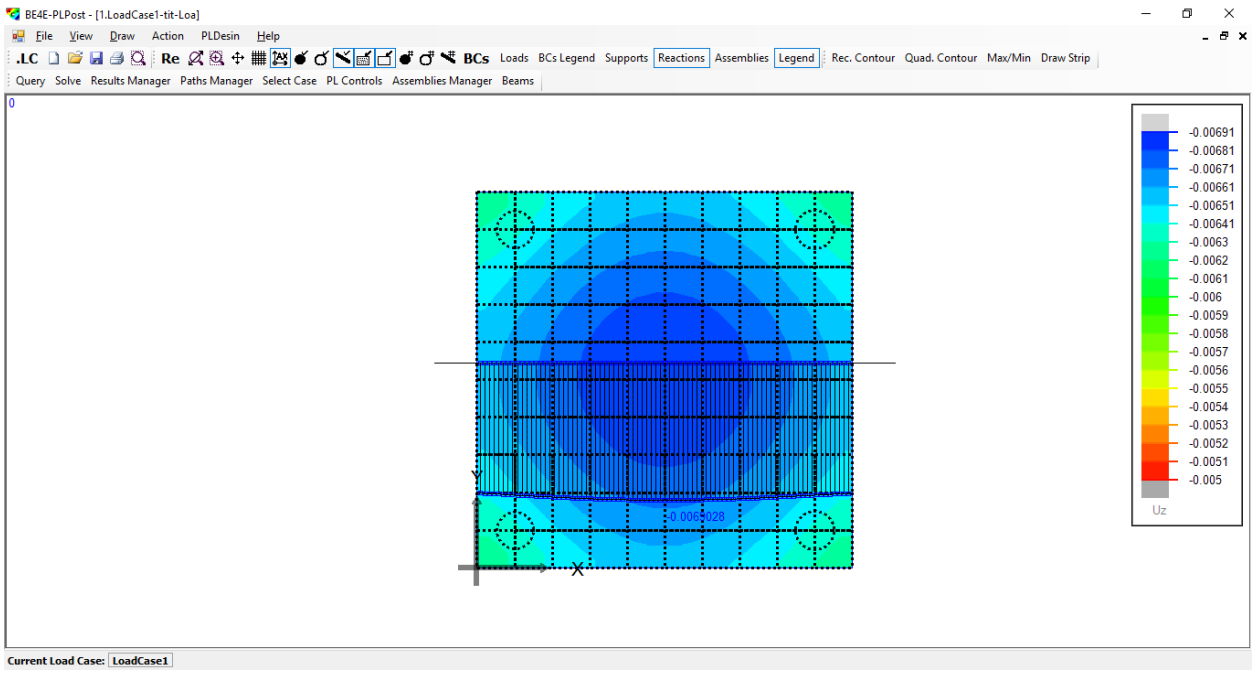
5- Close P-PPAK and go back to PLCoreMan.

6- Run PL.exe (Linear solver).



7- Show results on PLPost.




BE4E-PLPost - [1.LoadCase1-tit-Loa]
File View Draw Action PLDesin Help
.LC Re BCs Loads BCs Legend Supports Reactions Assemblies Legend Rec. Contour Quad. Contour Max/Min Draw Strip
Query Solve Results Manager Paths Manager Select Case PL Controls Assemblies Manager Beams
0
-0.00691
-0.00681
-0.00671
-0.00661
-0.00651
-0.00641
-0.0063
-0.0062
-0.0061
-0.006
-0.0059
-0.0058
-0.0057
-0.0056
-0.0055
-0.0054
-0.0053
-0.0052
-0.0051
-0.005
Uz
-0.005028
Y
X
Current Load Case: LoadCase1

Appendix 1
Input files Structure

1- Interaction input file:

- 0/1/2 0: if load transfer approach, 1: if elastic approach, 2: if user input interaction approach.
- N_p Total number of piles.
- r_1
  r_2
  .
  .
  .
  .
  r_{Np} } Radius for each pile.
- L_1, d_1
  L_2, d_2
  .
  .
  .
  .
  L_{Np}, d_{Np} } Length and number of divisions for each pile.
  (Note: Load transfer approach method, piles have the same length and same divisions.)
  i.e. this part will be only one line in this case **(L, d)**.
- F_1
  F_2
  .
  .
  .
  .
  F_m } Factors for including or neglect friction or end bearing (see Figure A).
  ($m = \sum d(i) + 2N_p$) $i=1 \rightarrow N_p$
  (Note: These factors are in cases load transfer approach and elastic approach only.)
- E_{p1}
  E_{p2}
  .
  .
  .
  .
  E_{pNp} } Young's modulus for each pile.

- 0/1/2 0: for including P-P interactions only, 1: for including P-P and S-S interactions only (neglecting P-S interactions), 2: for including all interactions (P-P, S-S, P-S).
- Layering method 1/2/3.1: Average E, 2: Equivalent E, 3: Poulos and Lee – (Modified E).

1.1. Pile-pile factors file (α):

- **1/2/3** 1: U_{ii} read from this file, 2: U_{ii} calculated from load transfer approach, 3: U_{ii} calculated from elastic approach.
- **U_1**
- **U_2**
- .
- .
- .
- .
- **U_{Np}**

U_{ii} for each pile. (Exist only in case of U_{ii} read from this file" i.e. the first line is 1").

- **α_{11}**
- **α_{12}**
- .
- .
- .
- .
- **$\alpha_{(Np*Np)}$**

[α] $_{Np*Np}$ pile-pile interaction factors matrix as % from U_{ii} written as a one column.

1.2. Pile-soil factors file (β):

- **1/2** 1: U_{ii} read from this file, 2: U_{ii} calculated from EHSPAK.
- **U_1**
- **U_2**
- .
- .
- .
- .
- **U_{Np}**

U_{ii} for each soil cell. (Exist only in case of U_{ii} read from this file "i.e. the first line is 1").

- **β_{11}**
- **β_{12}**
- .
- .
- .
- .
- **$\beta_{(Np*Nhs)}$**

[β] $_{Np*Nhs}$ pile-soil interaction factors matrix as % from U_{ii} written as a one column (row$_1$, row$_2$ . . . row$_{Np}$). (Note: **N_{hs}** is the total number of half space soil cells.)

2- Soil properties file (This file already exist in case of running EHSPAK before P-PPAK. Its name is $soil$ @ PLPAK folder):

- **N_{layers}**,**Idum**, **Idum** Total number of soil layers, Any two dummy integer numbers.
- **Idum**, **Idum** Any two dummy integer numbers.
- **H_L ,E_s , υ_s**
- **H_L ,E_s , υ_s**
- .
- .
- .
- **H_L ,E_s , υ_s**

Layer soil modulus, Layer's poison's ratio, Layer depth from soil top surface.

Friction or End bearing factors

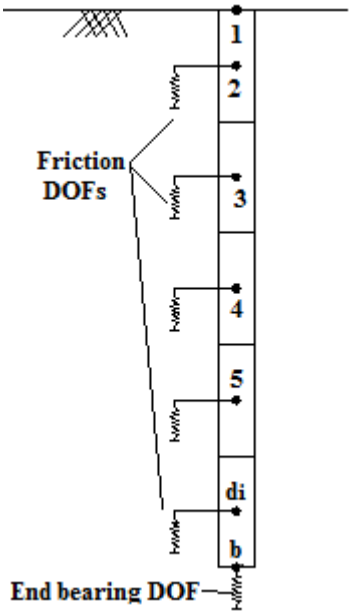


Figure A: Pile (i) friction and end bearing DOFs.

DOF 1: for connecting with the raft.

DOFs (2 to d_i): Friction DOFs.

DOF b: End bearing DOF.

Each pile has (d_i(number of divisions)+2(top and bottom)) DOFs.

All piles has m DOFs = $\sum d(i) + 2N_p$.

Several examples for write one pile factors in Interaction input file:

1	0	1
1	0	1
1	0	1
1	0	1
1	0	1
1	0	1
0	1	1
Friction pile(i) factors	End bearing pile(i) factors	Friction and End bearing pile(i) factors

Appendix 2
Input files problem 1&2 as example

1- Interaction input file:

Load transfer approach	Elastic approach	Field measurements input factors
0	1	2
4	4	4
0.5	0.5	0.5
0.5	0.5	0.5
0.5	0.5	0.5
0.5	0.5	0.5
10 5	10 5	10 5
1	10 5	10 5
1	10 5	10 5
1	10 5	10 5
1	1	100000
1	1	100000
1	1	100000
1	1	100000
1	1	2 (must be 0 in problem 1) (could be 1 or 2 in problem 2)
1	1	1 ← could be 1, 2 or 3
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
1	1	
100000	1	
100000	1	
100000	1	
100000	100000	
0 (must be 0 in problem 1) (could be 1 or 2 in problem 2)	100000	
1 ← could be 1, 2 or 3	100000	
	100000	
	2 (must be 0 in problem 1) (could be 1 or 2 in problem 2)	
	1 ← could be 1, 2 or 3	

2- Pile-pile factors file (α):

Read U_{ii} from this file	Load transfer approach	Elastic approach
1	2	3
0.002	1	1
0.002	0.25	0.25
0.002	0.5	0.5
0.002	0.25	0.25
1	0.25	0.25
0.25	1	1
0.5	0.25	0.25
0.25	0.5	0.5
0.25	0.5	0.5
1	0.25	0.25
0.25	1	1
0.5	0.25	0.25
0.5	0.25	0.25
0.25	0.5	0.5
1	0.25	0.25
0.25	1	1
0.25		
0.5		
0.25		
1		

3- Pile-soil factors file (β):

Read U_{ii} from this file	EHSPAK
1	2
0.0035 I =1	1 I=1, J=1
0.0033 I =2	0.25 I=1, J=2
0.0032	0.5 I=1, J=3
0.0035	0.25
.	.
.	.
.	.
.	.
.	0.25 I=4, J=97
0.0034 I=100 (EHS discritization 10×10)	0.15 I=4, J=98
1 I=1, J=1	0.15 I=4, J=99
0.25 I=1, J=2	1 I=4, J=100
0.5 I=1, J=3	
0.25	
.	
.	
.	
.	
0.25 I=4, J=97	
0.15 I=4, J=98	
0.15 I=4, J=99	
1 I=4, J=100	

4- Soil properties file ($soil$):

Problem 1	Problem 2
2 Any no. Any no. Any no. Any no. 10 3000 0.3 30 5000 0.35 Any no. Any no.	2 17 12 10 10 10 3000 0.3 30 5000 0.35 10 10

Getting Help

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