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PLPAK NEWSLETTER

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Analysis of Raft Foundations on Elastic Soil Support

Single-Layered Soil (Part 1) - EHSPAK

The EHSPAK is an add-on to the PLPAK to represent the soil under the structure. Using the EHSPAK, the modeler can include the elastic half space (soil profile) to the structural model in one step and without any iterations. The EHSPAK transforms the soil profile into a stiffness matrix that replaces the soil parameters introduced in the PLPAK's 'Soil Support object'.

Building foundations design has been a common interest for both structural and geotechnical engineers. In order to furnish an appropriate design for the foundations, appropriate structural analysis is necessary. Out of different types of building foundations, rafts are unique because they are supported only by the underlying soil. In order to perform structural analysis of raft problems, researchers and modelers arrived to a unique methodology that can be used to model rafts. This methodology simplifies the underlying soil (the supporting media) into springs/stiffness -patches. The challenge is always in calculating the spring stiffness that accurately simulates the soil rigidity.

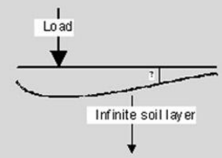
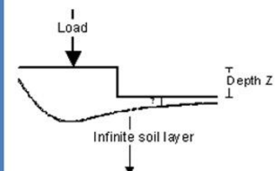
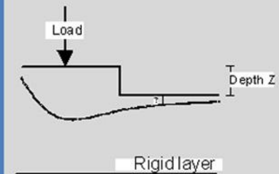
Supporting soil simplified to springs of equivalent stiffnesses

The most common soil model is the Winkler model. This model was very suitable to be coupled with finite element models because it is based on converting the soil media into discrete springs that can be added directly at the finite element nodes. However, the dependence on this model has two main drawbacks. The first drawback is that the Winkler model assumes that displacement occurs only under the loaded spring(s) and that the load has no effect on a distant spring; thus the Winkler model is called a "Single Parameter Model". The second drawback is that the Winkler model accuracy is greatly dependent on the value of the spring constant utilized; this value is normally retrieved from empirical data that has very wide ranges.

Improved models have been created to model the soil support. These models included the effects of soil shear modulus (Pasternak model), membrane effects (Hetenyi model), and others. The problem behind the application of these models is the spring constants calculated are dependent on foundation shapes and on applied loads.

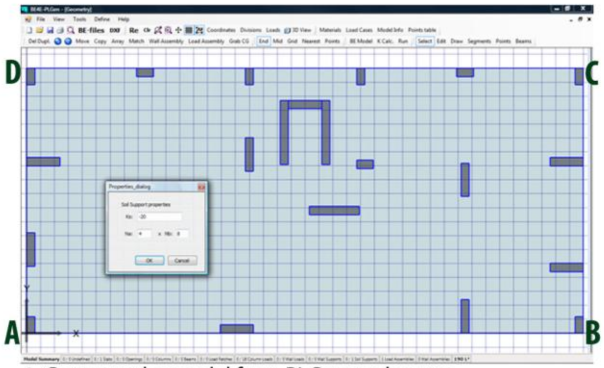
An improved methodology that is recommended by the ACI code of praxtice and the Euro-code is the "Elastic Half Space" model. This model represents the underlying soil as three-dimensional elastic medium. Three different elasticity solutions are implemented in the EHSPAK: Boussinesq, Mindlin, and Steinbrenner. Table (1) explains the difference between the three models. Manipulations can be made to consider multi-layering; *these manipulations will be covered in next month's part (Part 2) along with a detailed flow-chart on how the current EHSPAK incorporates these techniques and uses them with the boundary element method.*

Table 1 : Current model types incorporated in the EHSPAK

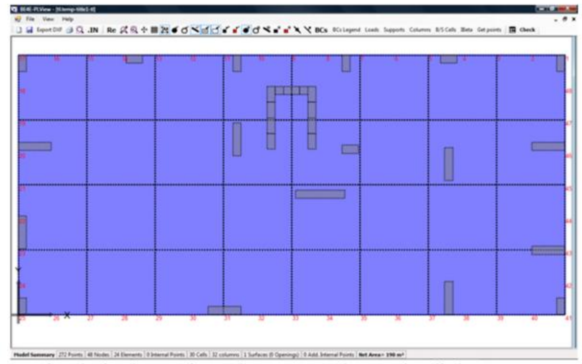
EHS Model Type	Schematic	Displacement calculated at different depths	Infinite soil layer/ Supported on a rigid base
Boussinesq		No	Infinite soil layer
Mindlin		Yes	Infinite soil layer
Steinbrenner		Yes	Rigid base

Practical Example Using the PLPAK - EHSPAK

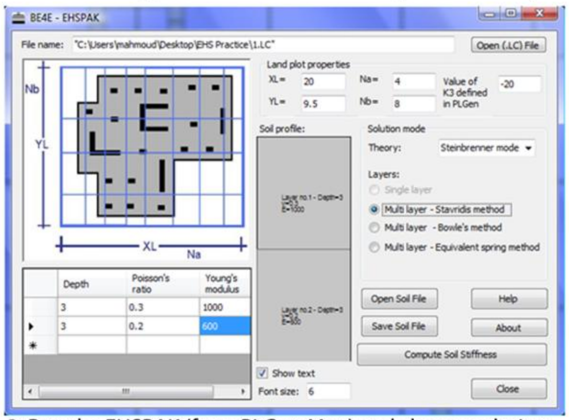
The following practical raft foundation is analyzed using the EHSPAK. The raft has a thickness of 1.7m; while its concrete material property is fcu =30 N/mm^2 and E =24100 N/mm^2. The soil supporting the raft is solved as a steinbrenner model, using the Stavridis method of multi-layering. There are 2 layers of different properties for this soil profile; three meters deep each. All properties related to the solution method and soil profile choice is simply added or altered in the EHSPAK window (while the usual model generation is done through the PLGen). The steps for this procedure is shown below:



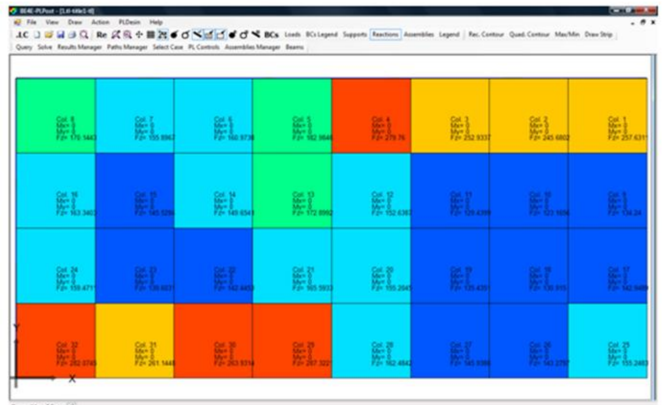
1. Generate the model from PLGen; make sure that the soil support is drawn from A to D (anti-clockwise).



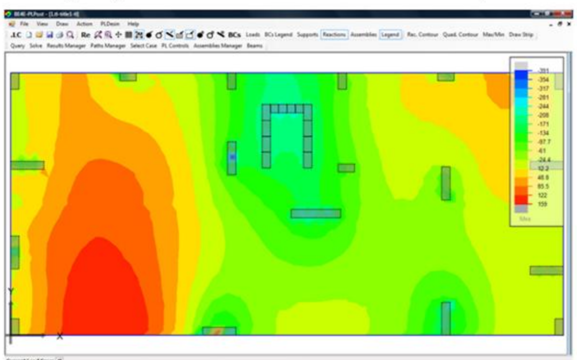
2. Check the boundary element nodes and cell divisions from the PLView.



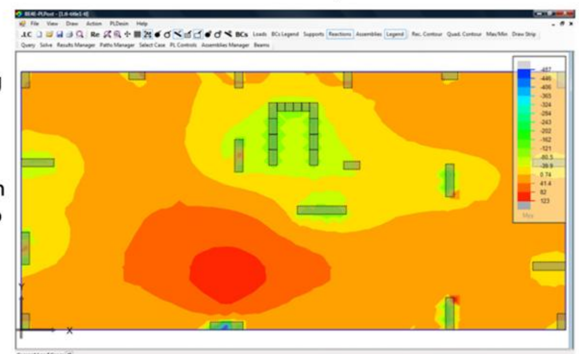
3. Run the EHSPAK (from PLCoreMan) and choose solution and layering method. The soil stiffness is then computed.



4. Open the PLPost to any required results. Shown is the current reactions for the stiffness patches.

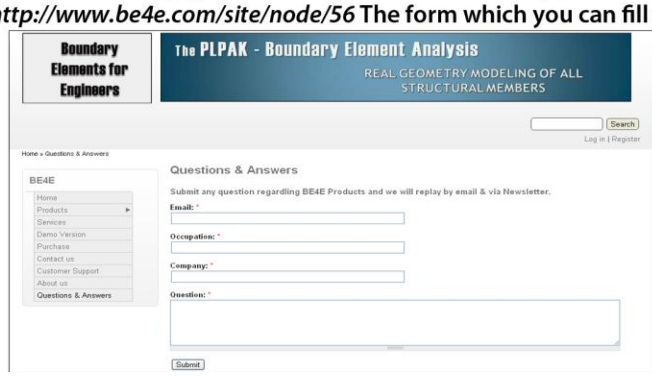


5. Other straining actions could be solved for the raft foundation (Mxx - moment in the x-direction to the right; Myy - moment in the y-direction to the left).



In need of more questions answered?

We are always on the alert to answer your queries and support your smooth transition to a better boundary element sense in analysis. Send us any queries or comments to our new [Questions & Answers] page and await our reply in the coming issue! *http://www.be4e.com/site/node/56* The form which you can fill out is shown below:



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