ENGM048 Soil Structure Interaction

Coursework Assignment (2021/22) : SSI Modelling

Key information

Unit of Assessment	Soil-Structure Interaction Modelling
Unit of Assessment weighting	40%
Submission format	PDF via SurreyLearn (max. length 3,000 words)
Submission date	Wednesday 11 May 2022 (Week 11)
Return date	Tuesday 31 May 2022 (Week 14)

Intended Learning Outcomes**:**

1. Select the most appropriate SSI model for a given application
2. Determine the data required for a given SSI model
3. Set up and analyse SSI models of continuous footings, rafts, laterally-loaded piles, and embedded retaining walls
4. Compare and contrast discrete spring and continuum models of SSI
5. Validate the solutions obtained from commercially available software packages

Overview

A reinforced concrete strip footing 10 m long, 1.5 m wide and 350 mm deep will be constructed on the surface of a thick deposit of clay. The footing will support a vertical knife edge load (KEL) of 750 kN per m width acting at a distance of 3.5 m from the left-hand end, and an anticlockwise moment of 250 KNm per m width applied at a distance of 3 m from the right-hand end, Figure 1.

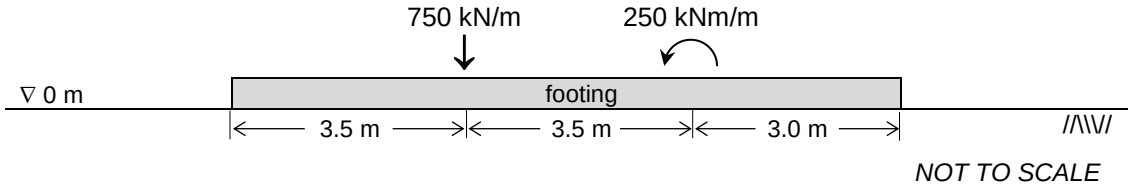

Figure 1

A single percussion borehole was made on the site, from which U100 tube samples were retrieved and taken to a laboratory. There they were extruded and subjected to consolidated undrained (CU) triaxial tests, in which the in-situ mean effective stress levels were re-established for each depth before shearing, and from which the following soil parameters were determined:

Depth below ground level (m)	5	10	15
Undrained shear strength (kPa)	67	104	126

Based on the inferred overconsolidation history and plasticity index of the clay, E_u/c_u for the clay was considered to be approximately 750. The groundwater level was just below ground level.

Specific Tasks

(1) Estimate the vertical deflections of the footing and the bending moments and shear forces acting in it, using **both** discrete Winkler spring (finite difference) and continuum (finite element analysis. It is suggested that you use one of the BOEF[1] workbooks for the former, and PLAXIS[2] for the later, but you are welcome to use software of similar functionality that you may be familiar

[1] provided on SurreyLearn in the Week 3 unit

[2] see details on how to access in the SSI Modelling Coursework unit

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with. In both cases, the footing will need to be modelled explicitly, but there is no requirement for any specific interface behaviour in the continuum analysis – **which should be linear elastic** to be directly comparable to the discrete spring analysis. Discuss your results, comparing and contrasting the results of the discrete spring and continuum analyses. You should also carry out an independent check on your results using an appropriate method.

(2) A more thorough site investigation has revealed that part of the site is occupied by a backfilled excavation around 6 m deep. Poorly controlled backfilling has produced ground that has a stiffness that is only about 50% of the surrounding clay. The left-hand 4 m of the footing rests on this backfill, with the remainder of the footing on the original clay, Figure 2.

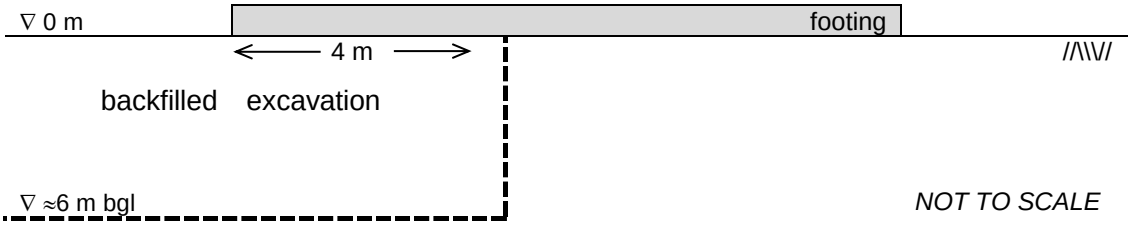

Figure 2

Adapt **both** the continuum and discrete spring models set up in (1) to accommodate this backfilled zone and re-run the analyses with the same applied loading. [NB: a minor adjustment to the BOEF workbook will be required.]

(3) One of the limitations of the discrete spring model is that it allows tension to develop in the springs, such that if the beam was to lift off the ground the springs would try to restrain it. Modify the BOEF workbook used for the analysis in (1) so that tension cannot develop in any of the springs. Explain carefully what you have done to achieve this and any precautions that have to be taken whilst running it. When you are satisfied that you have made the required changes, re-run the discrete spring analysis from (1) and compare the results. Discuss whether or not you consider this modification to have been a worthwhile improvement. [NB: you are not required to re-run the continuum analysis.] You should submit the modified workbook along with your report as a separate file so that the correctness of the implementation can be verified.

Note: The information given above is not sufficient to perform the analyses. You will need to make judgements about appropriate geometric discretization, and any material properties not specified above (in particular, the coefficient of subgrade reaction). You should do this on the basis of the other study units in this module, your reading of relevant literature, and your engineering experience – providing clear reasons and justification for doing so. You should expect to have to do some background research for a coursework assignment at FHEQ Level 7.

Submission requirements

A **written report** in **PDF** format (A4 size, font size 11, single line spacing, and minimum 2.5 cm margins) must be submitted via **SurreyLearn**. Put your URN in the document header on every page. The submission should not exceed **3,000 words**, so chose carefully what to include.

The written report should be presented in a professional manner; that is, laid out clearly and explained in a way that could be followed by an independent engineer. Full sources for any figures, equations, charts, tables etc included should be given (citation and reference); the units of assumed and calculated values must be stated; appropriate precision should be used for all significant results.

The following must be included in your report:

- Details of the models used in (1), (2) or (3), including diagrams of the FD grid and the FE mesh, material properties and any other parameters selected / chosen – including the assumptions or judgements behind them
- Details of (and justification for) the independent check you used in (1)

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- Appropriate output (whether numerical or graphical) from the software used; be selective and include only what is relevant
- Tables of *maximum* values, and X-Y scatterplots of (i) vertical deflection, (ii) bending moment and (iii) shear force along the whole length of the beam, facilitating comparison of the results obtained by the continuum and discrete spring models used in (1) and (2), **and** comparison of the results obtained by the original and modified discrete spring models in (1) and (3).
- Discussion of the results in each of (1), (2) and (3); are they what you would have expected? Are there any unusual features? What are the engineering implications? Be critical and describe the evidence for your acceptance (or otherwise) of the behaviour you see.

You should also submit a copy of the BOEF **Excel workbook** that have modified for task (2).

In summary, the assessment of your work will be based on: completeness of the tasks required, logic and justification for the modelling decisions, clarity of the results, quality of discussion relating to your answers, and overall standard of presentation.

See also the *Grade Descriptors for FHEQ Level 7* in the Coursework sub-unit on **SurreyLearn**, so that you are familiar with what characterises work in the different mark ranges.

Mark allocation

Task 1

Comparison of discrete spring and continuum analyses: original ground profile	45%

Task 2

Comparison of discrete spring and continuum analyses: inclusion of backfilled excavation	30%

Task 3

Modification of discrete spring model for no tension: comparison with unmodified discrete spring analysis: original ground profile	15%

Overall

Report structure, use of English, standard of presentation and overall effort	10%
Total	100%

General matters

Support before submission

If you have any questions about this brief, please post them on the SurreyLearn **Discussion forum** in the first instance. Zoom “drop in” sessions will also be arranged; see SurreyLearn News for details.

Applicability of feedback to other assessments

There are no other coursework assignments in ENGM048, but feedback on this assignment will reinforce your understanding of soil-structure interaction in preparation for the online examination at the end of the semester.

Support after return

After this coursework assignment is returned to you with marks and feedback there will be an opportunity to seek additional feedback and clarification on marks awarded within one week of the return date. Arrangements for this will be posted on SurreyLearn News nearer the time.

R I Woods
01.04.22