Introduction

This report describes the features of a spreadsheet called PileGroup2.0 for analysis of lateral load resistance of pile groups, including the resistance provided by embedded pile caps. The previous version of this spreadsheet, PileGroup, developed in August 2002, did not include options for considering variations in pile head fixity in the analyses of pile groups. This new version includes consideration of nonlinear soil behavior, pile-soil-pile interaction, the resistance to lateral loads provided by pile caps, and the degree of pile head fixity, varying from zero to 100%. These effects have been discussed in a paper by Duncan, et al. (2005).

Background

The methods used in the PileGroup2.0 spreadsheet have been developed through studies of the behavior of laterally loaded piles over a period of about 20 years:

- Evans and Duncan (1982) used dimensional analysis techniques to characterize the behavior of free-head and fixed-head laterally loaded piles in dimensionless form. The method, called the Characteristic Load Method (CLM) made it possible to represent the behavior of a wide range of pile and soil conditions with a small number of graphs. The method, which was described in a paper by Duncan et al. (1994), could be used to compute the deflections at the top of a single pile or drilled shaft and the maximum moment.
- Ooi et al. (1991), and Ooi and Duncan (1994) used the CLM, and methods for analysis of pile groups suggested by Focht and Koch (1973) to develop simplified analysis procedures for groups of piles and drilled shafts.
- Brettmann and Duncan (1996) developed curve-matching equations for the graphs developed by Evans and Duncan (1982), to make it convenient to use the CLM for spreadsheet analyses of single piles and drilled shafts, and suggested that similar procedures could be used to develop spreadsheets for pile groups, based on the empirical equations developed by Ooi et al. (1991). The first such CLM spreadsheet, which was not published formally, was developed by Brettmann, Ooi and Duncan. The spreadsheet was found to be accurate for single piles and drilled shafts, but it was found to overestimate the deflections of groups of piles and drilled shafts in most conditions.
- Mokwa and Duncan (2001a), and Mokwa and Duncan (2002) developed improved procedures for analysis of laterally loaded pile groups based on the p-y multiplier concept.
- Clarke and Duncan (2001) developed a spreadsheet that incorporates the improved method of evaluating the behavior of pile groups developed by Mokwa and Duncan.
- Mokwa and Duncan (2001b, 2001c) showed that considerable resistance to lateral load results from passive earth pressure acting against pile caps, and developed procedures for including the resistance of pile caps in analyses of laterally loaded pile groups. The procedures they developed were incorporated in an Excel spreadsheet called PYCAP.

- Robinette and Duncan (2002) developed an Excel spreadsheet called PileGroup for analysis of laterally loaded pile groups. PileGroup incorporated the improved procedures for representing the lateral load behavior of pile groups developed by Mokwa and Duncan (2001a), and also the lateral load resistance of pile caps (Mokwa and Duncan, 2001b). PileGroup incorporated a slightly modified version of PYCAP to compute cap resistance.
- PileGroup2.0, described here, is similar to PileGroup. PileGroup2.0 can be used to analyze the lateral load behavior of pile groups with pile restrain varying from 0% (the free head condition) to 100% (the fixed head condition).

Summary Spreadsheet

Data are entered and the results are displayed in the Summary spreadsheet – see Figure 1. Data are entered in the shaded areas (shaded yellow on the computer screen) – the other cells that display labels, instructions, or computed results are locked. Definitions of the variables are included, and dimensions are shown in a sketch on the sheet.

Data are entered for the soil around the cap, and for the soil around the piles, after selecting the appropriate material types by typing CLAY or SAND, or by using the drop-down list. Only the cells requiring input for the specified conditions are available for data enty – the others are blank, and the unused options are labeled "Not Applicable." If the option "NO CAP RESISTANCE" is selected, cap resistance is set equal to zero.

Iteration is required to solve for the resistance of pile caps in sand. It is necessary to click on the button labeled "Press to Calculate Cap Resistance in Sand – Iteration is required for this calculation" to activate the log spiral macro that performs the calculation.

The Summary sheet displays three graphs of cap load versus deflection, pile load versus deflection, and combined load versus deflection displayed on the right side of the sheet. Curves for pile load and combined load are shown for 0%, 50%, and 100% pile head fixity.