Simulation of interaction CFA pile with a soil mass under static vertical load

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At the present time the foundations of bored piles are widespread. Among of them the most common are Continuous Flight Auger (CFA) piles. Therefore, it is actuality to correctly reproduce the tests of CFA piles under static vertical load by numerical simulation [1] and [2]. This will allow you to more reliably predict the work of pile foundation.

The main purpose of this work is reproduce a full-scale static test of CFA piles by numerical simulation.

To achieve this purpose it was necessary to solve the following problems:

1) determine the geometry of the calculation model.
2) identify the mechanical parameters of the soil (E, c, ϕ).

The soil at the experimental site is represented by sands, sandy loam, clay and loam.

The calculation model is presented by prism which consists of the six and eight nodal universal isoparametric finite elements. The CFA pile is located in the center of this prism. The pile has got a diameter of 620 mm and a length of 21.3 m. (Fig. 1).

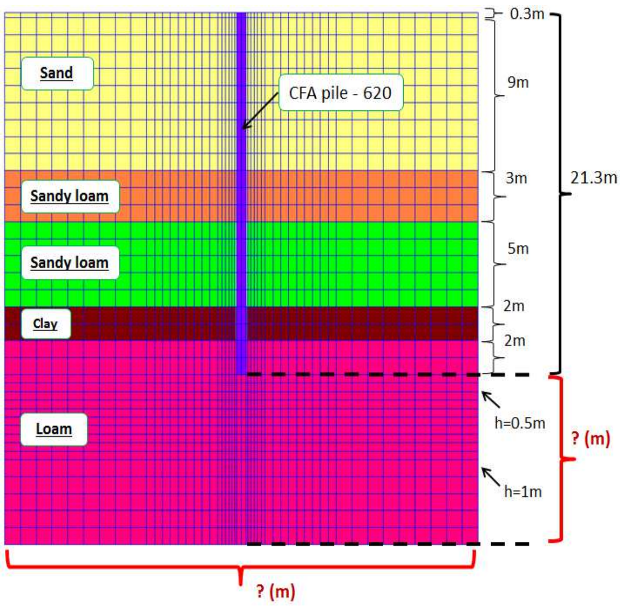

Figure 1. Vertical section of the calculation model.

In the case of a nonlinear calculation we applied ideal elastic-plastic model with Botkin condition of strength:

$$\sin(\phi)\cdot\sigma_0 + 3\cdot\sigma_i - 2\cdot c\cdot\cos(\phi) \le 0, \quad (1)$$

$$\text{where} \quad \sigma_0 = \sigma_1 + \sigma_2 + \sigma_3\,, \quad (2)$$

$$\sigma_i = \frac{1}{\sqrt{2}}\sqrt{(\sigma_1-\sigma_2)^2 + (\sigma_2-\sigma_3)^2 + (\sigma_3-\sigma_1)^2}. \quad (3)$$

For the correct calculation, it is necessary to set the such dimensions of the soil mass (thickness of soil under the pile tip and size in the horizontal plan) which will not affect on the result of calculation.

Four variants were modeled for pick up the height of the soil mass under the pile tip: 2.5 m; 5m; 10m; 20m. Since starting from 10m and up to 2.5m the deviation of diformation does not exceed 5%. So we take 10m as a basis thickness of soil.

Then we selected the size of the soil in the plan. Five variants were considered: 5x5m; 10x10m; 20x20m; 30h30m; 40x40m. For the basis size was taken 30x30m.

The next stage of identification is the mechanical characteristics of the soil (E, c, ϕ). The identification is carried out only in a shell around a pile with thickness 10 cm.

At first we use linear calculation to identify Young's modulus (E). Four variants were considered: E, 2E, 4E, 8E. "4E" was taken as the basis because it most closely matches the results of full-scale static test within the framework of elastic soil work.

It was found that the identification of unit cohesion does not make a significant contribution to the relationship between load and displacement. Therefore, it is accepted "c" = const.

Nonlinear calculation (with "4E" and "c") was taken as the basis for the identification of friction angle (ϕ).

There 2 options were compared: ϕ; 0.75ϕ. The latter option is accepted because it is most relevant to the nature graph of full-scale static test (Fig. 2).

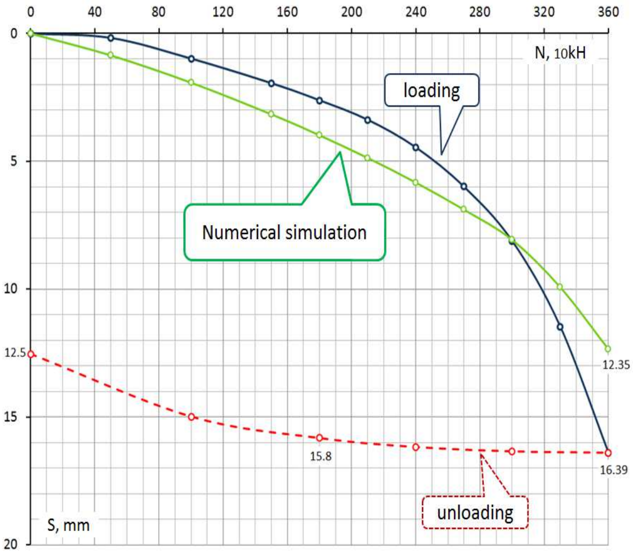

Figure 2. The resulting graph of numerical simulation

References

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