DISCUSSION

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on "Downdrag Settlement a Single Floating Pile"
authored by W.H. Ting
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The Author addresses the calculation of the settlement of a single pile in a compressible soil layer due to a fill on the ground surface. The following statement of the Author attracted the Discusser's attention**:** "*the … force causing downward movement of the pile is the applied load … acting together with the downdrag force. . .*" (Point 2 under the heading of Application of Method). By the words "*downdrag force*", the Author means the dragload. The statement implies that dragload can cause settlement. This is incorrect, of course. Although, the Author's appendix to the paper indicates that dragload does not contribute to the pile settlement, the Discusser finds the phrasing misleading.

The Author uses an elaborate formulation for calculation of the location of the neutral plane, the point of equilibrium of forces. The calculation is based on the assumption, essentially correct, that the shear force along the pile is proportional to the effective stress. On the assumption of a rigid pile, the settlement of the pile is the soil settlement at the neutral plane. To quantify the settlement of the pile, the Author then calculates the settlement of the soil assuming an elastic response of the soil to the load imposed by a fill on the ground surface. That is, the induced settlement reduces linearly from the ground surface to the bottom of the compressible soil layer, and the settlement at the neutral plane is assigned as proportional to its depth. The Author illustrates his method with a case history on a 54.5 m long, 800 m diameter "spun concrete" pile installed at the Miri Port Housing site where 65 m thick, homogeneous compressible soil layer exists. The groundwater table lies at the ground surface and the pore pressure distribution is assumed hydrostatic. The soil total unit weight is 18.5 KN/m^3. The applied static load is 1,500 KN, and the pile toe resistance is given as 271 KN. The Author calculates a neutral plane located at a depth of 37.5 m. A 0.5 m thick fill is placed on the ground surface and causes the soil to compress and the Author indicates a ground surface settlement of 224 mm and a settlement at the neutral plane of 96 mm (determined by linear proportionality to depth).

For the given toe resistance and other information, the depth to the neutral plane is not sensitive to the choice of effective stress parameters (beta, phi, K_0). For a depth varying by about 0.5 m from the

Author's value of 37.5 m, the beta-coefficient can be shown to range as widely as from about 0.2 through about 1.0. No surprise; the neutral plane for a pile "floating" in clay lies always about at the lower third point (two-thirds of 54.5 m is 36.3 m). The Author's elaborate calculations of the depth to the neutral plane appended to the paper fail to impress.

The Discusser disagrees strongly with the Author's assumption that the settlement would reduce linearly with depth. Under the conditions presented by the Author, the settlement must reduce exponentially. Conventional backcalculation from a 224 mm ground surface settlement of a 65 m thick, normally consolidated clay layer with a density of 1,850 kg/m^3 (corresponds to a void ratio of 1.0) determines the C_c-value to 0.18 (the corresponding values of Compression Ratio, CR, and Janbu Modulus Number, m, are 0.90 and 25, respectively). The settlement calculated using this uniform compressibility results in a settlement at a neutral plane at about 35 m depth of only about 25 mm as opposed the Author's value of about 100 mm.

To illustrate the comments, the Discusser performed a routine effective stress analysis of the Mori Port Housing case and the results are shown in Fig. 2. The load and resistance curves are determined by the values of the static load, 1,500 KN and toe resistance, 271 KN, combined with an assumed beta-coefficient of 0.25. The diagram indicates an assumed transition from negative skin friction to positive shaft resistance between the depths of 30 m and 40 m.

The settlement calculation has been fitted to produce a 224-mm settlement at the ground surface applying a conventional analysis using the conventional approach for clay. The settlement diagram makes it clear the large difference between the linear-proportionality method of the Author and the conventional settlement analysis method.

The shortening of the pile needs to be taken into account and the Author's assumption of a rigid pile is an oversimplification. As shortening due to dragload is somewhat compensated for by the shortening due to residual load, the extra settlement of the pile head due to shortening of the pile between the pile head and the neutral plane is mostly due to the applied 1,500-KN load. Thus, assuming that the spun concrete pile has a 100 mm wall and is empty, the shortening is about 5 mm for the example case. Because of the exceptionally small toe resistance, no allowance needs to be included for partially mobilized toe resistance. Moreover, as the analysis refers to a single pile and not to a large pile group, compression of the soil below the pile toe is minimal and can be ignored.

The beta-coefficient chosen for the Discusser's calculation is a low-boundary value. The analysis indicates a more than ample factor-of-safety for the piles. If a settlement of almost 100 mm was acceptable for the structures, then, obviously the 800 mm diameter pile was installed a good deal deeper than necessary, or, alternatively, was assigned a rather uneconomical value of allowable load.

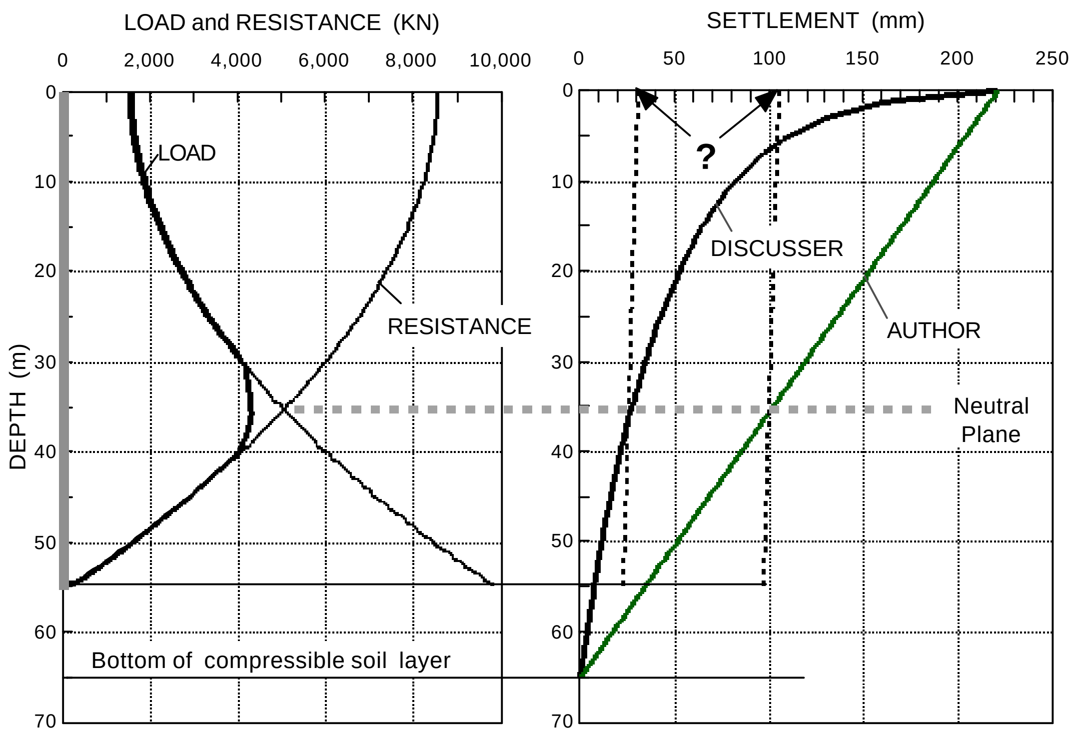

Fig. 2. Load and Resistance Curves and Distribution of Settlement for the Mori Port Housing Case