NRC Research Press

DISCUSSION

Reply to the discussion by Fellenius on "Plugging effect of open-ended piles in sandy soil"[1]

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The authors would like to thank Bengt H. Fellenius for his discussion of our paper (Fellenius 2015).

The Discussion incorrectly states that no such fixed connection was made at the pile head. The gap at the pile toe was welded to prevent any intrusion of soil during the tests, and the gap at the pile head was also welded to fix the two pipe piles. The fixed connection between the two piles ensured that the two piles moved in unison. As stated by the discusser, dynamic test gauges were installed on the outer piles, and the cross-sectional area for dynamic test analysis applied to the sum of the two pile annulus areas.

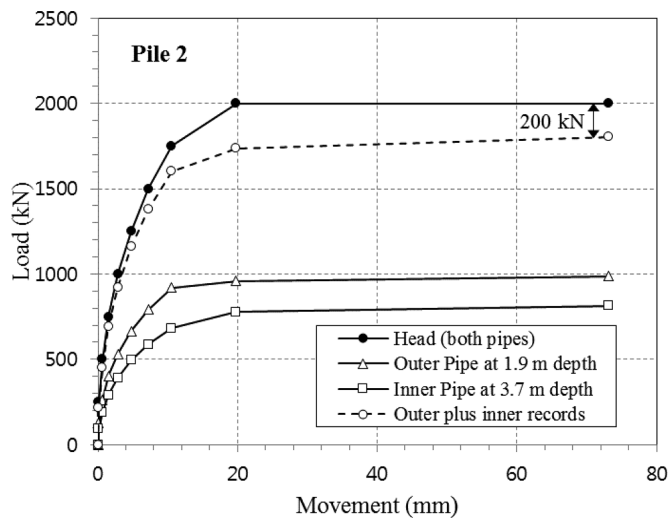
Due to the setup effect, the ultimate bearing load derived from static load test is generally larger than the one from the "end of initial driving" (EOID). However, in this study, geometric characteristics of the double-walled pile system and the assumed sum of the two pile annulus areas allowed the ultimate bearing capacity of EOID to be greater than the single pipe pile (not double-walled pile). This value is approximately the same with the static load test.

Figure 2 in Ko and Jeong (2015) represents the general bearing capacity mechanism for open-ended piles. This figure is not illustrating the force direction of the core, but rather the shaft resistance acting between the core and inside of the pile. Nevertheless, inner shaft resistance, Q_{in}, is the frictional force generated between the core and inside of the pile that has displayed upward direction. The values of the outer shaft resistance, Q_{out}, also signify that the frictional force generated between the soil and the outside of the pile are all on the outside of the pile in an upward direction.

As mentioned in Ko and Jeong (2015), Q_{plug} is the smaller value of either the inner shaft resistance, Q_{in}, or the bearing capacity of the soil beneath the plug base, Q_{base}. Thus, if Q_{in} is greater than Q_b, the pile will fail in the plugged mode. In pile driving, the inner shaft resistance, R_{in}, can exceed the end-bearing resistance of the soil beneath the plug, R_b, because the inertia force of the soil plug is mobilized. As the discusser states, it has been noted that the core is compressed as spring action. It is similar to the concept of the soil plugging index (SPI) in this study. In Ko and Jeong (2015), the authors state that the inner shaft resistance was mostly mobilized at the location between the pile tip and 18%–34% of the total plug length.

As shown in fig. D2 in Fellenius (2015), there is misleading information. When the analysis was rerun, the increase of axial load for outer pile TP-2 was extrapolated, and is estimated to be 120 kN not 80 kN. Figure R1 shows the load–movement curves resulting from applying the data from fig. 12 in Ko and Jeong (2015). The measured data of the inner pile at the first gauge level is not 610 kN, but is 814 kN due to an error that is illustrated in fig. D2 by the discusser. Thus, the difference between the "head" and "outer plus inner piles" is not approximately 400 kN, but about 200 kN as shown in Fig. R1.

Fig. R1. Pile 2. Load–movement curves for pile head and gauge depth at 1.9 and 3.7 m for the outer and inner piles, respectively.



In addition, the axial load at the inner pile head does not change, and the axial load at the outer pile head is predicted to increase to a value of 120 kN by extrapolating the axial load at the pile head. Therefore, it is assumed that the axial load at the inner pile head is 814 kN and is 1100 kN at the outer pile head in the final loading stage. Figure R2 shows the axial load distribution of the outer pile of pile 2 as determined by extrapolation.

Figure R3 shows the load–movement curves determined by extrapolation. The difference between the "head" and "outer plus inner piles" is about 75 kN. When comparing this with the ultimate bearing capacity, the difference between the two is within the range 0%–10%. This difference may have occurred due to the double-walled system. As mentioned by the discusser, the difference is determined to occur when using the welding method rather than the sealing method. However, in this study, the weights of test piles TP-1, TP-2, and TP-3, were 1.71, 2.91, and 5.24 t, respectively. These are heavier than the test piles studied in the literature. Thus, the welding rather than sealing method was chosen, as a solution to the problem of heavy pile weight.

Received 6 March 2015. Accepted 10 March 2015.

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[1]Appears in the Canadian Geotechnical Journal, **52**(5): 664–667 [doi:10.1139/cgj-2015-0029].