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Discussion of Pile Aging in Cohesive Soils by Doherty, P. and Gavin, K. (2013) in ASCE J of Geotechnical and Environmental Engineering, 139(9) 1620-1624.

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Most published case histories of growth of pile capacity with time are limited to a rather short period of observations, usually no more than a few weeks. This makes the authors' ten-year period of observation most welcome. I would like to add the following three case histories.

Case "**Sandpoint**" (Fellenius et al. 2004) consists of a 400-mm diameter, closed-toe, concrete-filled, pipe pile installed into soft clay to a depth of 44 m in Idaho, USA. The pile capacity was determined in a dynamic restrike test (CAPWAP) one hour after the end of driving and in a static loading test 48 days later when piezometer measurements showed that the pore pressures induced by the driving had dissipated. The pile capacity was again determined in a restrike dynamic test 2,728 days (almost 8 years) later (four years after the case was published).

Case "**Paddle River**" (Fellenius 2008) consists of a series tests in Alberta, Canada, on two 324-mm diameter, closed-toe, concrete-filled, pipe piles driven in clay to depths of 16 and 20 m. One restrike dynamic test was performed less than a day after end of driving, static loading tests were performed 15, 30, and 1,495 days (4 years) after driving. Most, but not all, of the induced excess pore pressures had dissipated at the 30-day test.

Case "**Konrad and Roy**" (Konrad and Roy 1987) include capacity determined in static loading tests performed in Quebec, Canada, on a 220-mm diameter, 7.6 m long pipe pile driven in soft clay. The tests were carried out 4, 8, 10, and 33 days after end of driving and, on an identical "companion pile" 4 years after end of driving. All induced pore pressures had dissipated at the time of the 33-day test.

The capacities determined in the mentioned three cases histories are plotted versus time in a logarithmic scale in Figure 1. I have included the results of the authors' tests and the authors' trend line. The Konrad and Roy and the authors' pile tests (250-mm, 6-m length concrete piles) can be considered small-scale tests with regard to diameter and/or pile length. In order to fit the data into the plot, I have scaled up their capacities by a factor of 10.

The figure shows not only an approximately linear logarithmic-scale trends of capacity growth, it also shows all slopes to be somewhat parallel. However, this is a misleading impression. Had I scaled-up the results of the half-scale cases, by, say a factor of 20 or 25 instead, their slopes would have been very different to those of the full-scale pile cases.

The use logarithmic scale is visually deceiving because the small increase of capacity with time beyond about 100 days is exaggerated. This is made clear in Figure 2 showing the same data plotted in a linear time scale for the first 200 days. I have added approximate trend lines as dashed lines. The linear-scale plot shows that the process of capacity increase is the result of two processes: pore pressure dissipation and aging, as also the authors mention. For the case data, the measured time for the pore pressure dissipation ranged from about 24 through 50 days after pile construction, which is also when the trend of growth was curved. The small continued growth over the next 100 days is essentially a straight, almost flat line.

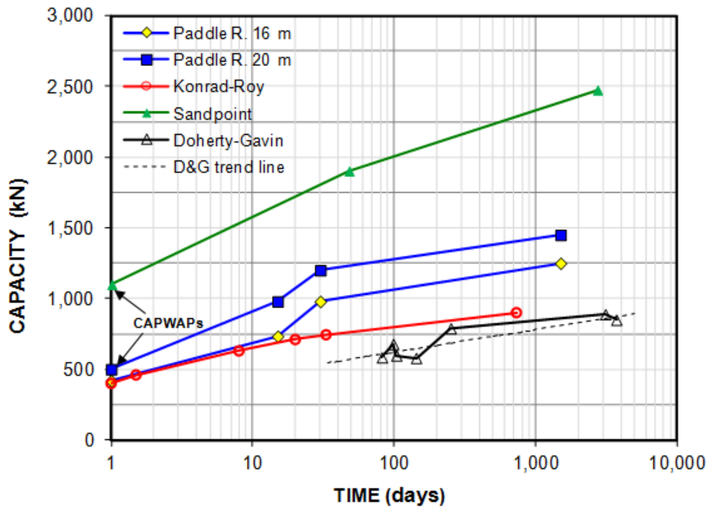

Fig. 1 Capacity versus days after construction in logarithmic scale. The Konrad-Roy and Doherty-Gavin values and trend line have been scaled up by a factor of 10

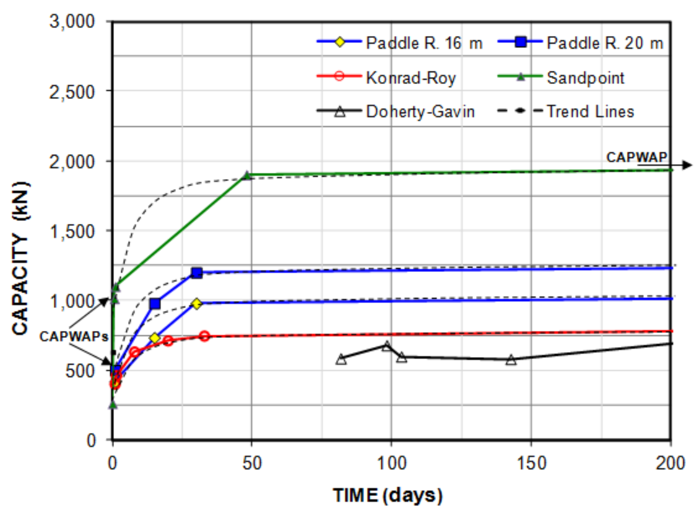

Fig. 2 Capacity versus days after construction in linear scale. The Konrad-Roy and Doherty-Gavin values and trend line have been scaled up by a factor of 10

Normalizing the capacities is of course a better way to compare the case records than scaling-up. I agree with the authors that such normalization should be to a capacity after the induced excess pore pressures have dissipated and that the capacity determined for 100 days after end of construction is a practical choice for the 100-% value. Figure 3 shows this normalization of the records. Two trend lines are necessary: one before 100-day capacity and one beyond, the latter showing the trend of the process after the full dissipation of the induced pore pressures. There is a tempting analogy with the settlement theory for clays consisting of a "primary" process during the dissipation (consolidation) and a "secondary" process thereafter (as in secondary compression). Moreover, the authors' trend line addresses the secondary process, not the primary.

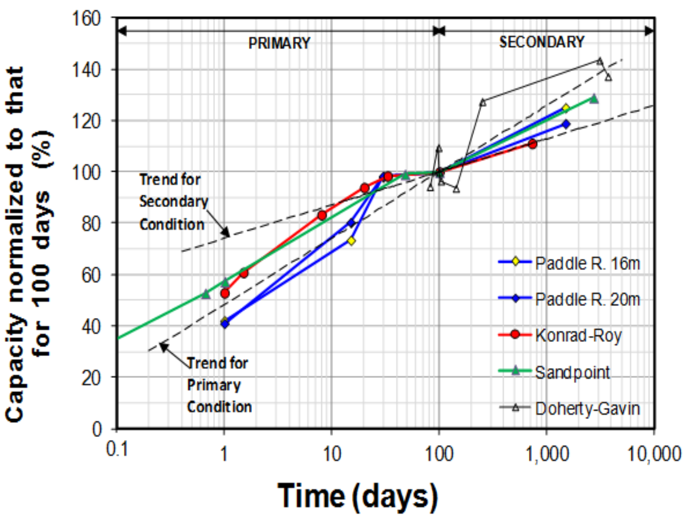

Fig. 3 Capacity normalized to 100 % of the value at 100 days after construction with trend lines for primary and secondary developments

If the growth of capacity during the primary process is established for a specific project, the full capacity at the end of the secondary process could be forecast by extrapolation of the results of early tests. Not for direct use in design, but for indicating whether or not it could be worthwhile to wait and perform a confirming capacity test when the primary process is complete.

However, I do not think the secondary process is of much use for actual design of piled foundations. Significant secondary growth of capacity will simply take too long. Occasionally, if years after a structure is built, say a need arises for adding a storey or two to a building or an extra lane to a bridge, then, it might be interesting to assess what growth the secondary process might have resulted in and try to benefit from it.

Acknowledgements

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