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# Extrapolation of Pile Capacity from Non-Failed Load Tests

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## Abstract

Static pile load test to failure is the ultimate procedure available to examine the capacity and integrity of deep foundations. Being expensive and time consuming, the procedure is often substituted for the application of a load to a certain factor (most often two) times the contemplated design load. In fact, only a proof test is carried out while the ultimate capacity and actual factor of safety remain unknown. This procedure results in uneconomic foundation solution, unknown capacity when modifications are required and inability of the engineer to gain insight of the controlling mechanism for improved design.

The described state of practice calls for the ability to reliably estimate the ultimate pile capacity for non-failed load tests. A practical analytical method is proposed, capable of extrapolating the measured load-settlement relations beyond the maximum tested load. The proposed procedure along with two other possible methods are evaluated. The procedures are examined through a data base of 63 piles load tested to failure. Loading is assumed to be known for only 25%, 33%, 50%, 75% and 100% of the actual ultimate capacity. The "known" data is then extrapolated using the different methods and the obtained ultimate capacity is compared to the actual measurements. For consistency, only one failure criterion (Davidson) is applied. The obtained results are analyzed statistically to evaluate the accuracy and reliability of the proposed methods of analysis.

It is shown that the accuracy of the proposed method is  $0.99 \pm 0.21$  (1S.D.),  $0.96 \pm 0.27$ ,  $0.87 \pm 0.3$  and  $0.78 \pm 0.33$  when assuming 75%, 50%, 33% and 25% of the ultimate capacity to be known, respectively. The obtained results for the 63 data base cases suggest that even when the predicted ultimate capacity is four times the maximum actual tested load, the associated risk is zero for exceeding the design load, when using the extrapolated value with a factor of safety of 2.0.

Case history analyses of six load-tested piles at two sites are presented. The analyzed cases indicate possible substantial savings when the ultimate capacity well exceeds the maximum applied load. Moreover, the method already demonstrates its enormous importance from both aspects, engineering and financial.