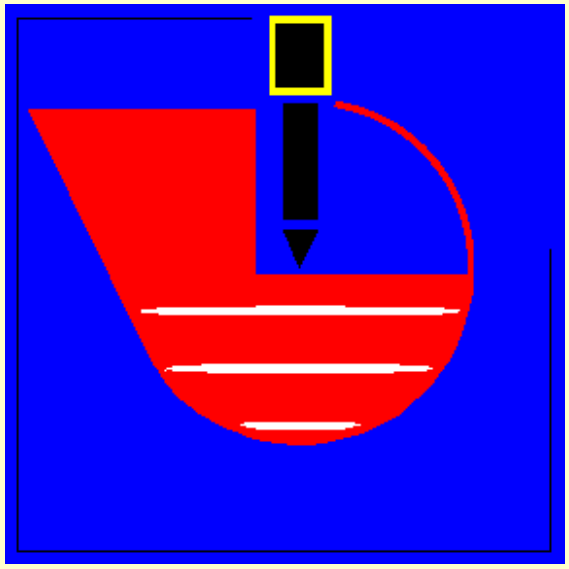
2°C.F.P.B.

CONGRESO INTERNACIONAL
DE FUNDACIONES PROFUNDAS DE BOLIVIA
del 12 al 15 de mayo de 2015
SANTA CRUZ - BOLIVIA



# Static Loading Test and Prediction Outcome

*Bengt H. Fellenius*

Fellenius, B.H., 2015. Field Test and Predictions. Segundo Congreso Internacional de Fundaciones Profundas de Bolivia, Santa Cruz May 12-15, Lecture, 22 p.

May 9 2015

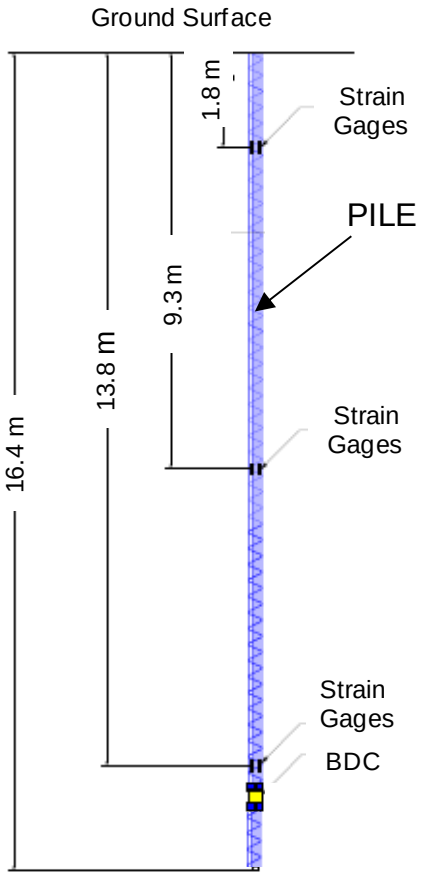

# A Prediction Challenge to All Delegates to the 2nd CFPB, Santa Cruz, Bolivia.

## Mario H. Terceros and Bengt H. Fellenius

We have constructed an instrumented pile and performed a static loading test that we intend to add a bit of spice to the conference. To this end, we challenge everyone to submit a prediction of the test results. Then, on Friday, we will start the day with a "*Brief report on results of the static loading test and outcome of the low-key prediction*". The "Prediction" referred to is yours.

**The Pile**

The pile, TP1, is a 600 mm diameter, 16.4 m long, bored pile constructed on April 20 by pushing a 600-mm diameter, OD, temporary casing into the ground while augering out the core as the pipe is pushed down taking care not to auger beyond the toe of the pipe. Once the pipe reached the intended depth and had been augered out, concrete (cylinder strength 21 MPa) was poured into the pipe while it was extracted always maintaining an inside head of concrete. A 14.0 m long reinforcing cage consisting of six 20-mm reinforcement bars placed in a circle with an 450-mm outside diameter was then inserted into the pipe. The cage had been instrumented with three levels of a single strain-gage pair at depth 1.80, 9.30, and 13.80 m below the top of the cage (i.e., at the ground surface). A 310 mm high hydraulic jack was attached to the bottom of the cage to serve as a bidirectional cell (BDC) in the first phase of the static loading test. Thus, in the test, the pile would be separated in an upper 14.8 m length and a lower 1.6 m long length. Telltale guide pipes were attached to the cage so as to measure the opening of the BDC and movement of the lower end of the BDC.

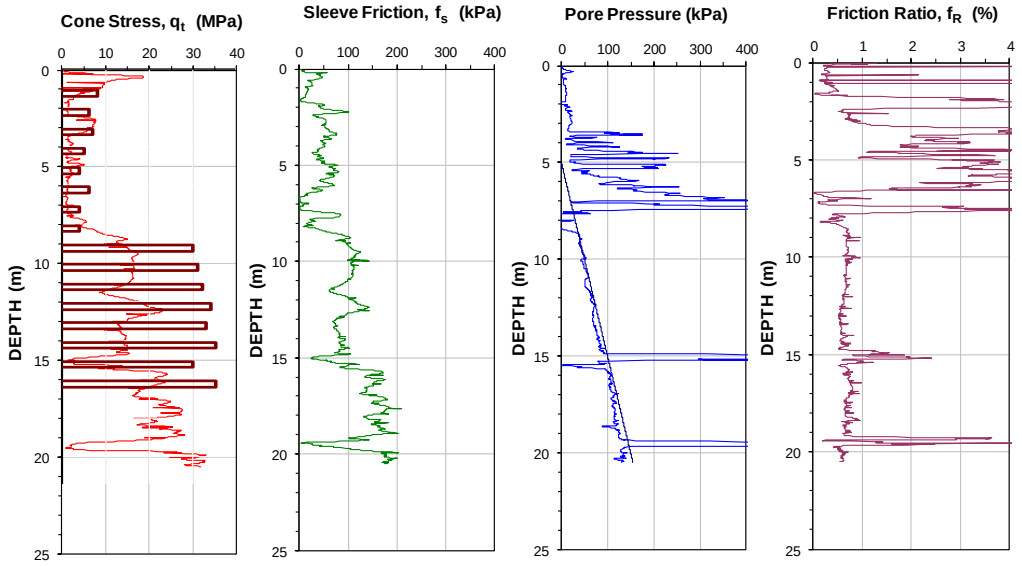



The static loading test was performed in two phases. Phase 1 was performed on May 7, 2015, and consisted of a bi-directional test. In the bidirectional test, the BDC pushes the length above the BDC (the "upper length") upward and the length below (the "lower length") downward. The load increments were 50-kN, each with a 10-minute load-holding time. At the maximum load of 700 kN, the lower length (1.6 m) plunged. No movement occurred at the pile head and the net BDC opening was 60+ mm.

Phase 2 test was performed on May 8, 2015. It consisted of leaving the BDC open (free-draining) and performing a head-down test by means of a conventional reaction pile arrangement. The load increments were 100-kN, each with a 10-minute load-holding time. The prediction event deals with Phase 2 test, only.

F.y.i., TP2, a companion pile of equal length and size, was constructed on the same day 5 m away from TP1. It was tested as a full-length pile after the tests on TP1. Pile TP2 is not a part of the prediction event.

**The Soil--CPTU and SPT diagrams**




The bar in the figure represents the N-indices and the bl/0.3m scale is numerically the same as the $q_t$ cone stress, MPa. The SPT was performed with a constant height-of-fall. The soil profile consists of 9 m thick layer of silty fine sand, followed by 6 m of fine sand on sand. A 0.2 m thick clay layer was encountered at 15.0 m depth. The groundwater table is located at 5.0 m depth. The saturated solid densities of the three soil layers are 2,100, 2,000, 2,100 kg/m$^3$, respectively.

**The Prediction Submission**

The primary submission is a prediction of the load-movement of the pile shaft (Phase 2) and the capacity of the shaft, as determined from that same load-movement curve. Submit the values in table showing two columns, one for load (kN) and one for movement (mm). Use at least 8 load-movement points on the curve to the maximum load. Give the evaluated capacity as a separate value. You can use either a Word document or an Excel file. Please submit your prediction to Bengt by e-mail to address: Bengt@Fellenius.net. The submission deadline is noon May 14.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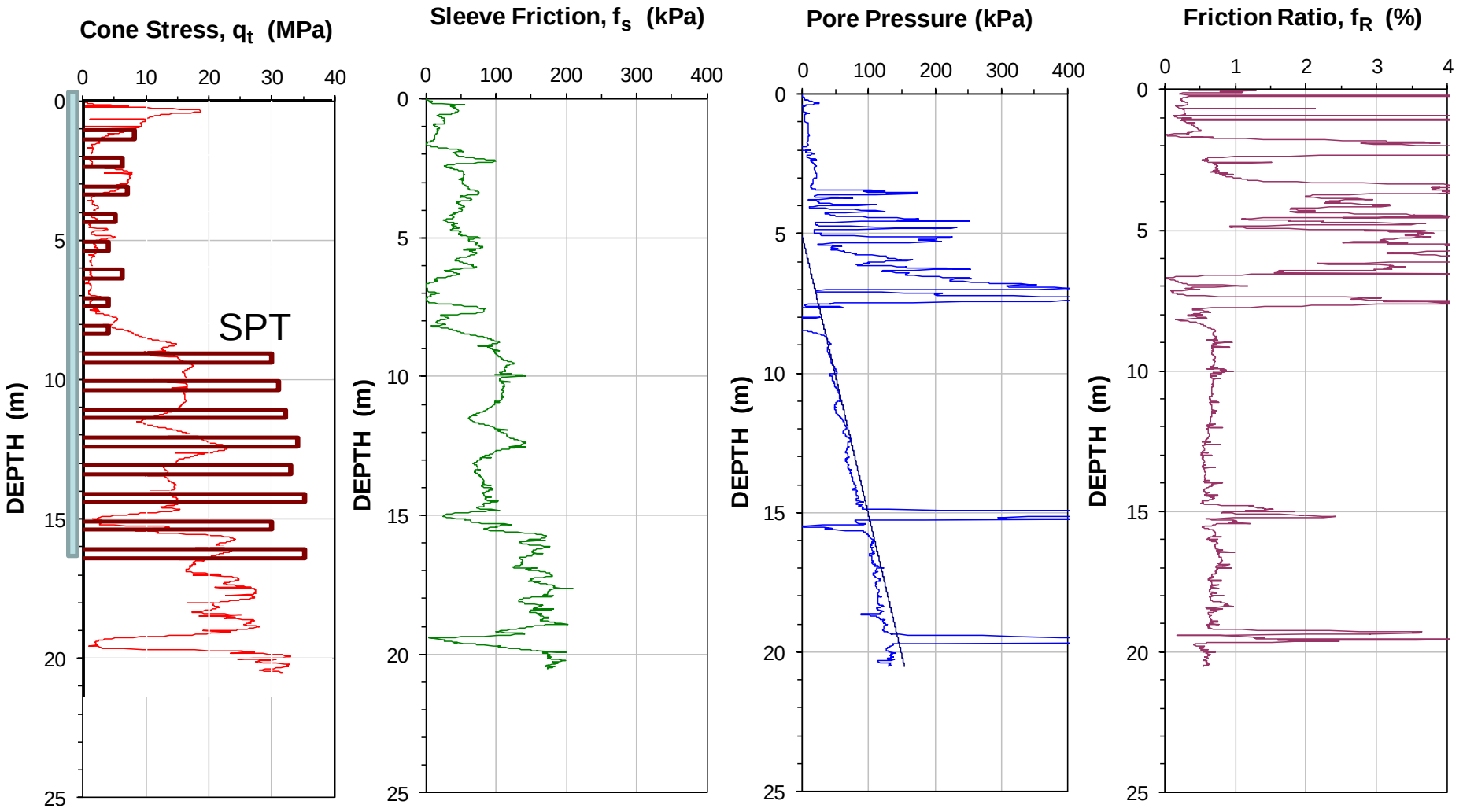
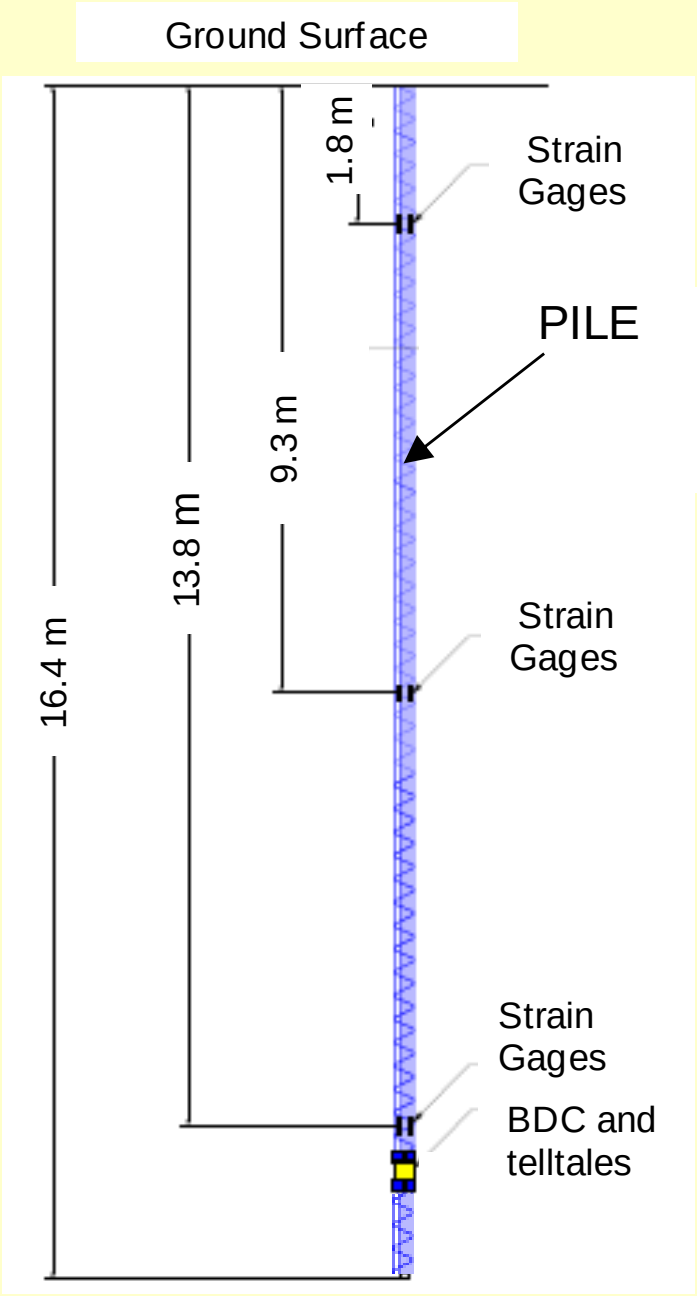
# Soil Profile







"BDC" = Bidirectional Cell; a sacrificial hydraulic jack

# Test Programme

Phase 1 Activate the BDC to perform a bidirectional test, pushing the upper length upward and the lower length downward. This will create an opening between the two pile lengths.

Phase 2 Activate the jack on the pile head to perform a head-down test on the upper pile length with the BDC free-draining The pile will then function in shaft-bearing only with no toe resistance until the BDC opening is closed).

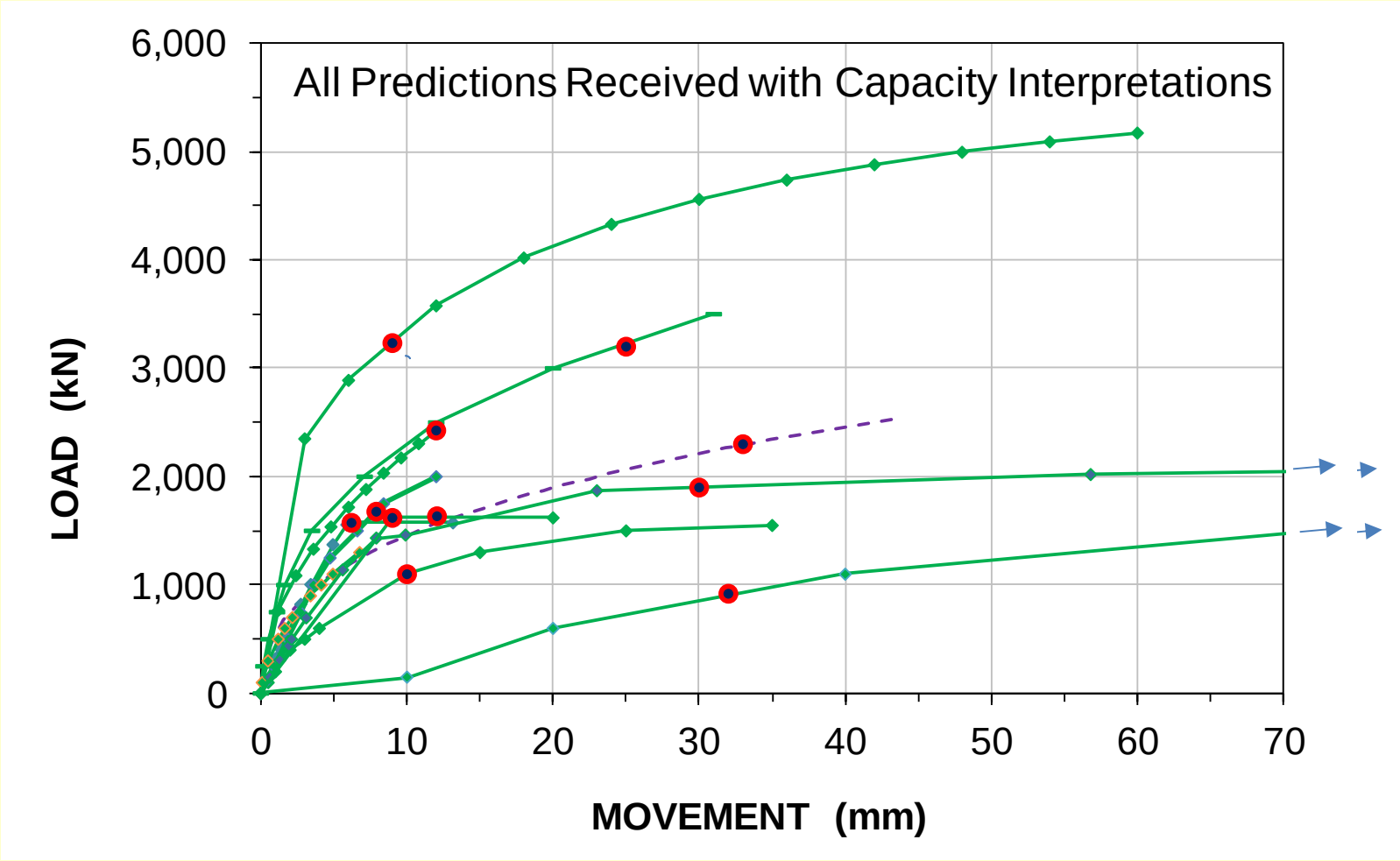
Phase 3 If the full resistance of the lower length was not engaged in Phase 1, then , the jack at the pile head will be closed and the BDC be re-engaged (The jack at the pile head will now provide the additional resistance needed).

# Test Results

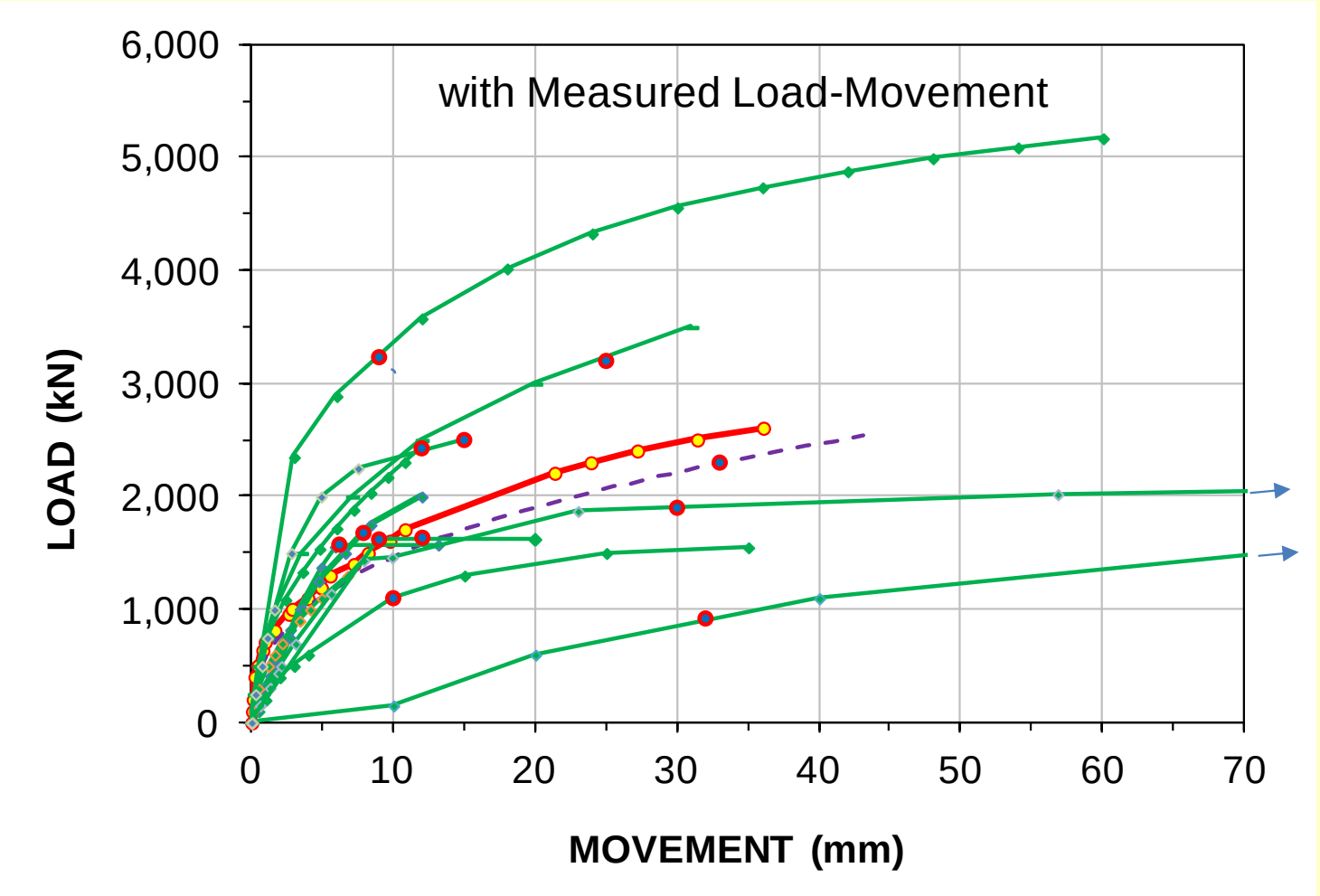
**Phase 1**

The bidirectional (BDC) test pushed the lower length downward a distance of abut 60 mm at the 700-kN maximum load---plunging type response. The measurement is approximate, only, due to friction of the telltales in the guide pipes. The pile head showed no movement. Upward movement at the BDC level was small representing the pile shortening for the load.

# Predictions

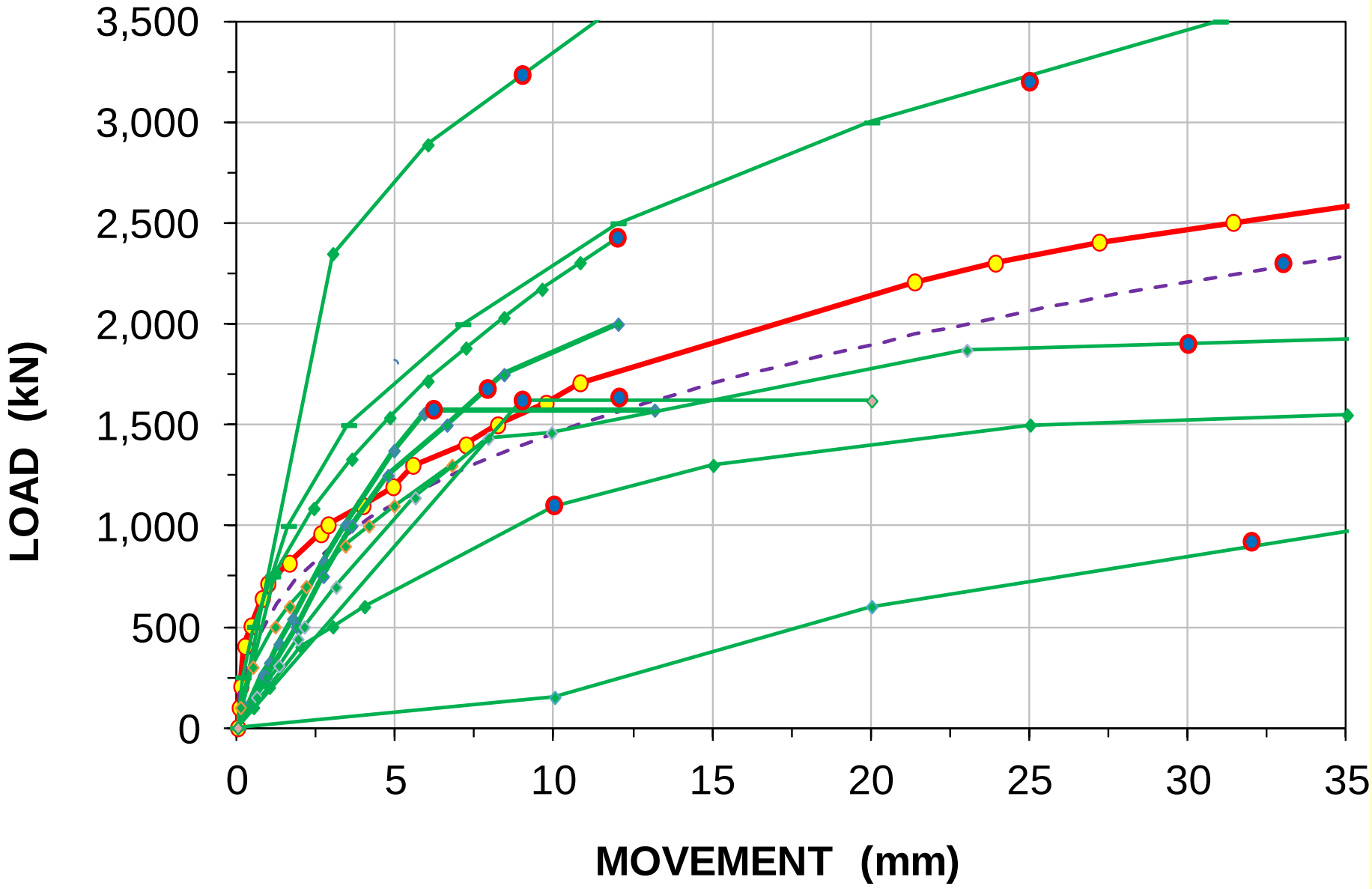



The circles are the capacities as interpreted from each curve by the particular predictor

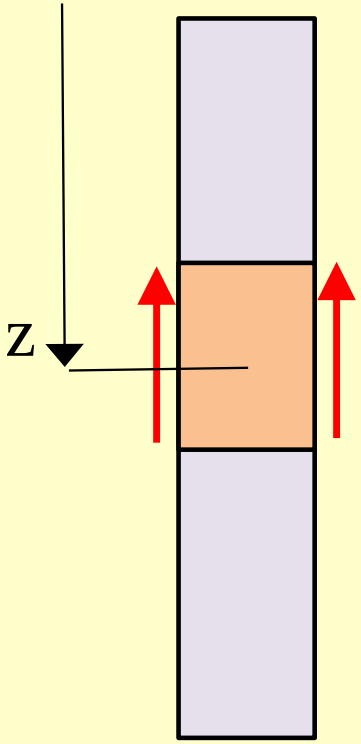



Dashed curve is my prediction prepared with full benefit of the results of the 2013 tests on similar piles in very similar soil—hardly Class A .

# Enlarged View of Predictions and Head-down Test on TP1 Upper Length



# Fitting analysis to the results

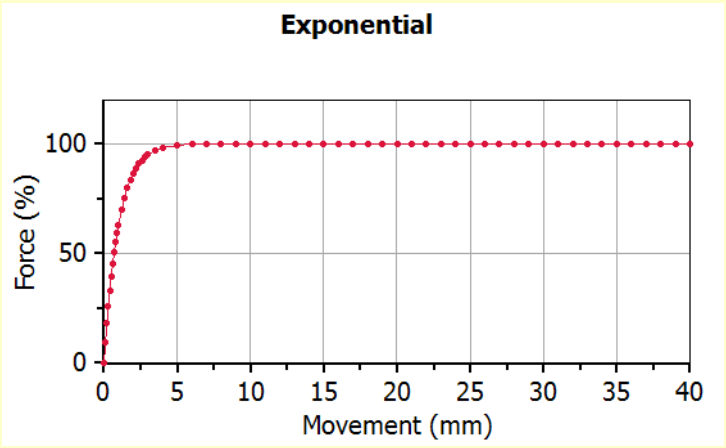


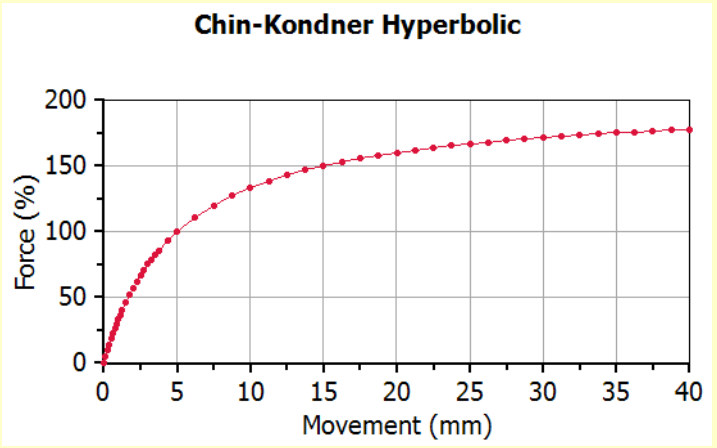

$r_s = \beta\sigma'_z$

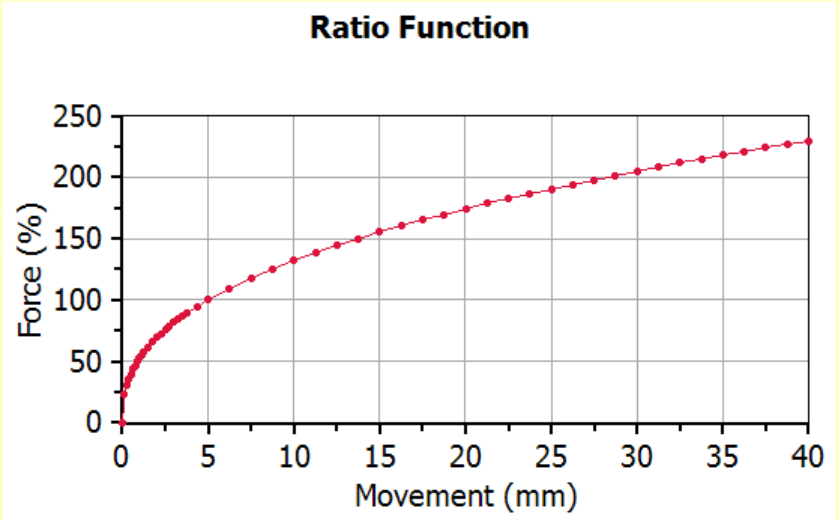
The pile is assumed made up of a series of short elements, each affected by soil resistance

$r_s = f(\text{movement})$

Movement = function of E-modulus

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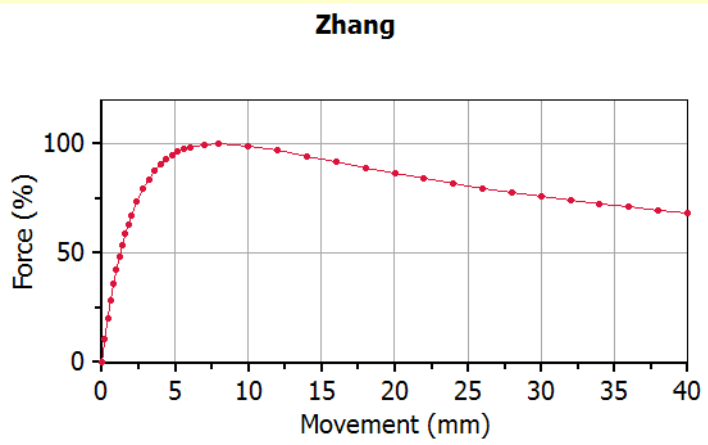
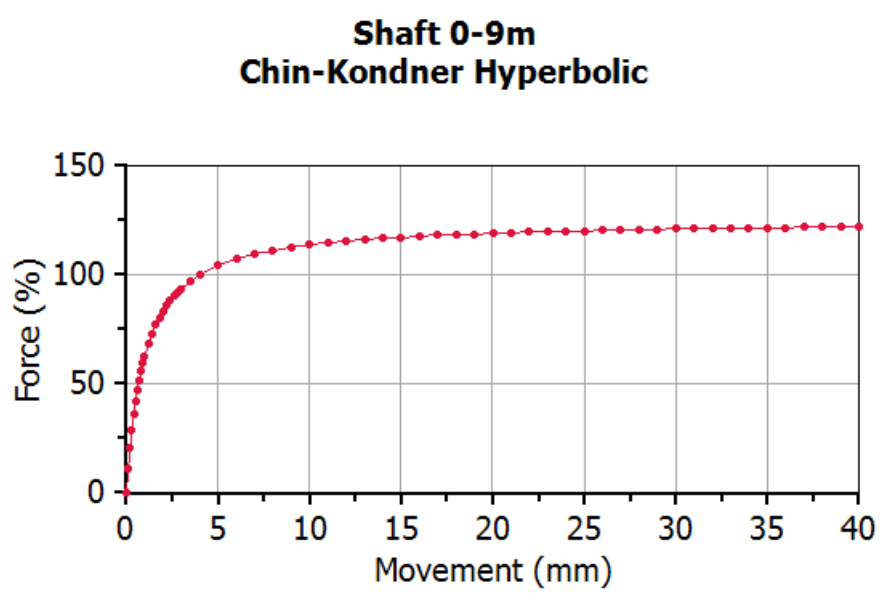
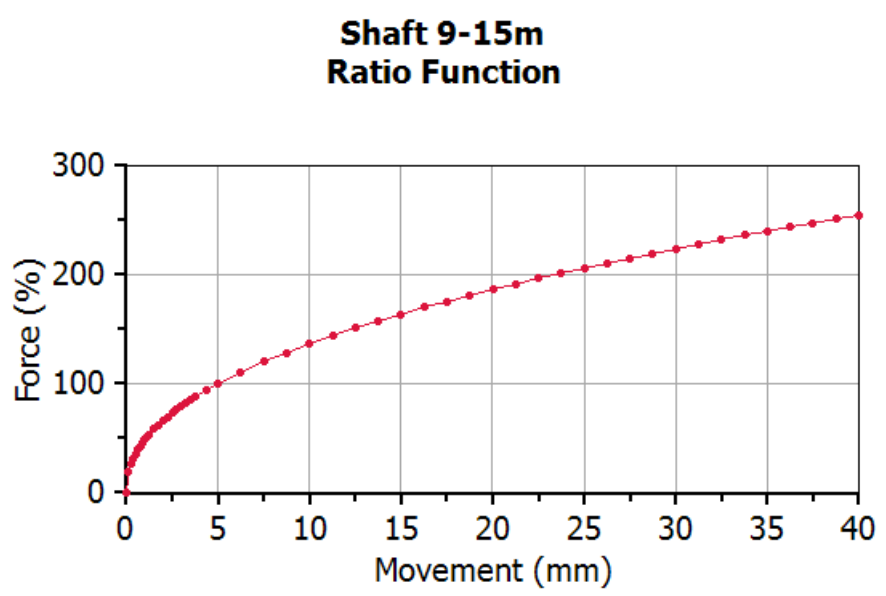
**WHICH TO USE AND HOW TO MODIFY**

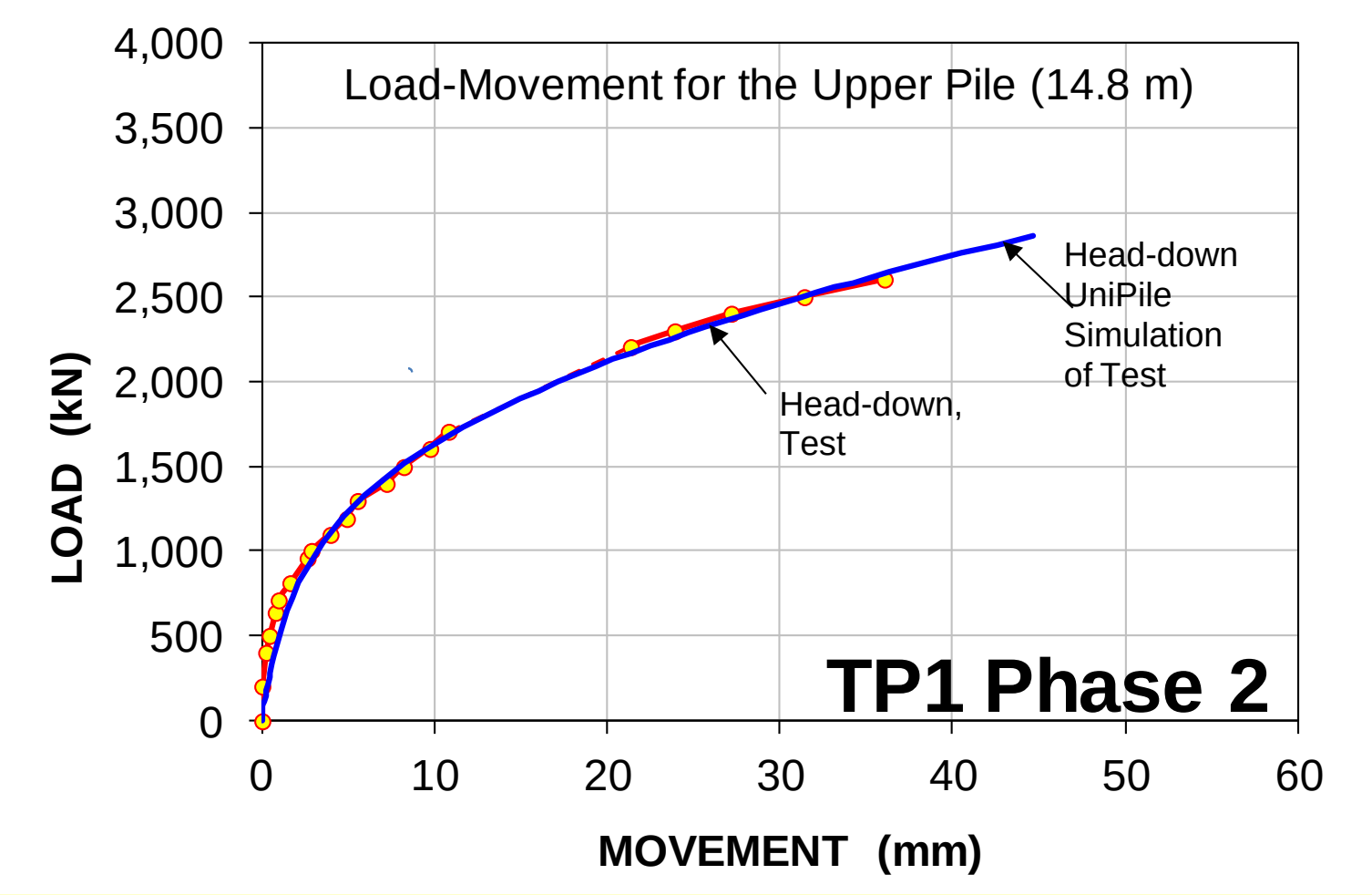


# The t-z functions actually used for the best fit



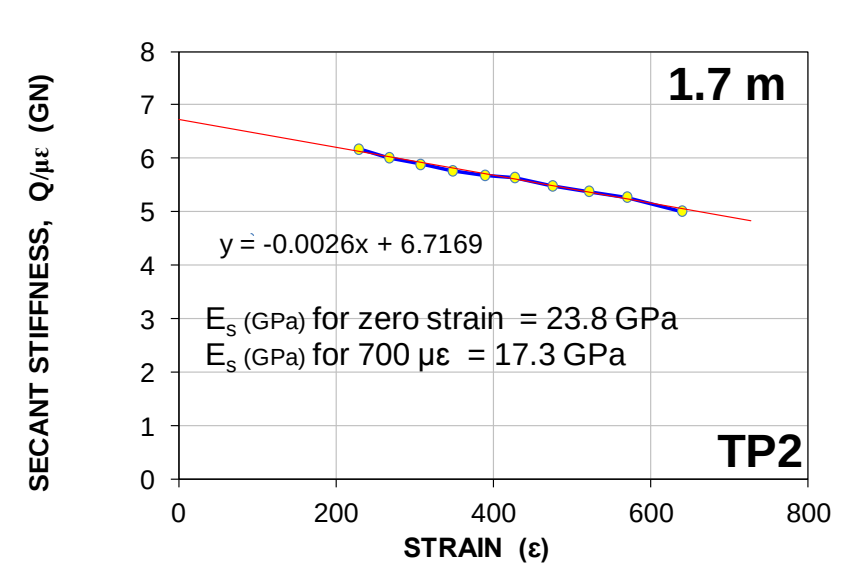



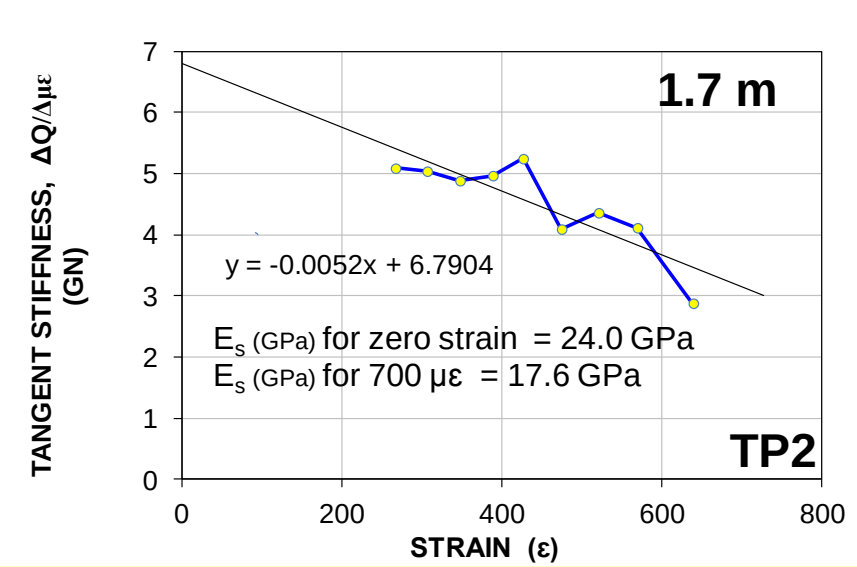
# The final fit



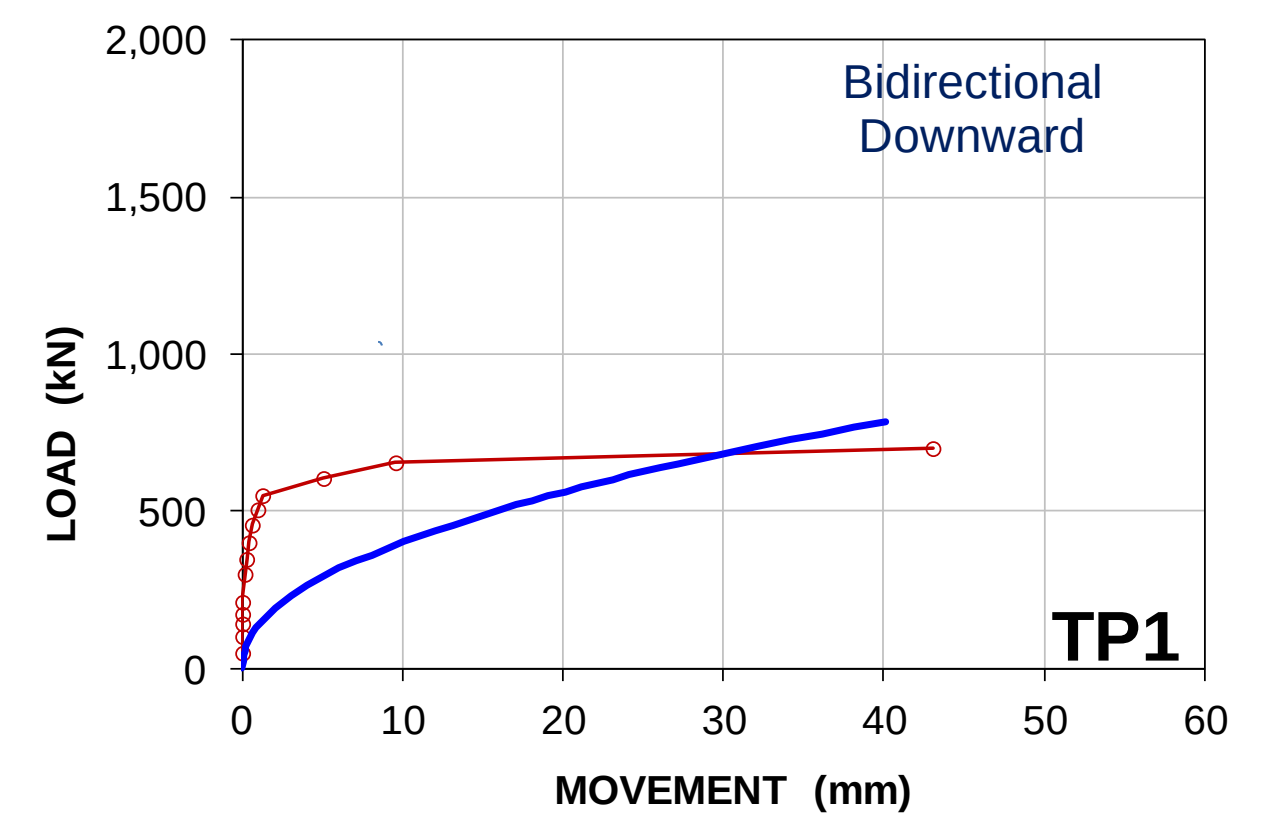
# The Pile Stiffness (EA) Evaluated from the Uppermost Strain-Gage

Unfortunately, the other strain-gages either did not survive the construction or survived, but were dislocated---No usable strain-gage data were obtained



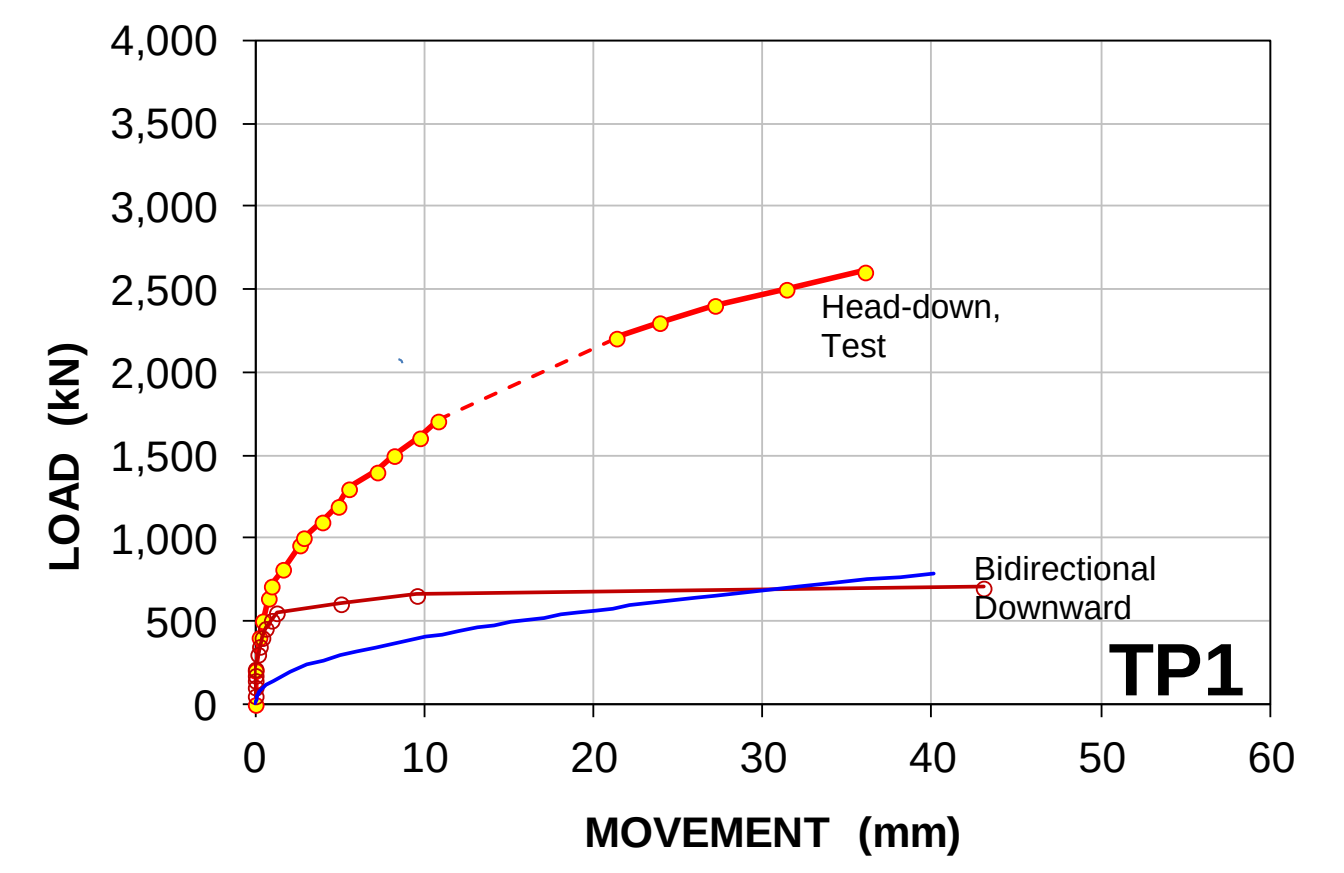



# Now the results of Phase 1, the bidirectional test



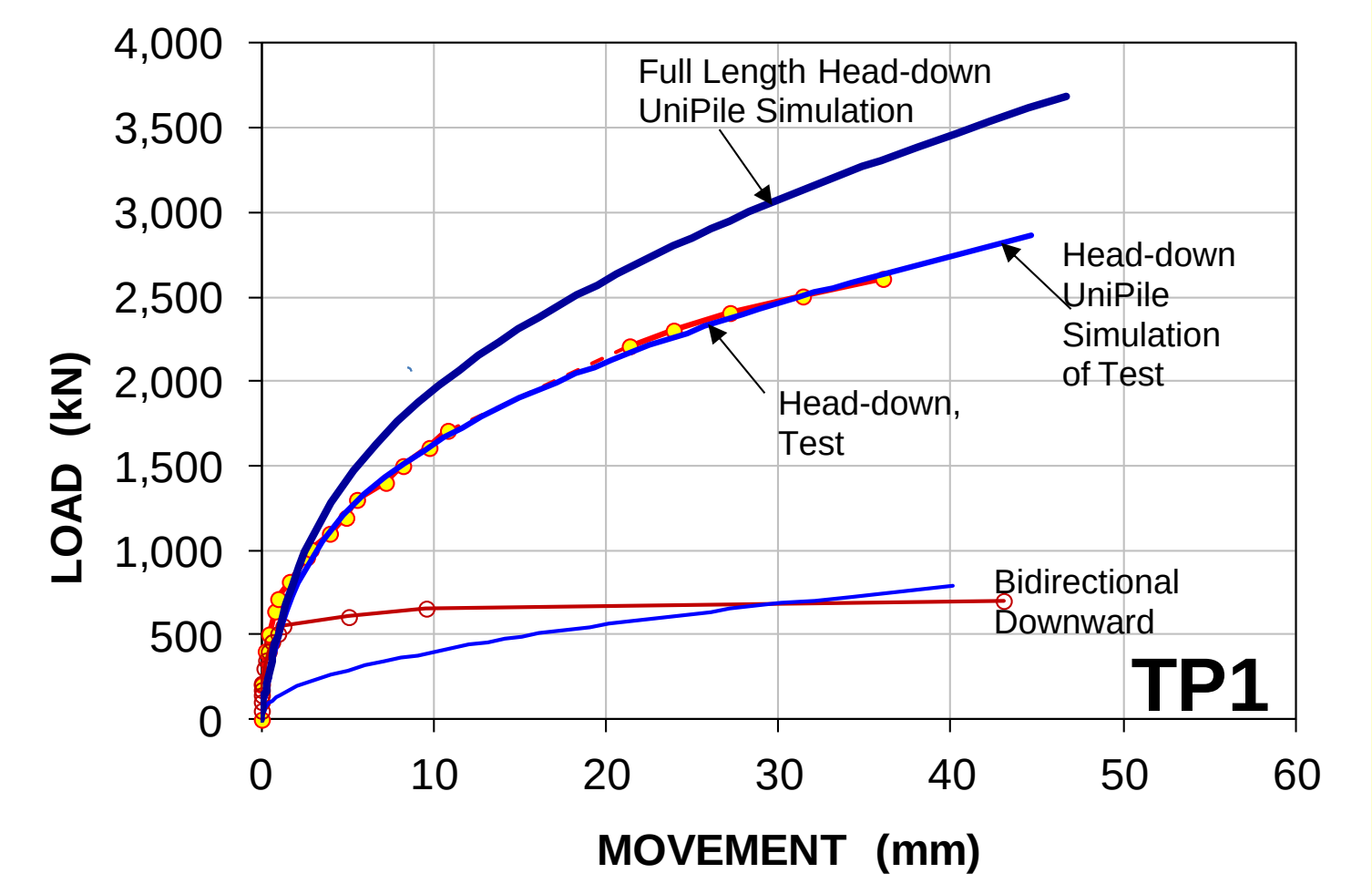

**The downward movements are unfortunately impaired due to friction along the telltales**

# Phases 1 and 2 together

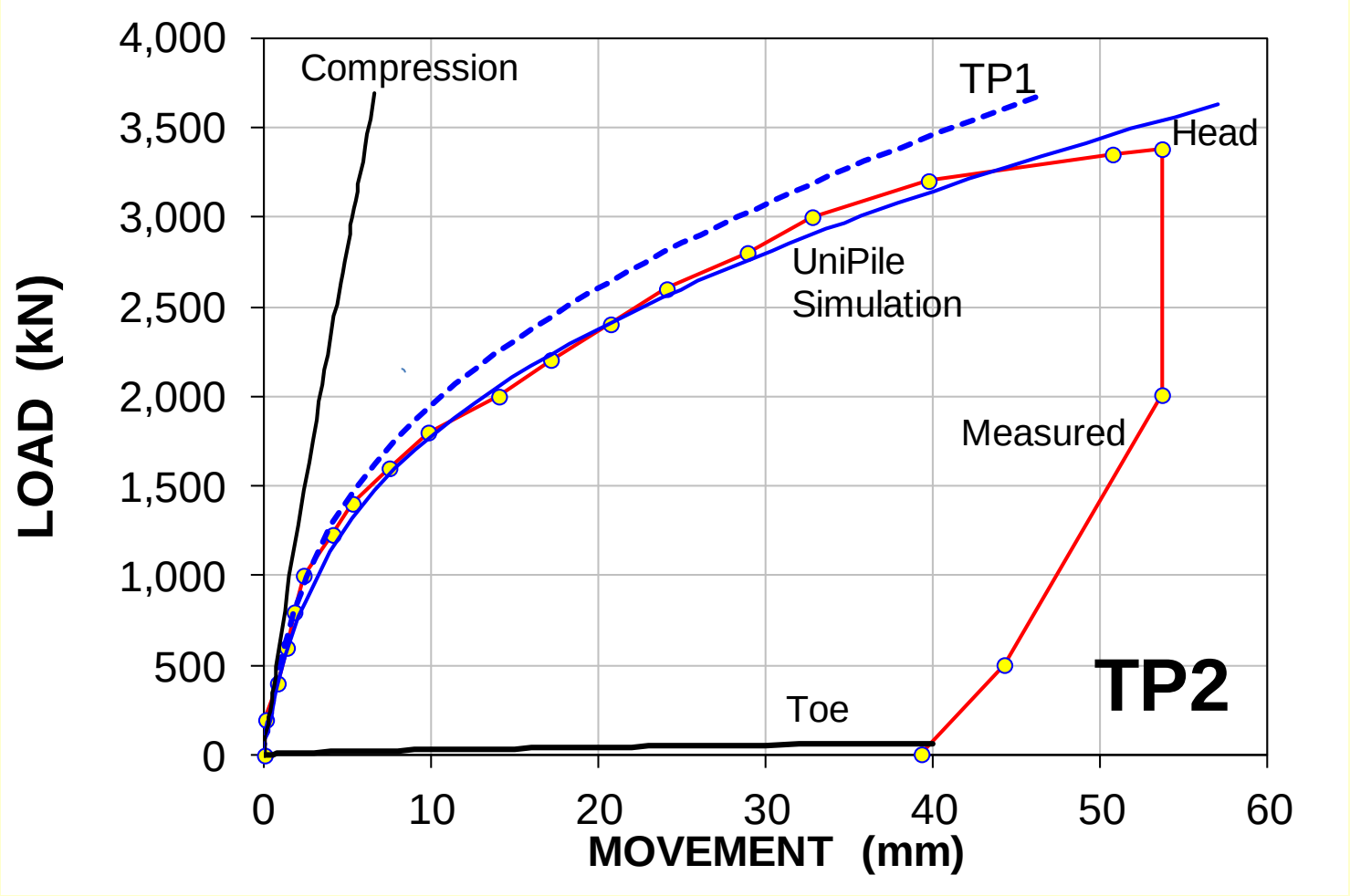


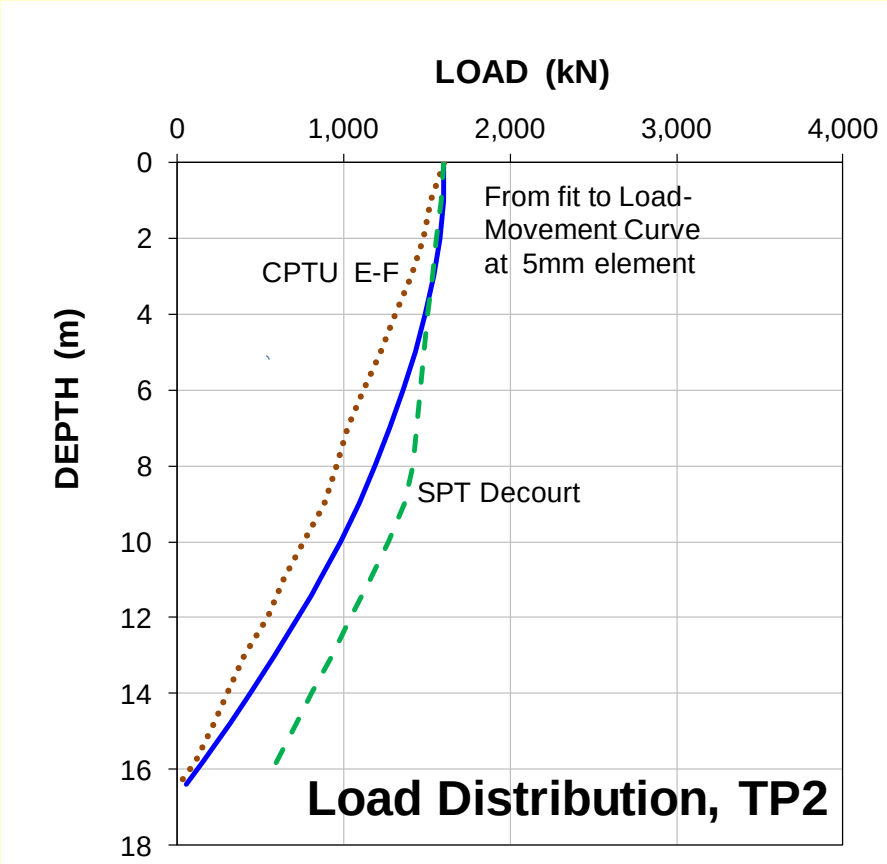

**The blue curve is the probable load-movement curve for the lower length; "Downward"**

# Combining the results to the load-movement curve for a head-down test on the full length of pile

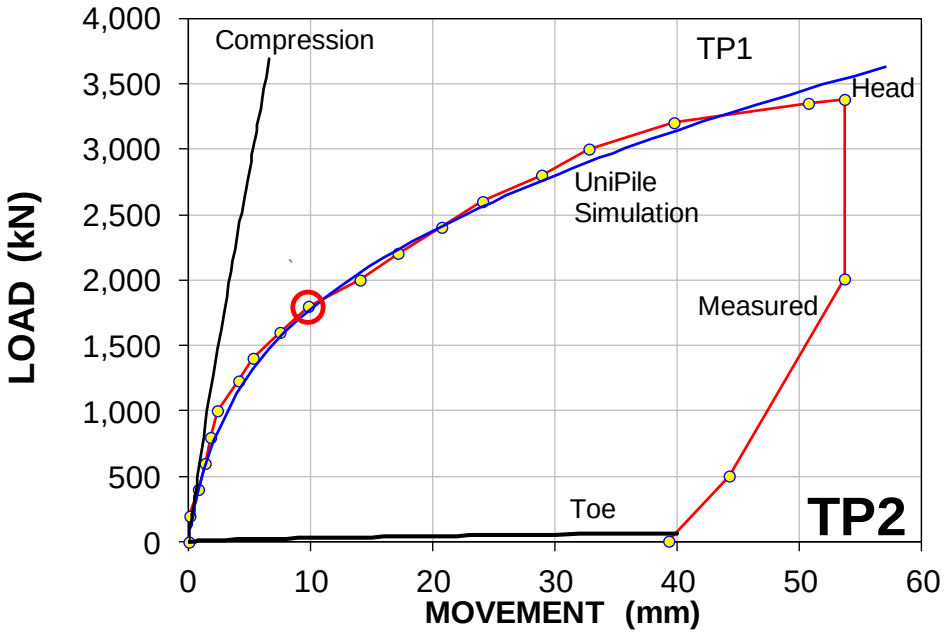


# The load-movement curves for the head-down test on Pile 2 with a fit (UniPile) to the data and a comparison to same for Pile 1.






**Load distributions at the ≈5-mm element movements for Phase 2 (TP1) combined with the distribution from CPTU and SPT analysis of shaft resistance**




Thank You