# CAPWAP®

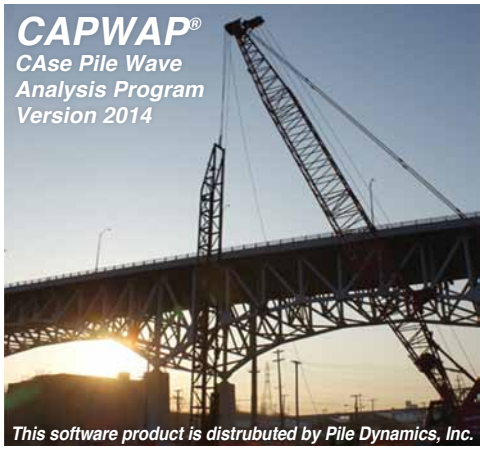
## For reliable Dynamic Load Tests on any type of deep foundation

Pile Dynamics, Inc.

**CAPWAP is a Signal Matching Program that uses force and velocity data measured by the Pile Driving Analyzer® (PDA) system to**

- **Calculate**
  Static soil resistance, magnitude and distribution along the shaft element
  Static end bearing
  Stresses at any point along the pile.
- **Simulate** a static load test in compression and tension (uplift).
- **Predict** the instantaneous load displacement behavior of the tested pile.

CAPWAP analyzes not only data obtained during PDA testing of driven piles, but also of drilled shafts (bored piles) and augered cast-in-place or continuous flight auger piles. Use of the word "pile" is this document is to be understood as any of these types of deep foundation elements.

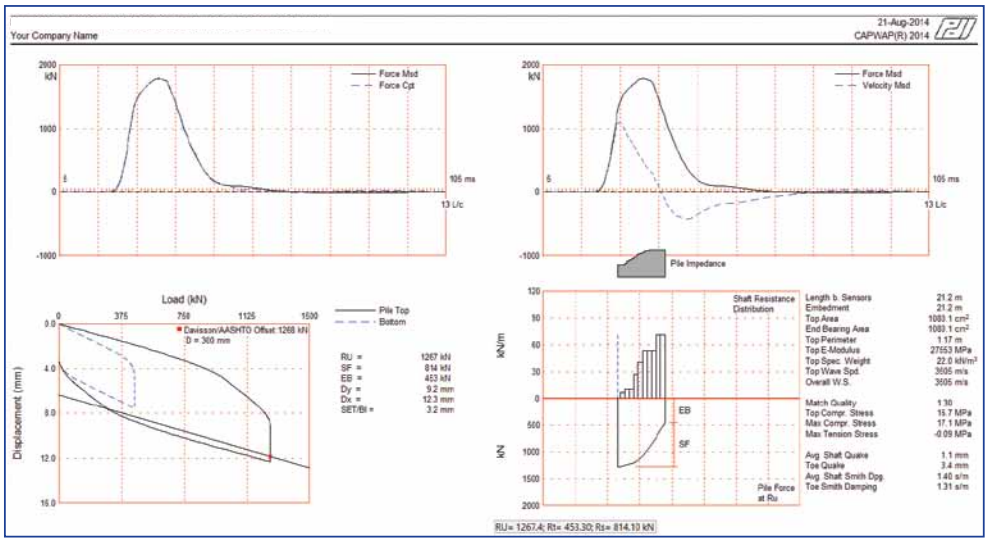



## Output

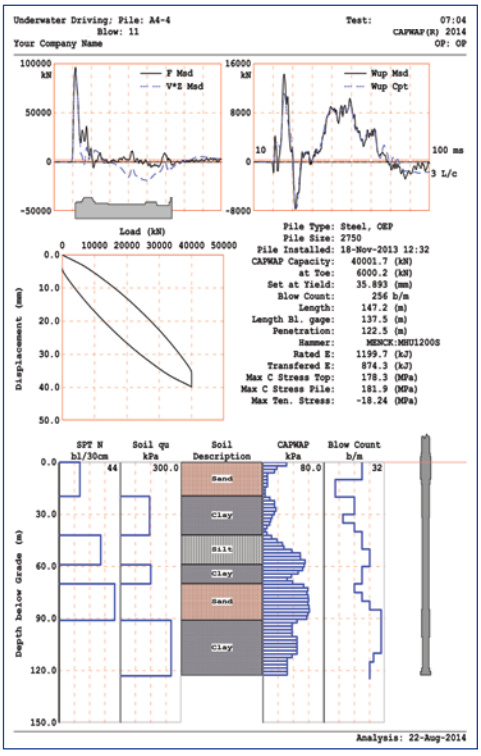
- Simulated static test
- Resistance distribution
- Forces and stresses along the shaft
- Shaft and toe damping and quake
- Measured and computed forces and velocities
- Maxima of displacement, velocity and transferred energy along the shaft
- CASE Method results
- Comprehensive report page *(below right)*

CAPWAP has special tools to analyze Cast-in-Situ and Other Concrete Piles:

- Variation of time increment and/or wave speed
- Calculation and display of modified pile models, their volume, mechanical properties and wave speed
- Automatic pile impedance adjustment.




*CAPWAP output (counter clockwise from top right: measured signals; signal match; resistance distribution; simulated static test.)*




*Comprehensive CAPWAP report; summary and extrema tables are also provided.*

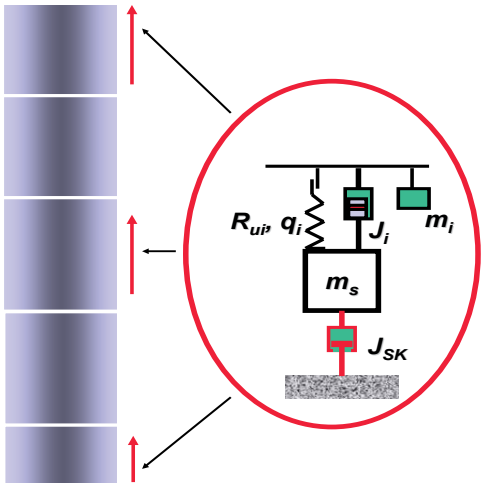
## Quality Assurance for Deep Foundations

## The CAPWAP® Pile & Soil Model

CAPWAP models the pile as a series of continuous uniform sections (characteristics model) and the soil based on a greatly expanded Smith approach.

In its default mode, CAPWAP models the deep foundation as a series of 1 m long uniform segments with elastic properties. Pile damping, splices, non-uniformities and multiple pile or shaft materials may also be modeled.

The soil resistance is typically lumped into individual resistance forces at 1 or 2 m intervals with elastoplastic static, linearly viscous and mass related dynamic properties. Radiation damping is represented by an additional mass and dashpot. The user has the option of using individual toe resistance parameters such as a plug mass, a resistance gap and a true Smith damping approach. It is also possible to model up to 2 additional toes, useful for certain non-uniform piles or to approximate a hyperbolic toe resistance behavior. Other options include Residual Stress Analysis for end of drive situations and Multiple Blow Analysis to analyze restrike tests.




*CAPWAP Soil Resistance and Pile Model*

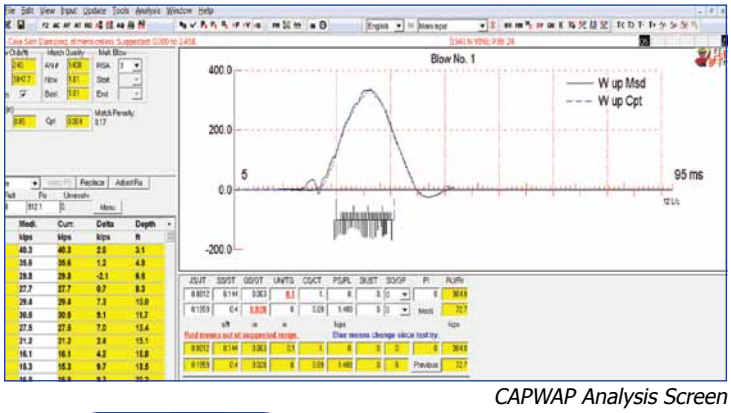
## Typical CAPWAP Analysis

Forces and velocities occurring at the top of a pile during ram impact are complementary quantities, related to each other by pile characteristics and soil parameters. The basic CAPWAP procedure uses this fact and consists of the following steps:

1. Retrieve force and velocity data measured by the Pile Driving Analyzer.
2. Setup pile model with known physical quantities such as areas, materials and length, and assume a set of soil parameters including resistance, quake and damping.
3. Perform analysis using one of the measured quantities as an input and calculate the complementary quantity.
4. Compare measured with computed quantity.
5. If match is not satisfactory, adjust soil parameters and go back to step 3.
6. Output soil model, satisfactory match and simulated static test.

**Each analysis in step 3 may take as little as 1/100 of a second.**

CAPWAP finds the set of soil parameters that best matches the dynamic measurements of pile top force and velocity, either automaticity or interactively.




*CAPWAP Analysis Screen*

## Help Features

CAPWAP helps the user during input and as the user adjusts the large number of variables that affect the signal matching process:

- Convenient input data quality checks
- Automatic signal matching option
- Accurate calculation of the area of each pile model segment, including for tapered piles
- For cast-in-situ piles, automatic calculation of area of each pile model segment based on field measured volumes
- Built in iCAP® routine
- Automatic search for best individual or groups of variables
- Automatic resistance distribution
- Automatic toe parameters check
- Automatic and quick static resistance-damping exchange
- Automatic shaft and toe resistance exchange
- Automatic end bearing to skin friction ratio determination
- Extensive expert help system
- Match quality indicators that encourage progress towards a best match
- Prevention of output of extremely poor matches
- Warning indicators

The background manual completely covers theory, models and recommended procedures. A training class prepares the software novice. Continuing technical support from Pile Dynamics is available to all registered users.

Calculations can be performed in English, SI or Metric units. CAPWAP licenses are available with hardware or software locks.

**Requirements:**

- Windows 7 or higher operating system; 32-bit or 64-bit version.
- Program to be operated by a person with an engineering degree from an institution of higher learning with additional preparation by Pile Dynamics or its representatives.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