Statnamic tests gain ground

Acceptance of Statnamic pile testing in Europe was initially slow, but is gaining momentum. European Foundations charts the development of the alternative to traditional pile load testing.

While Statnamic testing is widely used in Asia, the US and Canada, Europe has been reluctant to accept it as an alternative to conventional static and dynamic testing.

This is mainly because European building codes are often based on strong preferences for certain tests. For example, in the Netherlands there is little direct testing of piles, with performance based on CPT testing. In the UK, Belgium and Germany static load tests are preferred.

Moreover, dynamic load testing is well-established as a reliable method for driven piles. Regulations did not, and in many cases still do not, mention Statnamic as an acceptable method for pile load testing and there is still the perception that it is expensive.

European interest is growing, however. In 1999, one of the founders of the technique, TNO Building and Construction Research of The Netherlands, set up TNO Profound (Professional Foundation Diagnostics) with the aim of increasing its use in Europe. Research projects have been carried out in the Netherlands, Belgium and Hungary to compare the results of Statnamic tests with traditional pile test methods, and more are planned in Germany, Spain, Poland and Turkey.

Statnamic testing was developed by TNO and Canadian firm Berminghammer Foundation Equipment in the early 1990s, in response to industry demand for cost-effective and accurate means of load-testing pile foundations.

Static load testing was considered expensive and time-consuming, while dynamic load-testing had proved to be unreliable for predicting static load behaviour of bored and other types of cast insitu piles.

The Statnamic test uses a reaction mass that is launched by generating high pressures in a pneumatic cylinder by the burning of a special fuel. This causes the pile to be gently pushed into the soil, with the load imposed measured by a load cell and pile head displacement registered by means of a specially developed laser sensor. Both the load cell and laser sensor are integrated components of the Statnamic device so no instrumentation has to be installed on the pile shaft. The required reaction mass is only 5% of the force generated.

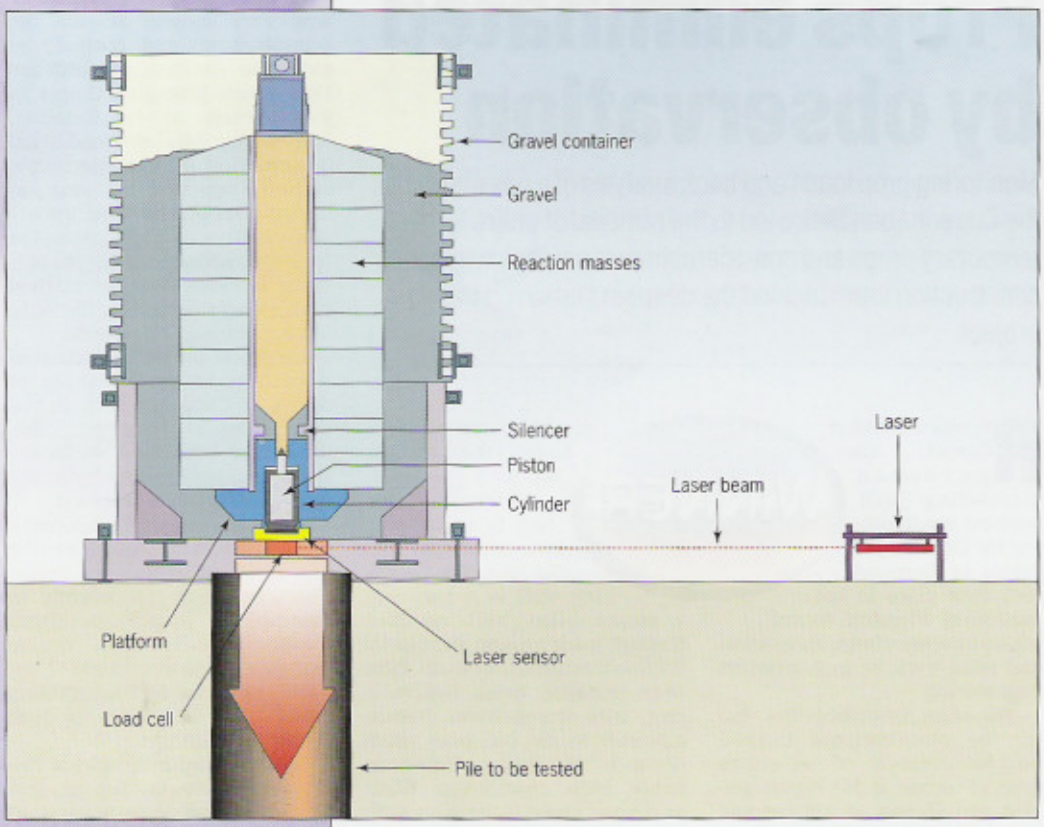
During Statnamic load testing, pile behaviour is modelled as a mass on which inertia forces and soil resistance are acting. This allows simple calculation of the static load behaviour. The point of unloading (maximum displacement) in the Statnamic load displacement diagram allows the direct calculation of the maximum static soil resistance during testing.

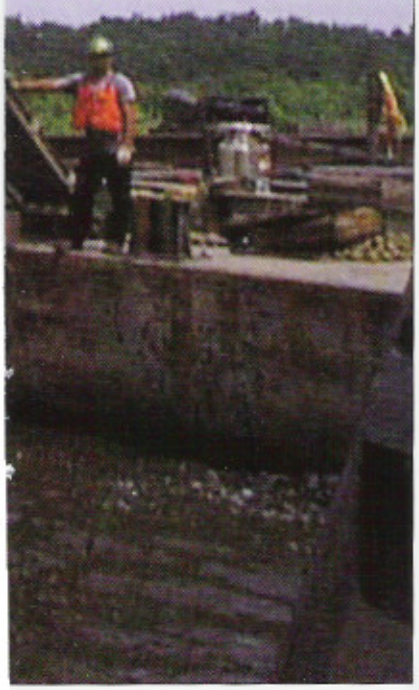
Statnamic load testing can be performed on piles installed in soils with a strong dynamic response. It produces reliable results in stiff and granular soils, although loading rate effects have to be taken into account. The influence of soil viscosity alongside build-up of pore water pressure in fine-grained soils requires further development of analysis tools and more experience.

Soil viscosity shows up in two different ways: as creep and as velocity dependent soil behaviour. Creep cannot be determined by Statnamic or dynamic tests and in many cases not even with static tests.

Velocity dependent soil behaviour can be split into soil damping phenomena and strain rate dependency. Soil damping phenomena can be derived simply from a Statnamic test.

Strain rate dependency for fine-grained soils is still subject to study, for example by the University of Sheffield in the UK (AFL Hyde et al, 1998). Well-documented data from pile load test projects is becoming available to support insight into strain





LEFT: A recent development of the technique uses water as the reaction mass when testing on or near water. RIGHT AND ABOVE: The test uses a reaction mass launched by generating high pressures in a pneumatic cylinder by burning a special fuel.

rate effects (Holeyman et al, 2000).

As well as individual piles, the method can be used to test pile groups and structural elements such as bridge piers and spread footings. Because the principle of Statnamic is based on the acceleration of masses, piles can be tested in any direction as well as horizontally and under batter.

The method first gained widespread acceptance in Asia, where alternative ways of pile testing were introduced to cope with high demand for pile testing in strong developing economies. There was much to gain, especially on larger construction projects, where pile testing appeared to be cumbersome and expensive. The authorities were convinced of the value of Statnamic testing after comparisons with static tests showed results were the same or similar in many cases.

Following its success in Asia, the technique quickly gained acceptance in the US, with more than 300 tests carried out to date. Again, acceptance was gained through comparisons of static and Statnamic testing to confirm the reliability and accuracy of the method. Codes in these countries have now started to include Statnamic testing, including the Japanese code for pile load testing and the American Society for Testing and Material code.

More than 1000 Statnamic load tests have been performed in Canada, the US, Japan, Malaysia, the UK, the Netherlands and many other countries. Modern equipment can perform load tests from 0.1MN to 30MN and higher capacity Statnamic devices capable of testing to 60MN and above are being developed.

To educate European engineers on the theory and practicalities of Statnamic testing, TNO Profound holds regular technical seminars and practical demonstrations. It is forging links with universities and research institutes in a number of countries, to facilitate the introduction of Statnamic testing into national regulations.

A recent significant development is in the use of water as a reaction mass when testing piles over or near water. By mobilising the inertia of the water body, very large tests can be performed using equipment weighing only 1% of the test load. The 5% or 10% reaction mass is provided by water stored in a vessel below the water surface. This weightless reaction mass means it is possible to carry out very large tests of longer duration than are practical today.

Statnamic testing using a water reaction mass was first carried out by Berminghammer in 1998 in Hamilton Harbour, with tests up to 600kN. The first field test was performed for the Port of Lake Charles in Louisiana in 1999 by Applied Foundation Testing, assisted by Berminghammer, with loads up to 5 MN.

Geert Jonker of IHC Foundation Equipment came up with the idea of extending the use of the water reaction mass as a pile-driving tool. Berminghammer, IHC and TNO are now working together to build an underwater Statnamic hammer, which will consist of a large inertial mass made of water and a Statnamic tool capable producing multiple loading pulses. This tool will be used to push an anchor pile into the seabed and measure its capacity at the same time. In the future small onshore and offshore piles will be able to be driven using an underwater tool that is virtually weightless.

This article is based on an original paper by Peter Middendorp, director of TNO Profound.