DATA HANDLING AND REPORTING
The measured strain and acceleration data of each individual signal of every blow are digitized, and stored on removable hard discs with a capacity of 3400 blows per drive.
This leads to an improved data management as follows:

- signal-time data of every blow are available for further back analysis,
- the entire drive can be reprocessed to evaluate signal quality of individual sensors, or to analyze a drive in a detailed diagnostic form,
- no tape recorder or chart recorder are required as all data can be fully reproduced from the digitally created data base.

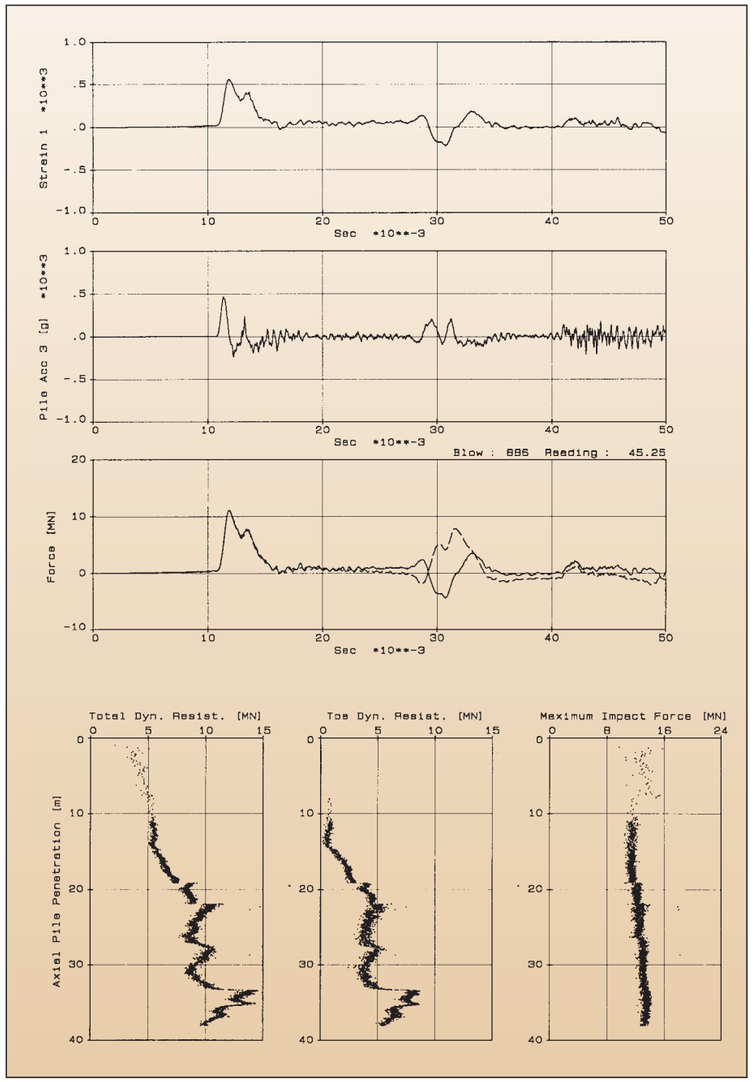
In addition the above system displays on screen real-time the results of the twenty previous blows as well as the average of the previous five driving intervals. This feature allows to trace changes in driving characteristics in an easy manner.
Typical test results are:

- dynamic soil resistance, divided between shaft and toe resistance,
- net pile induced driving energy (enthru energy),
- impact force,
- maximum pile stress.

Other results, derived from further back analyses, include:

- static bearing capacity,
- predictions of the load settlement characteristics of the pile,
- evaluation of the parameters, which determine pile driving characteristics behaviour,
- recommendations for the use of a particular hammer-pile combination for the project.

In addition to in-house developed logging and processing software, a suite of reporting software has been developed to ensure quick reporting. For instance, within minutes after completion of a drive the real-time processed pile driving parameters can be plotted versus pile penetration to support installation management decisions. The above Fugro system permits the use of standard off the shelf computer hardware and obviates the need for purpose built pile driving analysers.



Typical data pile monitoring

Pile monitoring

OBJECTIVES OF PILE MONITORING
Measuring the dynamic pile response during driving and analyzing the measured data allows a quantifiable assessment of the pile driving process.
The objectives of pile monitoring are to:

- log pile driving performance for quality control,
- check pile integrity,
- evaluate the actual performance of hammer-pile-soil system(s) in correlation with the predicted driving behaviour,
- assist in pile acceptance,
- create a data base for improved design and installation criteria for future pile foundations.

Pile monitoring can be of particular use in situations such as:

- unconventional pile design,
- pile installation in areas with insufficient soil information,
- unexpected problems during pile installation.

The specification of the equipment in this data sheet may be subject to modifications without prior notice

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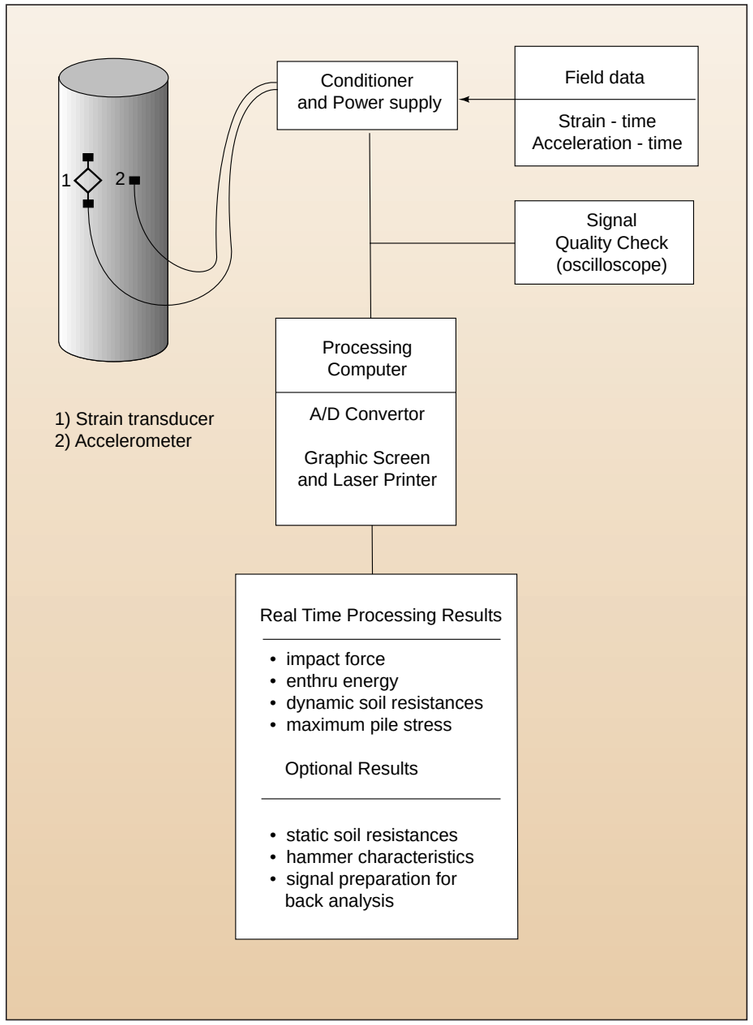
Pile monitoring

Many instances arise where concern is expressed that discontinuities in the pile cross-section occur which result in the pile being unable or insufficiently capable of performing its task as part of the foundation construction. By means of pile monitoring it is possible to distinguish between broken rather than cracked piles; in addition, for cast in-situ piles defects such as necking or barrelling can be shown.

DYNAMIC TESTING

Fugro has adapted a method developed in the U.S.A. which compiles information on the load bearing capacity and pile drivability. Knowledge and experience in the disciplines of geotechnics, mechanics and instrumentation within the company was used to substantially improve measurement procedures and-interpretation of data. Examples of this in-house development are a signal conditioning unit linked to an IBM compatible computer, logging and processing software, and a pile driver (hammer) designed and constructed specially for the dynamic testing of piles.

Pile Preparation



Pile Instrumentation Mounting

BACKGROUND TO THE DYNAMIC TESTING METHOD

Dynamic testing of piles is based on 1-D solutions of the well known wave-equation used in pile drivability studies. This equation suggests that, with force and velocity measurements, it is possible to determine the soil resistance during pile driving. The velocity of a pile element cannot be recorded directly with sufficient accuracy. The most practical and generally adopted method is to measure acceleration and then to derive the required velocity by integration. The force in the same pile element is recorded with the aid of strain gauges. Thus the variation of the acceleration and strain signals with time are recorded.

When a shock wave is applied to a pile head, the wave experiences soil resistance on its way to the pile tip and back. This (soil) resistance causes reflections which can be quantified. This enables the pile length, the dynamic friction and end bearing resistance to be calculated. The dynamic soil resistances can be converted to static values using existing correlations. For such analyses it is essential to have a proper geotechnical background.

PRACTICAL POINTS

Measurement preparations consist either of grinding the pile wall surface, drilling and tapping holes and/or welding mounting blocks. The transducers are secured with glue or bolts at two or three pile diameters below pile head level. The transducers are connected by signal cables to the recording equipment.

Measurements can be performed both during pile driving and after pile installation. In the first instance with proper planning there should be no delays in the pile installation process. Should measurements be made after pile installation, for example, with cast in-situ piles, then further additional procedures are necessary to produce the required energy. Three to five blows are usually sufficient to determine bearing capacity if monitoring for drivability, blows are applied on a more or less continuous basis.

The number of tests that can be carried out per day depends principally on the number of blows (for measurements) that can be applied. An average of two to six piles per day is attainable. Througout the last two decades numerous projects have been successfully executed for the Oil and Gas Industry and international civil contractors. Major projects include many offshore platform installations in the North Sea, Mediterranean, Arabian Gulf, Gulf of Mexico and civil infrastructures and buildings such as the Canary Wharf, London, the Tagus Bridge, Portugal and the Jamuna Bridge, Bangladesh.

Pile monitoring in practice