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Machine data and the quality of screw displacement piles

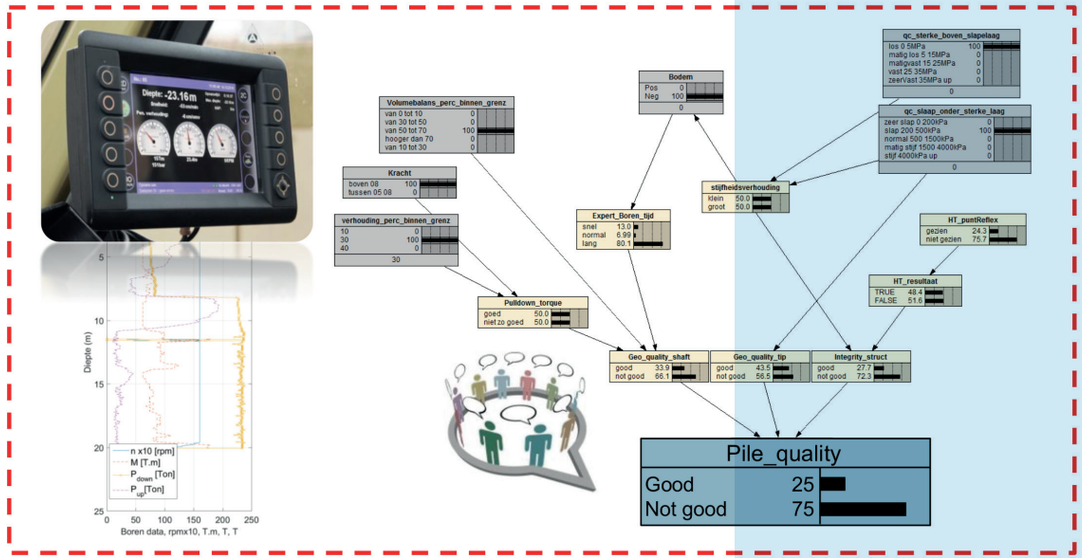
Photos: courtesy Fundex

During the installation of piles, data are gathered which allow the machine operator to make decisions. These data about the process parameters for screw displacement piles can be used by other people and in different phases of the project, reducing the discrepancy between the levels of attention devoted to the design and the installation phases of pile foundations. In this project, pile installation databases and expert knowledge were combined in a Bayesian belief network approach to take all the information into account in a systematic way and to infer the quality of the installed piles.

In the case of screw displacement piles, quite a lot of machine data, such as torque, pull-down and velocity, are collected during installation. Moreover, the machine operator works with implicit assumptions and decisions but there is no systematic way of processing this knowledge during or after installation.

The study was set up jointly with the piling companies in the Netherlands (BAM, Fundex, Hektec, VSF, and Bauer) and with GeoConsult. A contribution was received by the former Geo-Impuls programme. The main focus of this study was the delivery of a proof of concept in which machine data, process parameters and expert knowledge can be used to assess geotechnical and structural pile quality.

The Bayesian belief networks (BBN) technique is suitable for this proof of concept, because it is a 'machine and human/expert learning approach' and practice in this field is often based on experience and expert judgement. The BBNs are based on the probability theory and readily combine available statistics with expert judgement. The discussions and the expert knowledge of the different partners were important for the definition of the model structure and parameters. In addition, the outcomes of statistical analyses of their databases have improved the performance of the BBN.



At first, a geotechnical review of the boring process revealed a relationship between the diameter of the pile and the pile head, the pitch of the screw and forward velocity. In addition, relationships were established between cone resistance, torque and pull-down. In the next step, these relations, the statistical outcomes and geotechnical parameters relating to soil conditions were included in a BBN describing both the boring process and the production of the pile as the casing was being pulled up. The BBN was used to determine whether pile quality will be adequate in certain conditions.

The project showed that the BBN can help the piling companies to monitor and control the pile installation process in real time. The BBN can be improved by using more pile testing data and by extending the expert knowledge included in the system. Furthermore, the approach could be extended to other types of displacement piles.