ROYAL Eijkelkamp

The importance of a construction site with sufficient load-bearing capacity

Penetrologger white paper

Meet the difference

Contents

Trafficability of construction sites

Toppling cranes, lorries getting stuck causing construction works to come to a standstill, personnel slipping or sinking and then staying home as a result of their injuries; these are some of the dangerous situations that occur when the ground of a construction site has insufficient load-bearing capacity. This prompted the 'Federation of Piling Specialists' (FPS) to develop the Working Platform Certificate (WPC) a number of years ago. In the Netherlands, we use the Bouwterreincertificaat Nederland (Construction Site Certificate Netherlands).

The Bouwterreincertificaat Nederland (BTC) was introduced in late 2016. It is an initiative of the Nederlandse Vereniging Aannemers Funderingswerken (NVAF) (Dutch Association of Foundation Contractors). The Bouwterreincertificaat Nederland is a declaration – usually from the main contractor – that the construction site, as described in the certificate, is designed and constructed in such a way that work can be carried out safely. To ensure the work can actually be carried out safely, a visual inspection is performed first when inspecting the machine layout at the construction site. During this visual inspection, the elements of dryness, load-bearing capacity and the flatness of the construction site are analysed. Further inspection takes place based on the results of one or more soundings or manual soundings. The penetration resistance is one of the main indicators in this regard.

A construction site with sufficient load-bearing capacity

For man and machine, the trafficability (on foot or in a vehicle) of a construction site are determined by the load-bearing capacity of the soil. The condition of the construction site has a direct influence on the stability of the equipment and material, but also on the working conditions of the personnel. Poor terrain conditions lead to accidents every year, sometimes even with a fatal outcome. Moreover, employees run the risk of neck and back complaints as well as other musculoskeletal problems. Pursuant to the Working Conditions Decree (Construction Process Section), the health and safety of employees on the construction site must therefore be taken into account as early as the design phase of a construction project. This is often already described in the RAW specifications. Therefore, the quality of the top layer, the load-bearing capacity of the ground surface and the type of vehicle are of great importance to a proper trafficability of a construction site.

Soil density and resistance

RAW specifications

RAW specifications serve as an information carrier and contract document between the customer and the contractor. The responsibilities, authorities, and risks of both contract partners are defined in a balanced way. The RAW specifications describe the requirements for compaction for bank fillings, embankments, and plant beds. These requirements are expressed in terms of a specific Proctor value or resistance.

The Proctor test is a test carried out in a laboratory to determine the maximum density of a soil sample. By using different moisture percentages when performing this test, the optimum moisture content can be determined in order to achieve the maximum density of a certain type of soil. Determining the Proctor value in the field is often costly and time consuming. Measuring the resistance, on the other hand, is not.

In cohesive soils (clay and loam), the resistance of a soil is largely dependent on its moisture content (dry clay, high resistance, wet clay, low resistance). In sandy soils, the influence of the moisture content on the resistance is much less. There is a fairly consistent relationship between the measured resistance and the compaction of sandy soils. In many cases, a resistance measurement provides sufficient information about the compaction.

Density of the soil

The walkability of a construction site depends in part on the density of the soil. In civil engineering, a soil must be sufficiently compacted to offer the right resistance to all machines that will place a significant burden on construction sites. Vehicles entering a construction site where the soil is not yet sufficiently compacted will easily sink into the ground or topple over. A compacted soil therefore provides a stable basis for buildings, footpaths, and construction sites, amongst other things. The density of the soil is related to the load-bearing capacity of the soil, also known as penetration resistance. This penetration resistance is an important factor in determining the suitability of foundations, buildings and infrastructure projects.

Penetration resistance

The penetration resistance is a measure to determine the load-bearing capacity and the root penetration of the soil. This resistance is a mechanical property, which, at a given texture, depends on variable parameters such as

Penetrologger

moisture content, density, and the strength of the bond between the mineral particles of the soil. The moisture content in the soil has a very strong influence on the resistance of the soil. This is particularly true for cohesive soils, such as clay and loam varieties. In the case of non-cohesive soils (sandy soils) that are mainly used in civil engineering, the moisture content has less influence on the resistance.

For the determination of the trafficability of construction sites for persons and vehicles, we look at the pressure that is exercised on the ground by the person or vehicle. This pressure is called the Vehicle Cone Index (VCI). The Vehicle Cone Index is related to the resistance the soil can offer. This is expressed in the Cone Index (CI). A comparison is then made between the soil number CI and the vehicle number VCI. If the soil number is greater than the vehicle number, the terrain is capable of supporting man and machine. When the soil number is lower, measures must be taken to ensure that personnel and machines can continue to carry out their work safely.

Penetrologger

The penetrologger is the perfect instrument to determine the penetration resistance and thus the trafficability and load-bearing capacity of a soil. The penetrologger is used to carry out measurements to a maximum depth of 80 centimetres. In exceptional cases, the measurement can be extended to 3 metres. The field work instrument is equipped with a built-in logger for storing the processing of a large number of measurement data (1500 soundings). This makes the penetrologger particularly suitable if a large number of measurements need to be taken. The penetrologger has a built-in penetration speed control. Rapid and jerky penetration produces values that are not representative of the soil. The measuring method is accurate and has a measuring range of 1000 N.

In addition to determining the trafficability and load-bearing capacity of soil, the penetrologger is also used for the laying of cables and pipes. Once cables and pipes have been laid, the trench in which they are located must be recompacted. The Proctor value is one of the options to measure whether the trench has been sufficiently compacted. In practice, a comparison of the penetration resistance with measurements next to the trench or measurements made prior to excavation is sufficient. During the compaction process, the penetrologger can be used to measure directly whether the sand is sufficiently compacted.

Penetrologger CBR

The penetrologger has an ergonomic design and is lightweight and easy to operate. The penetrologger also has an accurate internal GPS-system to determine the exact measuring point. Optionally, the field work instrument can also be equipped with a soil moisture sensor. This sensor measures the soil moisture content at a single depth.

The penetrologger is standard supplied as a complete set. The set consists of the penetrologger, various cones, probing rods, a reflection plate, tool set, battery charger, communication cables for the computer, software, manual, and a calibration certificate.

Penetrologger CBR

In cooperation with the Bundeswehr (the German Federal Army), Eijkelkamp Soil & Water has started a project to develop a new type of penetrologger. The reason for this is that the German army needed a penetrologger for its ground troops. This part of the army is looking for suitable locations to serve as a landing strip, among other things. Determining the load-bearing capacity of the soil is an essential part thereof. With the specially developed penetrologger CBR, it is possible to measure the load-bearing capacity of the soil to a depth of 60 centimetres.

The penetrologger CBR directly measures the CBR values by means of a statistical penetration test using the standard CBR cone. The standard California Bearing Ratio (CBR) is a penetration test for assessing the mechanical strength of road foundations and roadbeds. The CBR value is the basis for determining the thickness of the soil and composite layers, and is used in road and airport design. The CBR value of a soil is an indication of the shear strength of the soil under a standard load, compared to the shear strength of a standard material (broken limestone), exposed to the same load. The test is performed by measuring the pressure required to penetrate a soil with a standard diameter cone. The measured pressure is then divided by the pressure required to achieve the same penetration using a standard material of crushed stone.

In practice

In practice

Vroom Funderingstechnieken is an all-rounder in pile systems and pre-fabricated foundation structures. Thanks to their extensive expertise and years of experience in the field of foundations, Vroom is often involved at an early stage in complex, specialist work on foundations. Jaap Bol, Project Manager at Vroom Funderingstechnieken, explains why he regularly uses the penetrologger for compaction checks on construction sites.

'It is important to determine the load-bearing capacity of construction sites. After all, we wouldn't want cranes toppling over because the trafficability of the site is inadequate. Therefore, we always measure the resistance of the soil before we start a project,' says Jaap. 'First, we analyse the site, taking into account the surroundings and the location of the construction site. In addition, the season gives us an important indication of the condition of the soil. Based on these factors, we determine whether to perform additional measurements, for instance with the penetrologger. The penetrologger is more often used for measurements in autumn than in summer. The reason for this is that the soil is wetter in autumn than it is in summer, meaning the construction pits are wetter and weaker.'

Jaap explains. 'The measurements are performed manually using the penetrologger. Based on the measurements, I draw up a report with subjects such as a general site plan, the weight of the machines that are used during construction, the situation of the soil and, of course, advice on how the load-bearing capacity of the construction site can be restored.'

'I think the penetrologger is a useful field measuring instrument, because it allows you to print out the measurements on paper. In addition, you can effectively assess the situation of a construction site and give the right advice to the contractor or the engineering firm,' Jaap says. 'Measuring the trafficability of a construction site in advance ensures that any construction delays are prevented. It prevents us running into problems during the process. Moreover, you establish in advance whether the site is safe for man and machine. It is true that it requires a small investment prior to starting as a project, but in the long run it will save money. After all, you don't run the risk of damaging the material or equipment you use because of problems with the soil.'

Multifunctional use

Multifunctional use

The penetrologger is multifunctional and is used for general soil surveys, basic advice on shallow foundations, evaluating artificial compaction of the soil, research into growing conditions of plants in the soil, evaluating the trafficability of the soil for cranes, trucks, and army equipment and for research on grass and sports fields.

In the agricultural sector, the penetrologger is also regularly used as a field measuring device. Piet Peters, Education and Research Associate at Wageningen University & Research, explains why it is necessary to use the penetrologger in soil surveys. 'For civil engineering, it is important that the soil is well compacted, so buildings, machines, and people have a stable surface. This is not the case for agriculture. Compaction is becoming a worldwide issue. Not only in the Netherlands but globally the soil is deteriorating very badly. The machines used by farmers, for instance, are getting heavier and heavier and cause the soil to come under a lot of pressure. This results in an overly compacted soil. The compact layer of this compacted soil has to be loosened again, so the balance of the soil is restored,' Piet says.

'There are several ways to cultivate the land without damaging it. In addition to ploughing, for instance, you now have the No Tillage trend. No Tillage means not working the soil. In other words, you avoid treating the land with machines as far as possible. This minimises soil compaction, which keeps the soil in good condition for a longer period of time. More and more attention is being devoted to this for the benefit of soil life. In addition to No Tillage and ploughing, we also have a new method in the Netherlands, namely Non-Inversion Tillage (NIT). The term says it all; non-inversion. Ploughing turns everything upside down. However, Non-Inversion Tillage, aims to systematically avoid intensive inverting or mixing tillage. It is a method that aims to minimise disturbance of the natural processes of the soil. We use the penetrologger to test which method works best and to see what the effects of the various tillage methods are. One way of determining this is by directly comparing four fields . No tillage is used in the first field. The second field is ploughed. Non-Inversion Tillage is applied to the third field, and No Tillage to the fourth field. The penetrologger measures what happens in the meantime. This allows us to properly determine the effects of the various tillage methods and respond accordingly.'

More information: sales@eijkelkamp.com

‘To us, the penetrologger is very user-friendly and very useful for both experienced users and new users. You quickly become familiar with the device. The data is reliable and reproducible. The device has been designed in such a way that it doesn’t really cause any problems when used in the field. The penetrologger also has a handy GPS function and moisture sensor. We make extensive use of the GPS function. When performing a subsequent measurement, you can easily look up the coordinates and compare both measurements.’

For more information about the penetrologger, please contact our sales department at sales@eijkelkamp.com

ROYAL Eijkelkamp
Meet the difference

Nijverheidsstraat 30
6987 ZG Giesbeek
Nederland

T +31 313 880 200
E info@eijkelkamp.com
I www.eijkelkamp.com