ROYAL Eijkelkamp

Soil compaction is an underestimated problem

Penetrologger white paper

Meet the difference

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Soil compaction; a worldwide issue

Soil compaction is becoming a major issue worldwide. Not only in the Netherlands but globally the soil is deteriorating very badly. Soil compaction is a form of soil degradation, in which the soil structure is lost because the soil is compressed. This global problem is still underestimated and causes problems for agriculture, nature, and climate. Furthermore, soil compaction leads to loss of yield, loss of quality, and reduced water storage.

A soil with good physical properties is composed in such a way that both small and large pores are present in the soil. The moisture is retained in the small pores, and the large pores ensure an adequate supply of air and the removal of excess water. It is also important that growing roots do not encounter too much resistance in the soil, so a root system can develop that can absorb sufficient water and nutrients from the soil.

Soil compaction

Soil compaction reduces soil life, permeability to water and air, and the possibilities for plant growth. Soil compaction can reach a depth of more than one metre. Soils that are regularly ploughed often have a compacted layer at ploughing depth (approximately 25 cm). The degree of compaction depends on the moisture content and texture of the soil. In addition, the pressure of the machines also determines the compaction of the soil to a great extent. Heavy machinery poses a greater risk of compaction than light machinery. The size of the tyres and the tyre pressure are also a determining factor. Furthermore, moist soils are much more sensitive to compaction than dry soils. Tillage under wet conditions is therefore very unfavourable for the soil structure.

Alternative tillage methods

Alternative tillage methods

A lot of research is being done into soil compaction. Piet Peters, Education and Research Associate at Wageningen University & Research, explains the consequences of soil compaction and also explains alternative tillage methods. 'The machines used by farmers are getting heavier and heavier and causing the soil to come under a lot of pressure. Density is related to the structure of the soil. The soil is composed of clods and in between are the pores. It is important that the water and oxygen can enter the soil. This requires space and therefore pores. If this soil is pressed down by the heavy machines that are used nowadays, all that space is lost. Water and oxygen can no longer enter the soil, and as a result nothing grows. In conclusion, the soil is useless,' Piet says. 'So if farmers have an overly compacted soil, they have to make sure that they loosen that compacted layer. Balance in the soil is also important. There must be a good balance between the pores and the soil fauna. The soil fauna is actually responsible for the development of the soil (clods), which provides structure. If the structure is inadequate, the soil must be treated. Treating the soil requires a lot of time and effort and a lot of commitment on the part of the farmer.'

'Prevention is therefore better than cure. It is important that the soil is cared for and managed in the best possible way. By this, I mean exercising extreme care during tillage. This includes the correct methods of ploughing, sowing, irrigation, and the protection of the crop and the soil in which the crop grows. In addition, there are many alternative tillage methods available nowadays, improving the soil quality and reducing the risk of compaction.'

Ploughing

'Ploughing is the traditional way of preparing a soil for sowing and has its advantages and disadvantages. Ploughing means the soil is inverted to ensure that new seeds can be planted in a "clean" soil. Ploughing is in itself a good way of loosening the topsoil. This is because the infiltration rate of moisture increases with ploughing, and after ploughing the top layer of the soil dries faster. Ploughing reaches a depth of approximately 20 to 25 cm. The moment of tillage is very important with ploughing. It is best to plough when it is dry. The reason for this is that a dry soil has much higher load-bearing capacity than a wet soil. It is therefore important for farmers to be able to properly assess

Non-Inversion Tillage & No Tillage

when to plough the land. If ploughing takes place at the right time, it can reduce the compaction problems. The disadvantage of ploughing is that at some point a so-called plough pan will form. A plough pan is a compacted layer just below the ploughed soil.'

Non-Inversion Tillage

'Non-Inversion Tillage (NIT) is seen as a solution to increasing soil compaction in Dutch fields. This type of tillage can contribute to the improvement of soil quality. Ploughing is a relatively intensive tillage method during which the soil is inverted. Non-Inversion Tillage is much more superficial. During Non-Inversion Tillage, the soil is worked to a depth not exceeding 12 centimetres. The advantages of Non-Inversion Tillage are: better development of soil life, good soil structure, improvement of the load-bearing capacity of the soil, and faster infiltration of water into the soil.'

No Tillage

'A trend that is now very much on the rise is No Tillage. No Tillage means not working the soil. In other words, you burden the land with as few machines as possible. This minimises soil compaction, which keeps the soil in good condition for a longer period of time. In addition, No Tillage is becoming increasingly important in relation to food security and food production. This type of tillage is intended to stimulate food production. A considerable amount of research into the results of No Tillage is conducted nationally and internationally. Not only the consequences for compaction are studied, but also the influences on infiltration and soil life.'

In the field

'To test which tillage method works best and to see what the effects of the respective tillage methods are on compaction, we use the penetrologger. 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 in 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.'

Penetrologger

Penetrologger

The penetrologger is used to carry out measurements in which the soil resistance is recorded to a maximum depth of 80 centimetres. 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.

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 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.

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.

Advantages of the penetrologger

‘As we always say: one measurement is no measurement at all. To get a reliable result, you always need to perform a number of repeated measurements,’ Piet says. ‘If you perform a single measurement, you will see a certain value.

Multifunctional use

However, you can't say whether this value applies to the entire measurement area. The soil is not homogeneous in composition. Several measurements need to be performed to get a reliable and representative value. In our view, this device 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.'

Multifunctional use

The penetrologger is multifunctional and is used for basic advice on shallow foundations, general soil surveys, 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. An example of these measurements is the Proctor test. 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.

In civil engineering, the penetrologger is also regularly used as a field measuring device. Jaap Bol, Project Manager at Vroom Funderingstechnieken, explains why the penetrologger is regularly used 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, and 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.’

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

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