geotechnical and environmental consultants

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Geotechnical Tests and Methodology Explained

Assessing the ground beneath our feet often requires understanding the strength properties of the different layers of soil and rock. There are several methodologies which can be adopted to acquire the necessary information. These can often include in-situ and/or laboratory testing to determine the properties of the soil.

In-situ Geotechnical Classification Testing

During intrusive ground investigations, the ground conditions encountered are recorded and samples collected from various depths and changes in strata. In-situ testing within a ground investigation can include: Standard Penetration Testing (SPTs), and Dynamic Probing (DP), Shear Vane and Hand Penetrometer tests to determine the strength of the materials encountered, and tests to determine the California Bearing Ratio (CBR) of the ground.

Standard Penetration Testing (SPTs)

This test is completed within a borehole and is typically undertaken at regular intervals throughout. The results can then be used to determine the shear strength of cohesive soils, the relative density of granular soils and ultimately the bearing capacity of the materials encountered.

Dynamic Probing (DP)

Dynamic Probing (Super Heavy or Heavy) involves the driving of a cone vertically into the ground using a weighted sliding hammer which then records the number of blows for every 100mm of penetration. The results can then be correlated into an equivalent standard penetration test.

Shear Vane and Hand Penetrometer tests

Where site conditions, proposed development and/or financial restrictions do not permit the aforementioned strength tests, in-situ data can still be collected in other forms such as Shear Vane Testing and Hand Penetrometer Testing. These are both mobile hand-held devices that can be used within undisturbed cohesive soils to determine the soil's undrained strength. They are normally undertaken within machine excavated trial pits.

The Shear Vane test consists of a dial head and rods with a range of different sized vanes (propellers) that are attached to it. The Shear Vane is inserted perpendicular to the soil profile and rotated moving the dial on the dial head. The dial will move continually with rotation of the dial head until the soil shears, at which point the dial will return to its original position, with the dial head recording the maximum undrained shear strength of the soil.

The Hand Penetrometer test utilises a loaded spring of known strength to determine the undrained strength of cohesive soils. The pen shaped instrument is applied perpendicular to the cohesive soil surface, causing the penetration of the soil by the instrument. As pressure is applied the pen moves a dial perpendicular to the soil marking numbers which determine the strength of the soil. The test is concluded once a standardized mark on the penetrometer reaches the surface of the cohesive soil.

It should be noted whilst these methods offer a way to determine in-situ data, they are limited in cases of silty/sandy clays.

Laboratory Geotechnical Classification Testing

Geotechnical classification testing provides information for foundation and other design considerations. This typically involves:

- Soil chemical properties with regards to concrete classification (sulphate content and pH)
- Classification of soils characteristics (particle size distribution for granular soils, the plasticity for cohesive soils and the moisture content)
- Undrained shear strength to identify foundation parameters (i.e. bearing capacity) and use in pile design (Triaxial Tests).
- Provision of information on the influence of trees on the proposed development.

California Bearing Ratio (CBR) testing

Ground & Water offers several services which can help with the design of roads and hardstanding on your developments, including adoptable highways. Using a number of different techniques depending on the proposed design, your requirements or the requirements of the relevant authorities, we can provide California Bearing Ratios (CBR) for the soils upon which the roads and hard standing will be founded.

Dynamic Cone Penetrometer (DCP) - The first of these techniques is a DCP. This involves using an 8kg weight, dropped from a height of 575mm, to drive a rod, tipped with a 60° cone into the ground to a depth of ~1m. The penetration per blow of the hammer is measured and software is used to process this data to provide CBR values for the encountered soil layers.

Plate Load Testing (PLT) - Plate Load Tests (or Plate Bearing Tests) are in-situ verification tests of the ultimate bearing capacity of the soils on site. They are carried out in accordance with BS1377:1990: Part 9 and involve loading a steel plate which is placed at the anticipated formation depth of the road/hard standing or shallow foundation. The load is normally provided by an excavator. The larger the weight of the excavator the greater the loading pressure that is applied. The settlement of the soils underlying the plate is measured as the load is applied incrementally, this data can then be used to calculate the CBR value. A plate load test CBR is usually undertaken on granular deposits, including the sub-base and capping of adopted roads.

A PLT is typically carried out to determine load-settlement curves, ultimate bearing capacity, allowable bearing capacity and the modulus of subgrade reaction for shallow foundations and pavement design. PLTs are particularly useful where the mass characteristics of the soils are likely to differ significantly from the results of laboratory tests or where more precise values of settlement are required. Ground & Water can carry out the tests at ground level or within trial pits or trenches on-site. These results can subsequently be used to either; verify design assumptions, or be used as design parameters.

Laboratory CBR tests

The final standard method we offer for calculating the CBR is the Laboratory CBR test. This is undertaken on a bulk sample taken from the soils at the proposed formation depth of the road. The test is usually done in 'soaked' conditions to provide a worst case scenario and the load is applied to the sample via a 50mm diameter plunger at a rate of 1.25mm/min. The resulting load curve is then used to calculate the CBR.

The Design CBR of a cohesive formation level may also be determined via calculation of the plasticity for cohesive soils and reference to literature.

Modulus of Subgrade Reaction

The Modulus of Subgrade Reaction is a coefficient expressed as the load intensity per unit of displacement ($kN/m^2/m$) and is used when designing larger slab foundations, where the behaviour of the foundation itself is presumed to act in a flexible manner when loaded. The coefficient can be gained from a Plate Load Test or through Geostru modelling. On smaller foundations (generally $<2m^2$) simply applying a bearing capacity is sufficient as the foundation can be thought of as rigid with a uniform subgrade reaction acting across the base with limited interaction of the soils surrounding the footing. As the size of the foundation increases, particularly in slabs and where there will be multiple loading points across one slab, the subgrade reaction becomes variable and non-linear as the foundation no longer acts as one rigid body. By including the Modulus of Subgrade Reaction when modelling the ground profile and slab foundation design Ground & Water is better able to predict the expected settlement.

If you require any of the services described above, please email:
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