

THE STANDARD PENETRATION TEST

The Standard Penetration Test (SPT) is a widely used soil exploration tool that involves using a SPT hammer to drive a drill string with a split barrel sampler at the bottom. The sampler recovers soil samples. The number of blows required to drive the last 300 mm is the "N value", which is related to soil strength.

WHY CALIBRATE THE SPT HAMMER?

SPT Hammer Calibration is recommended by the American Society for Testing and Materials (ASTM); periodic calibration is required by many US Departments of Transportation.

Several different types of SPT hammers are used to conduct Standard Penetration Tests. Their efficiency varies, influencing the resulting N value. ASTM D1586 recommends that a measured N value be normalized by multiplying it by the ratio between the measured energy transferred to the rod and 60% of the theoretical potential energy (N 60). This compensates for the variability in efficiency and therefore improves the reliability of soil strength estimates used in geotechnical designs. Energy transfer measurements are required when SPT results are used to determine the liquefaction potential of sands (ASTM D6066), as in the evaluation of dams and levees and in areas of seismic activity. **The only ASTM-accepted means of determining energy for normalization of N values is by force and velocity measurements (ASTM D4633). This is the method employed by GRL Engineers.**



SPT rod section instrumented with strain gages and accelerometers.



GRL engineer calibrates an SPT hammer at Lake Raleigh.

THE CALIBRATION PROCESS

GRL Engineers attach an SPT rod section instrumented with strain gages and accelerometers to the SPT drill string rod (the instrumented section matches the drill rod type used in the drill string - AW, NW etc). As the drill string is driven into the ground, the strain gages and accelerometers obtain force and velocity signals. The signals are transmitted to a Pile Driving Analyzer[®] that displays the force, velocity and energy transmitted to the drill string for each hammer blow; calculates and displays the maximum transferred energy value; and stores the complete time record of force and velocity for all SPT blows. GRL engineers typically perform several SPT energy measurements per hammer at each test site location, to cover a range of depths.

If requested, GRL engineers may also estimate soil setup by attaching a torque wrench and transducer to the SPT rod, applying a torque, measuring soil shear strength and estimating the ratio of peak to residual torque.

Shortly after the test GRL furnishes a calibration report presenting transferred energies, energy transfer ratios (transferred energy divided by the theoretical SPT hammer free fall energy) and the N 60 value.

The Becker Penetration Test (BPT, or Becker Drill Test) is used in geotechnical investigations for coarse grained soils that are too hard for SPT testing. The test is particularly useful when liquefaction is a concern in earthquake-prone areas. A diesel hammer drives a double walled pipe into the ground. As in the SPT test, the number of blows required to drive the last 300 mm is recorded. This number is correlated to SPT blow counts to assess soil strength.

WHY INSTRUMENT THE BECKER PENETRATION TEST?

The energy output of the Becker drill diesel hammer varies with the air-fuel mixture, temperature and pressure, with the soil resistance and with other parameters. In order to account for this variability, the hammer energy must be measured. The most reliable way to determine the energy is by force and acceleration measurement. For an accurate assessment of soil strength with the Becker test it is also important to know how much of the resistance occurs at the pile toe. Only by understanding the transferred energy and knowing the end bearing component can the BPT blow count be reliably used in a correlation with SPT values.



Becker Test at Millsite Dam. These tests are common in liquefaction studies of dams and levees.



Notice accelerometer and strain transducer near the top of the Becker casing.

HOW DOES GRL INSTRUMENT THE BECKER TEST?

GRL Engineers use a Pile Driving Analyzer® (PDA) to measure the energy transferred into a Becker casing instrumented with strain transducers and accelerometers. The resistance distribution and end bearing component are obtained by performing CAPWAP® analyses on the signals collected with the PDA.

GRL Engineers have been successfully measuring the energies and assessing the resistance distribution of Becker Drills for several years, in dozens of job sites around the country, sometimes in conjunction with optional static load tests.

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