APPLICATION OF ASTM D 1558 TO FIELD TESTING FOR MOISTURE AND DENSITY

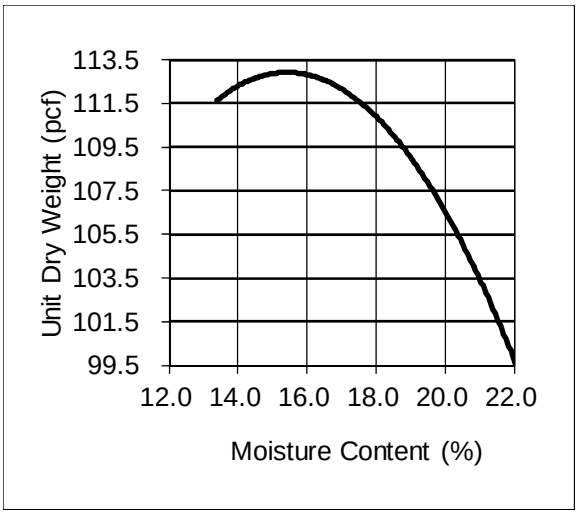
Ronald F. Reed, P.E.
Reed Engineering Group, Ltd.
rreed@reed-engineering.com

ASTM D 1558 is titled "Moisture Content Penetration Resistance Relationships of Fine-Grained Soils". This test method outlines development of a moisture/penetration curve while performing the Moisture/Density Relationship, frequently referred to as the "Standard Proctor" test in the laboratory.

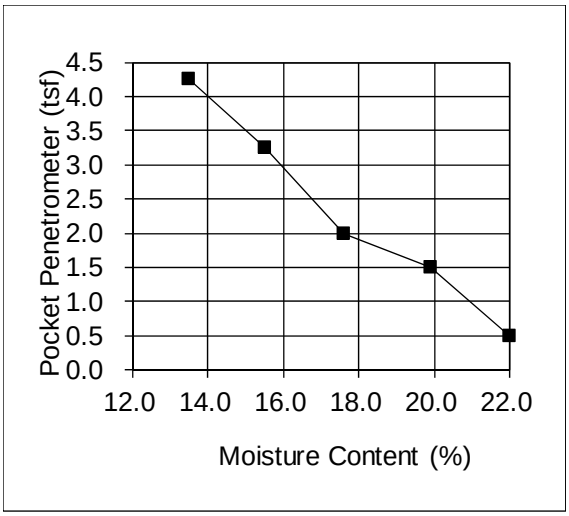
Prior to development and standardization of what is now known as the "Standard Proctor" curve, R. R. Proctor[1] observed that there is a unique relationship between the stiffness of a fine-grained soil as measured using a "plasticity-needle", with variation in moisture and density. ASTM D 1558 is an extension of the method Proctor employed, whereby a hand penetrometer has been substituted for the "plasticity-needle".

The "Standard" Moisture/Density Relationship is developed in the laboratory as outlined in ASTM D 698. During development of this relationship, the molded samples are tested for penetration resistance using a calibrated hand penetrometer. A graph can then be developed between the measured penetration resistance and moisture content. The figure below illustrates this relationship for dark brown clay with a Plasticity Index (PI) of 30. The graph on the left is the Moisture/Density Relationship (Standard Proctor Curve). The graph on the right side is the Penetration/Moisture content curve.

[1] Proctor, R. R., "Description of Field and Laboratory Methods", Engineering News Record, September 1933.



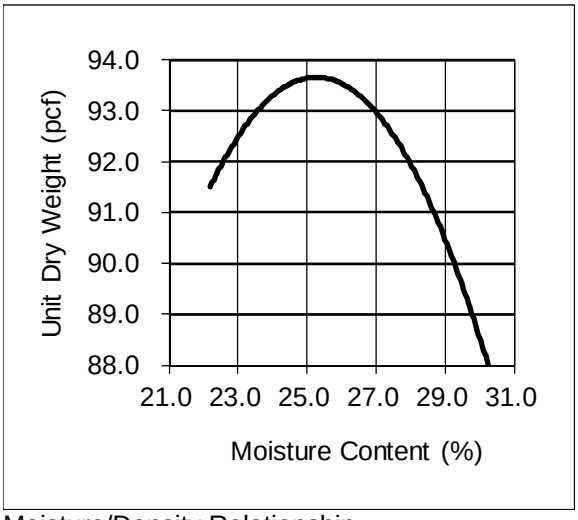
Moisture Density Relationship



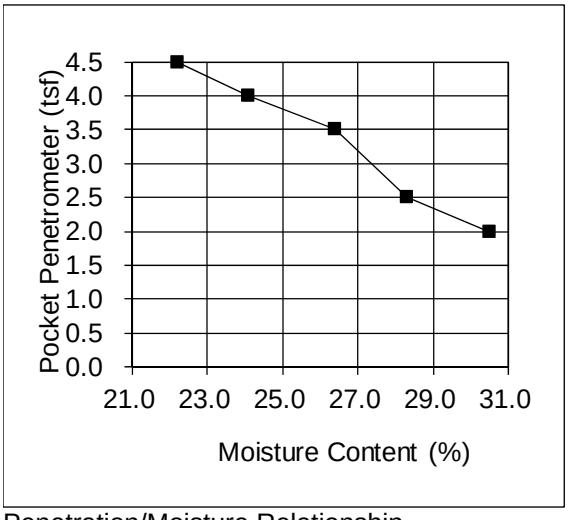
Penetration/Moisture Relationship

The optimum moisture from the Moisture/Density Curve is 15.8%. If the specified moisture was +2 to +5 percentage points above optimum, then the desired moisture of the fill in the field would be between 17.8% and 20.8%. In the field, if the technician is measuring 19% moisture, then the penetration resistance should be approximately 2.0 tons per square foot (tsf). If the penetration resistance is significantly either higher or lower, then the technician would know that something is amiss, with a possible cause being that the soil changed from that used to develop the Standard Proctor relationship shown in the graph on the left.

To further illustrate this point, the two graphs below are for a dark brown clay with a PI of 42. Although both this sample and the previous sample are the same color, they vary widely in plasticity.



Moisture/Density Relationship



Penetration/Moisture Relationship

For this dark brown clay, the optimum moisture is 25.1%. If the specifications require a moisture content of +2 to +5 percentage points above optimum, the desired field moisture would be 27.1% to 30.1%, with corresponding penetration values of 3 and 2.2 tsf. If the technician measured the moisture in the field at 19%, but had a penetration value of 2.0 tsf, he would know that the applicable "Proctor" curve to use would be for the dark brown clay with a PI 30; not the one shown above.

Good engineering technicians know the difference between soils with a PI of 30 and 42; however, use of the penetration resistance curve provides an additional tool to assure that proper testing is being performed.