How to Use a Moisture-Density Relationship (Proctor Curve)

Whether doing sitework compaction, foundation compaction, or pavement preparation, the key to saving time, effort and money is the Proctor curve. Understanding the moisture-density relationship and its relation to compaction specifications will help to coordinate the compaction process and the equipment need to achieve specification compliance.

Most specifications require either 95% or 98% of the maximum dry density to be achieved for proper compaction. As can be seen in Fig. A, achieving compaction varies with different Proctor curves, which are defined by different soil types. In Curve 1, the soil type is more moisture dependent than the soil type shown in Curve 2. This means that in order to achieve the desired compaction, significant attention must be given to the in-place moisture content of the soil. As can be seen, to obtain 95% compaction in Curve 1, the soil moisture content must be within +/- 2% of optimum moisture. To obtain 98% compaction, the soil moisture must be within +/- 1% of optimum moisture. Considering that the in-place moisture content of soil can vary from less than 1% to more than 100%, controlling the in-place moisture within such tight constraints is sometimes difficult. With a little planning and forethought, it can be done and the result will be a savings in time and money.

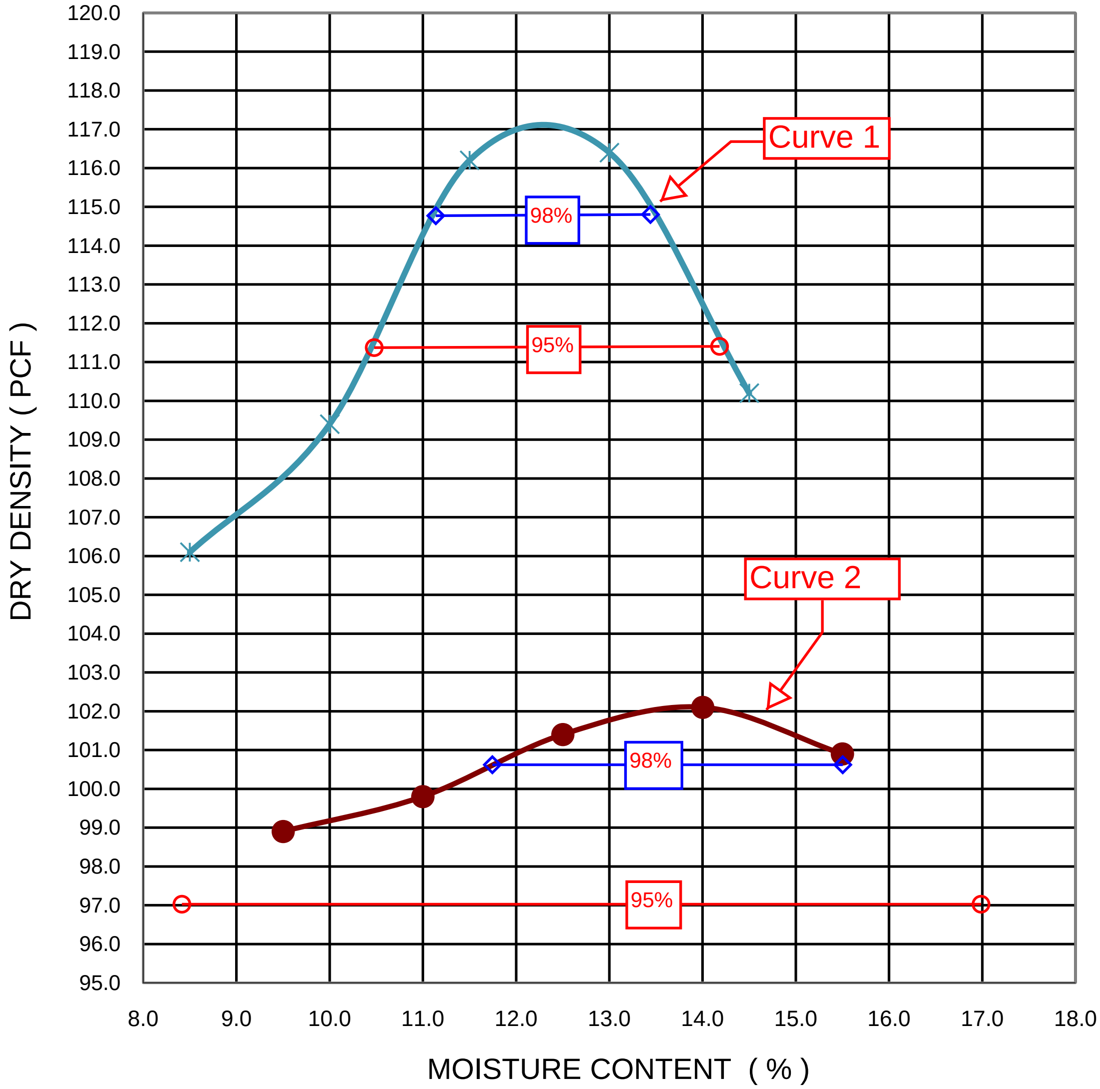
To get the in-place moisture content to the proper value (as near its optimum value as practicable) it is first necessary to determine the in-place moisture content. This can be done by the use of a portable moisture testing device, which can be either a calcium carbide reagent type or a nuclear moisture gauge. Testing laboratories often have both types. If the project is large and there is a lot of sitework to be done, it could be cost-effective to purchase a calcium carbide reagent moisture tester (commonly known as a "Speedy" moisture tester). Training for its use is relatively easy and its accuracy can be tested by taking a corresponding specimen to a testing laboratory to compare an oven-dried moisture content to the "Speedy" values. The other option is to have a testing laboratory perform such moisture content tests in the field to assist with the compaction process.

Once the in-place moisture content is known, the soil moisture can be adjust up or down by wetting or drying the area. Wetting the area is relatively easy as it can be done with water trucks. Drying overly wet soil can be more difficult since the area weather must be counted on to help. Some mechanical action such as disking and aerating the soil will help the drying process.

After the in-place moisture content is sufficient close to optimum, compaction can be started. When compacting soil near its optimum moisture content, less compactive effort is required, thus saving time and money.

As can be seen in Curve 2, the soil type is much less dependent on the in-place moisture content. The 95% compaction level can be achieved at almost any moisture content within the range of the curve, although experience with such soils will show that controlling the moisture content near optimum will actually shorten the time required for compaction.

Figure A



Curve 1-
Maximum Dry Density = 117.1 pcf
Optimum Moisture Content = 12.3 %

Curve 2 -
Maximum Dry Density = 102.1 pcf
Optimum Moisture Content = 13.9%