RESEARCH LABORATORY TECHNICAL REPORT

BARTLETT TREE EXPERTS
SCIENTIFIC TREE CARE SINCE 1907

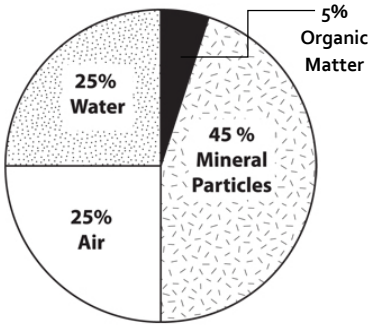
Soil Density

Analysis and Treatment

E. Thomas Smiley, PhD, Urban Forestry

Natural soils are a complex network of different-sized particles and aggregations of particles called peds. Organic matter formed from dead roots, decomposed leaves and branches is the main "cement" that holds the peds together. The spaces between particles and peds allow for the movement of air and water and the growth of roots. An ideal soil is composed of half pore space and half solid (Figure 1). Large pores drain quickly after rain or irrigation so they are usually filled with air. Smaller pores hold water more tightly, so unless there is severe drought, they hold water. Roots grow easily in the pore space, sending root hairs or mycorrhizal strands into the small pores to absorb water and nutrients.

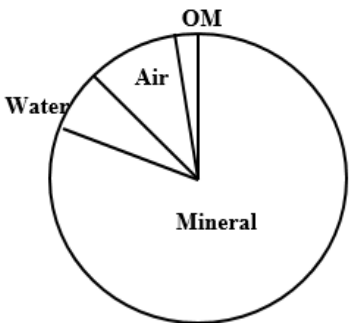
Figure 1: Ideal soil



In urban areas, there are many forces acting on the soil that compact it (Figure 2). These forces include foot or vehicle traffic, construction equipment and vibration from nearby traffic. Compaction decreases the pore space in soil. This creates an environment far less favorable for root growth. Compacted soils do not readily absorb water or allow for water drainage. There is less air to provide oxygen to the roots and carry carbon dioxide away and there are fewer spaces for roots to grow.

It is best to address compaction problems prior to planting. At that point, tilling the soil can significantly reduce the compaction. This can be done with an excavator, plow, or backhoe on large sites or with a rototiller on smaller sites.

Figure 2: Compacted soil



For established landscapes, the problem is more difficult. Before prescribing a treatment it is best to accurately diagnose the problem. This is done by determining the bulk density of the soil. If the density of the soil is above the threshold value, a drastic treatment is needed.

Bulk density (Figure 3) is typically measured in one of two ways: with a soil penetrometer or compaction tester (Figure 4); or with a bulk density sampler (Figure 5). The penetrometer simulates root growth. Root growth decreases linearly with increasing penetration resistance until practically stopping above 300 psi. Since readings are affected by soil moisture, it is best used when soils are at field capacity. Otherwise, and more commonly, it is used to compare soils in different parts of a property where relative soil compaction can be judged by comparison of one area of soil to another.

A bulk density sampler is used to remove a known volume of soil which is then dried and weighed to give a precise measure of bulk density/soil compaction.

Figure 3: Bulk density

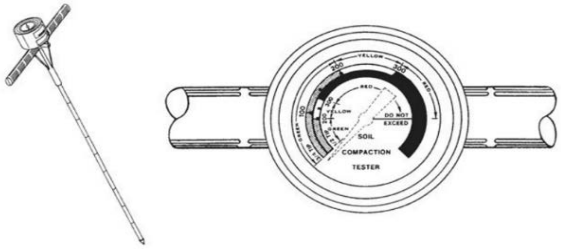
What is bulk density?
Bulk density is a measure of the dry weight of a volume of soil. It is the standard number used to quantify the degree of compaction in the soil. Solid rock has a density of 2.6 g/cc and water has a density of 1 g/cc. Some non-compacted forest topsoil actually has a density less than one, so it would float on water.

The threshold for bulk density between compacted and non-compacted soil is often not distinct. It depends on soil texture and the plants growing there. The Bartlett Tree Research lab does have a chart of accepted values.

Once the extent of soil compaction is determined, treatment for recently transplanted trees with little root growth into the surrounding soil should consist of rototilling in the area just outside of the root ball. On average, roots grow 18" (45 cm) per year. By tilling a 36" radius around the tree, two years of good growing conditions can be provided.

For established trees, treatments that avoid significant root damage need to be employed. There are two basic treatments that can be applied to reduce compaction: surface mulching and fertilizing, and Bartlett's Root Invigoration Program. If the soil is only slightly compacted, the combination of surface mulching and fertilizing is often sufficient although the process can take some time to have an effect.

Figure 4: Soil penetrometer (Dickey-John Co.)



For more compacted soils and or to elicit a faster tree response, root invigoration is recommended.

Figure 5:

Testing Bulk Density

Equipment needed:

Slide hammer
3" core measuring gauge
Split sampling tube knife
Bottle brush
Soil bags
Marking pen
Bulk density sampler head

Procedure

Clean the inside of the bulk density sampler head, the outside of the split sampling tube, and the screw threads of the slide hammer with a bottlebrush. Insert the tube into the sampler head and screw into slide hammer handle. Drive the head into soil to a depth of 4 to 5 inches (10-14 cm). Drive the slide hammer back upward to remove the core, being careful not to excessively rock the handle, as it has been known to break. Carefully unscrew the sampler and remove the sample tube and soil core. Remove half of the split tube to expose the soil core. Place the core-measuring gauge on the soil core and cut the core cleanly at either end to the exact length of the gauge. Remove all non-core soil from the tube. Slide the 3" (7.5 cm) core into a soil sample bag and send tot the Bartlett Tree Research lab for drying and weighing.

Founded in 1926, The Bartlett Tree Research Laboratories is the research wing of Bartlett Tree Experts. Scientists here develop guidelines for all of the Company's services.