Linda Chalker-Scott, Ph.D., Extension Horticulturist and Associate Professor,
Puyallup Research and Extension Center, Washington State University

The Myth of Vibrating Vehicles:
"Vibration from traffic causes soil compaction of adjacent landscapes"

The Myth

Urban soils are subjected to numerous environmental stresses. They may suffer from nutrient deficiencies, mineral toxicities, and chemical contamination. Urban soil compaction, however, may be the most significant stress, especially in terms of plant and soil health. Soil is compacted deliberately during preparation for pouring foundations and roads and more thoughtlessly through vehicular, human, and animal traffic. Even raindrops and irrigation spray contribute to the compaction of bare soil.

In addition to the crushing weight of construction and other heavy vehicles, the vibration from said vehicles is often identified as another source of soil compaction. This belief has been expanded to include landscapes adjacent to roadways (e.g. traffic circles and parking strips) but not directly impacted by traffic (Figure 1). Curious, I investigated the peer-reviewed literature to discover whether this perception was based on science or assumptions.

Figure 1. The weight from construction vehicles compacts and
destroys urban soils – but does the vibration from these trucks affect soils nearby?

The Reality

How much does vibration contribute to soil compaction? Unfortunately, there is little in the scientific literature that deals directly with traffic vibration and urban landscape soils. However, there are a number of related topics from which inferences can be drawn.

First, it's clear that the type of soil and its water content will greatly influence whether vibration will increase or decrease compaction. Sandy soils are the most porous and will settle the most when exposed to vibrations; finer-textured silt and lay soils are less likely to compact under similar conditions. Dry soils are less likely to compact than those that are wet.

Secondly, we need to separate the causes of soil compaction due to <u>weight</u> from that due to <u>vibration</u>. A non-uniform soil compaction results from a weight applied directly to the surface of the soil (rainfall, feet, tires). Compaction is greatest at the surface and dissipates as one goes deeper into the soil profile; compaction can extend several inches through the soil profile depending on the weight of the compacting force and other environmental conditions. In contrast, vibrational compaction is a uniform settling of soil induced by energy waves (primarily sound) and not weight. Therefore, <u>surface</u> compaction is not caused by vibration from vehicles or other sources.

Many studies, unfortunately, document soil compaction by tractors and other agricultural machinery to combined weight and vibration without separating their effects. It is likely that the two forces are synergistic; that is, the compaction due to the combined effect of weight and vibration is greater than the sum of the effects of weight and vibration tested separately. Industrial applications combine both weight and vibration to compact soils to the greatest possible density. Thus, vibratory rollers are commonly used to prepare roadbeds, rice fields, and in conjunction with mechanized tree-planting. Vibrational soil compaction (which includes the weight component) has been especially important in field situations where soils are coarse, nutrient-poor, and excessively well-drained; compacting these soils has improved crop quality and yield.

Evidence that vibration <u>increases</u> soil compaction

Vibrating probes are often used in laboratory situations to compact materials in greenhouse pots or soil columns prior to experimentation. Often the vibrating equipment was used in conjunction with a tamper or some other surface compacting implement. In every case, coarse, moist soils were most easily compacted by this method. In agricultural and forestry situations, vibration was found to increase compaction when combined with heavy pieces of machinery such as tillers. Likewise, clod size was significantly smaller if soils were subjected to vibration, though the addition of stabilizers (such as organic amendments) could reduce the negative effects of vibrational compaction. In the few cases where crop responses were also studied, vibrating machinery significantly compacted moist, coarse soils and consequently reduced crop yield. In none of these studies was the compacting effect of vibration <u>alone</u> assessed.

Evidence that vibration <u>decreases</u> soil compaction

In contrast to the previous studies, a number of researchers have reported on the ability of vibration subsoilers to relieve severe compaction stress in field situations. Scientists report decreased bulk densities and higher porosities of compacted soils subjected to various vibrational treatments, some of which were up to 33% more effective in reducing compaction than non-vibratory methods. Vibrational methods were particularly effective on slopes or other situations where severe soil disruption was contra-indicated. Likewise, vibration has been used in laboratory applications to loosen soil in columns and bins.

A final word of practicality must be inserted here. In assessing the likelihood of vibration-induced compaction for any site, we need to remember that unlike the soils in laboratory columns and experimental fields, urban landscape soils are more than just substrate. Root systems, especially those of trees and shrubs, will stabilize soils and make them less likely to shift due to vibrational disturbance.

The Bottom Line

- Compaction of urban soils is caused primarily by weight applied to the soil surface, including construction equipment and other vehicles, human and animal foot traffic, and rainfall.
- Moist, coarse soils are the most susceptible to compaction.
- Vibration in combination with an applied surface weight will compact soils to a greater extent than weight alone.
- There is no evidence that vibration alone can compact urban landscape soils.
- In the absence of surface weight, soils are generally loosened when exposed to vibration.

For more information, please visit Dr. Chalker-Scott's web page at http://www.theinformedgardener.com.