**COMPACTION BY VIBRATION**

**SUMMARY**
Cohesionless soils are best compacted using vibration. The vibration can be on the surface of the material or applied internally. For the saturation and internal vibration method, the lift thickness of the soil that can be densified is only limited by the depth the vibrator can penetrate.

Vibration shakes the soil particles, shifting them into a denser arrangement. Vibration works best for clean sands and gravels (containing 5 % or less fines). Vibratory compaction equipment includes vibratory drum rollers, vibrating surface plates, and insertion (or internal) vibrators. Vibratory drum rollers are steel smooth drum, sheepsfoot, or padfoot rollers that have vibrating drums. The pressure or kneading action is combined with vibration. Small vibrating drum rollers are used for trench compaction, either walk-behind or ride-on models. They have either a smooth drum or a dimpled drum for traction.

A surface plate vibrator, sometimes called a "turtle," is a vibrating flat plate that is guided over the soil surface, as shown in Figure 1.

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**FIGURE 1**  Vibration Compaction Devices  
(Courtesy Wacker Corp.)
The vibration from tracked dozers (crawler tractors) has been used to compact clean sands and gravels. Both the vibratory roller and plate vibrator are effective to about 30 cm (12 in) for clean sands and gravels, although the effectiveness of the plate vibrator should be checked. The small vibratory rollers used for silts and clays are probably only effective for about a 10 cm (4 in) depth for densities of 95% standard Proctor or higher.

SATURATION AND VIBRATION

Clean sands and gravels can be compacted in lifts of 2 m (6 ft) or more using the **saturation and vibration** technique. In this method, water is added to the soil and internal vibrators, such as the concrete vibrator shown in Figure 1, are worked down through the depth of soil that was placed (this is not the same as "jetting" which is discussed later). Internal vibrators are also known as "stingers," concrete vibrators, or "wiggletails." The depth of effective compaction is only limited to the length of the vibrator. A photo of a “saturation and vibration” operation is shown as Figure 2.

The effectiveness depends on the size of the vibrator head, the frequency and amplitude of vibration, what point in the operation the water is added to the soil, the amount of water, the spacing between vibrator insertions, and the speed at which the vibrator is withdrawn. Pneumatic vibrators are more effective than the electric ones. All of these factors, and the
specific type of soil that is to be densified, require that time must be spent at the beginning of the job (and when any of the factors change) experimenting to find the best combination that will compact effectively and efficiently. However, being able to compact very thick lifts means that this trial period can be extremely worthwhile. Unfortunately, for contractors unfamiliar with this method, the experimental period can be unsettling and may take more time than anticipated. While the method has been called "saturation" and vibration, only enough water should be added to lubricate the particles for ease of densification. If too much water is used when compacting the soil on the sides of a pipe, it is possible to float the pipe. This method is very effective in densifying soil in the haunch area, even if the tip of the vibrator is not close to the haunch.

This method may be more effective if the soil is added to water, rather than vice versa. In this way, the water is worked up through the soil, not down through the soil. It is harder to work air out of soil when water is over the air.

NOTE: Compaction using internal vibrators in cohesionless soils is described in Chapter 10 of Pipeline Installation by Howard and in ASTM F 1668 “Practice for Installing Thermoplastic Pipe.” A video of the procedure can be seen on the “links” page of the website AmsterHoward.com.

References:


ASTM F 1668 “Practice for Installing Thermoplastic Pipe”