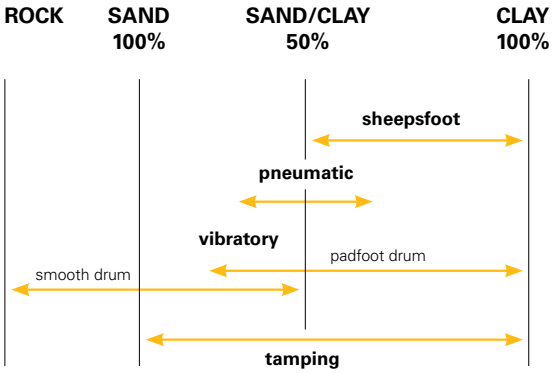
SOIL COMPACTION

DRUM SELECTION

Many factors influence the choice of compaction equipment. The type of equipment selected for a project is sometimes based on the contractor's previous experience, by the type of soil, method specification or available equipment. Another consideration is how well a machine will conform to the hauling and spreading operation. Climatic and traction conditions are also important. Sometimes, the contractor's interest in standardizing the equipment fleet plays a role in the decision-making process.

The application chart provides guidelines for matching equipment to job variables and soil types. There is no single compactor that will do all things in all applications. Each type has a definite material and operating range on which it is most economical. In many cases, there are applications where machines of different sizes and types can achieve the compaction target; but choosing the machine that is most suitable will complete the work most economically and efficiently due to reduced passes, reduced fuel use and less working time.

APPLICATION CHART



Vibratory Compactors – Vibratory compactors work on the principle of particle rearrangement to decrease voids and increase density and load bearing strength. They come in two types: smooth drum and padfoot drum. For increased versatility, smooth drum compactors can be equipped with optional padfoot shell kits, which allows the use of smooth drum rollers in padfoot applications, albeit with limited performance.

Smooth drum vibratory compactors generate three compactive forces: static pressure, impact and vibration. Padfoot drum machines generate the same forces, plus they also generate manipulative force. Vibratory compactors provide uniform compaction throughout the lift.

Density is achieved from the forces generated by the vibrating drum hitting the ground. Compaction results are a function of the frequency and amplitude of the blows, as well as the force of the blows and the time period over which the blows are applied.

Oval pads are a good match for cohesive soils and thicker lifts.

Square pads are best suited for semi-cohesive soils and thinner lifts.

The frequency/time relationship accounts for slower working speeds on vibratory compactors. Working speed is important because it dictates how long a particular part of the fill will be compacted. For vibratory compactors, a speed of 1-2,5 km/h (0.6-1.6 mph) for rock and clay, and 2-5 km/h (1.2-3 mph) for gravel and sand will provide the best results.

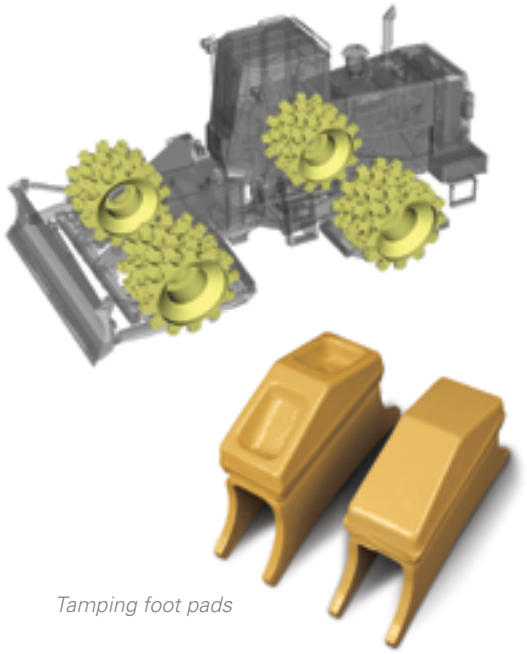
Smooth drum vibratory compactors were the first vibratory machines introduced. They are most effective on granular materials with particle sizes ranging from large rocks to fine sand. They are also used on semi-cohesive soils with up to 50 percent cohesive soil content. Lift thicknesses vary according to the size of the compactor. Whenever large rock is used in the fill, the lifts may be very thick—up to 1,2 m (4 ft) lifts are not unusual. One thing to remember when large rocks are in the fill is that the thickness should be about 300 mm (12 in) more than the maximum rock size. This permits lift consolidation without having large rocks protrude above the surface.

Padfoot drum machines expand the material range to include soils with more than 50 percent cohesive material and a greater percentage of fines. When the pad penetrates the top of the lift, it breaks the natural bonds between the particles of cohesive soil and achieves better compaction results. The pads are involuted to walk out of the lift without fluffing the soil and tapered to help them stay clean. The typical lift thickness for padded drum units on cohesive soil is in the 150-460 mm (6-18 in) range.

Caterpillar has two pad shapes available: square faced pads and oval-faced pads. Square pads perform well on semi-cohesive soils and thinner lifts of less than 150 mm (6 in). Square pads do a good job of sealing the surface.

Oval pads have less surface area than square pads, so they apply greater ground pressure than square pads. This allows the pad to penetrate deeper into the lift. Oval pads perform better on cohesive soils and thicker lifts of 150-460 mm (6-18 in). Oval pads do not seal the surface as well as square pads.

Caterpillar also offers a padfoot shell kit option for smooth drum compactors. The two-piece shell bolts onto the smooth drum, allowing the compactor to be used on cohesive soils like a normal padfoot drum. Both square pad and oval pad shell kits are available.



Tamping foot pads

Tamping Foot Compactors – Tamping foot compactors are high-speed, self-propelled, non-vibratory compactors. They usually have four padded steel wheels and are equipped with a dozer blade. Their pads are tapered with a rectangular face.

Tamping foot compactors compact from the bottom of the lift to the top. Because the pads are tapered, they can walk out of the lift without fluffing the soil. Therefore, the top of the lift is also being compacted and the surface is relatively smooth and sealed. Tamping foot compactors are capable of speeds in the 16-32 km/h (10-20 mph) range, but they typically operate in the 10-15 km/h (6-10 mph) range.

Generally, 2-3 cycles (4-6 machine passes) will achieve desired densities in 200-300 mm (8-12 in) lifts although 4 cycles may be needed in poorly graded plastic silt or very fine clay. Tamping foot compactors are effective on all soils except clean sand.

Tamping foot compactors leave a fairly smooth, sealed surface so hauling units are able to maintain a high speed when traveling over the fill. Also, since dozer-equipped tamping compactors do both spreading and compacting, the contractor may be able to reduce the number of track-type spreaders.

Tamping foot compactors are best suited for large projects. They need long, uninterrupted passes to build up speed that generates high production. On lifts greater than 300 mm (12 in) thick, tamping foot compactors are about 2 to 3 times more productive than single drum vibratory compactors. The application, jobsite size and the economics behind decision-making will dictate which kind of machine is best.

Sheepsfoot Compactors – Sheepsfoot compactors derived their name from the fact that early Roman road builders would herd sheep back and forth over base material until the road was compacted. The word "sheepsfoot" became a generic term to describe all types of padded drums. In reality, a sheepsfoot compactor is very different from a padded drum or tamping foot compactor.

A sheepsfoot pad is cylindrical, usually 200 mm (8 in) long. The pad is circular and will range in diameter from 76-127 mm (3-5 in). The pads on tamping foot or padded drums are tapered with an oval or rectangular shape. And the pad face is smaller than the base of the pad—that's an important difference.

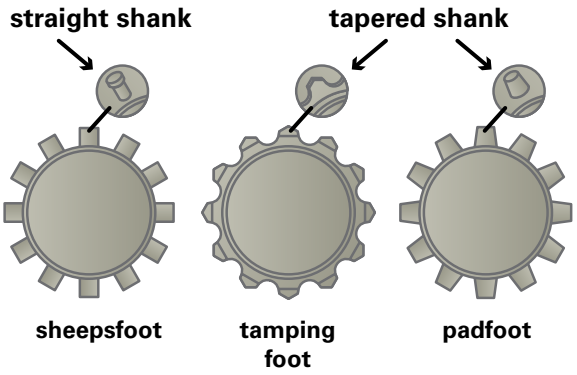
The pads on sheepsfoot drums penetrate through the top lift and actually compact the lift below. When a pad comes out of the soil, it kicks up or fluffs the material. The result is a loose layer of material on top. When more fill is spread, the top lift will be fluffed and the previous layer will be compacted. A sheepsfoot compactor truly compacts from the bottom up.

Using a sheepsfoot compactor has one definite benefit. Because the top lift of soil is always being fluffed, the process helps aerate and dry out wet clays and silts.

But the disadvantages of sheepsfoot compactors are numerous. The loose top-lift material can act as a sponge when it rains and slow the compaction process. The loose material also slows hauling units that deposit fill material, so haul cycle times are increased.

Plus, sheepsfoot compactors can work only at speeds from 6-10 km/h (4-6 mph), which cancels any benefit from impact and vibration. Pressure and manipulation are the only compactive forces exerted on the soil. Usually, 6-10 cycles (12-20 machine passes) are needed to reach target density on 200 mm (8 in) lifts. Sheepsfoot compactors are no longer widely used.

PAD CONFIGURATIONS



Pneumatic Compactors – Pneumatic compactors are used on small-to-medium size soil compaction jobs, primarily on bladed, granular base materials. Often, they are used as a finishing compactor after a vibratory drum compactor completes compaction of the lift. Pneumatic compactors are best suited for sealing the surface, special applications such as compaction of thin lifts, or special requirements dictated by the job.

The compactive forces (pressure and manipulation) generated by the rubber tires work from the top of the lift down to produce density. The amount of compactive force can be varied by altering the tire pressure (the normal method) or by changing the weight of the ballast (done less frequently). The kneading action caused by the staggered tire pattern helps seal and smooth the surface.

Pneumatic compactors can be used on soil and asphalt, an advantage that allows a road-building contractor to use one compactor for multiple stages of construction.

Rear Vibratory Plates – On non-cohesive material, single drum vibratory soil compactors can be equipped with rear vibratory plates, which provide a surface sealing that cannot be achieved with the single drum compactor alone. This enables the operator to account for the gradient of compaction: the single drum vibratory roller achieves deep compaction, and the vibratory plate compacts and seals the surface.

When the vibratory plates are not needed, the plates should be removed from the machine because their weight can reduce the linear load of the drum, which may mean that additional passes will be required to achieve the compaction target.