

# **Dynamic Compaction**

**By Robert Lukas and Bill Moore**

Many times “location, location, location” has been expressed as the most important criterion for establishing the value of a parcel of land. While not disputing the importance of location, another equally significant factor that must be considered by a buyer or developer of a site is the quality of the soil. The quality of the soil relative to its applicability of its intended use is of utmost importance. Soil characteristics may range from totally inappropriate, to marginally usable, to ideal. The Board of Realtors carries the motto “Under All is the Land.” What must never be forgotten, however, is that not all land was created equal.

As a result of many contributing factors, soil compaction and strength is highly unpredictable and, thus, engineering analyses and evaluations of the component properties of specific land sites are necessary. This involves intricate testing of the soil to determine suitability for proposed uses and to develop cost-effective remedial solutions where potential problems are detected. Testing usually includes much more than merely taking soil borings. A multi-disciplined staff of geotechnical and environmental engineers provide the user with greater confidence in knowing that construction on a site is economically feasible and, through implementing corrective steps, often can change the status of the site from marginal, or even unusable, to a condition of viable usefulness.

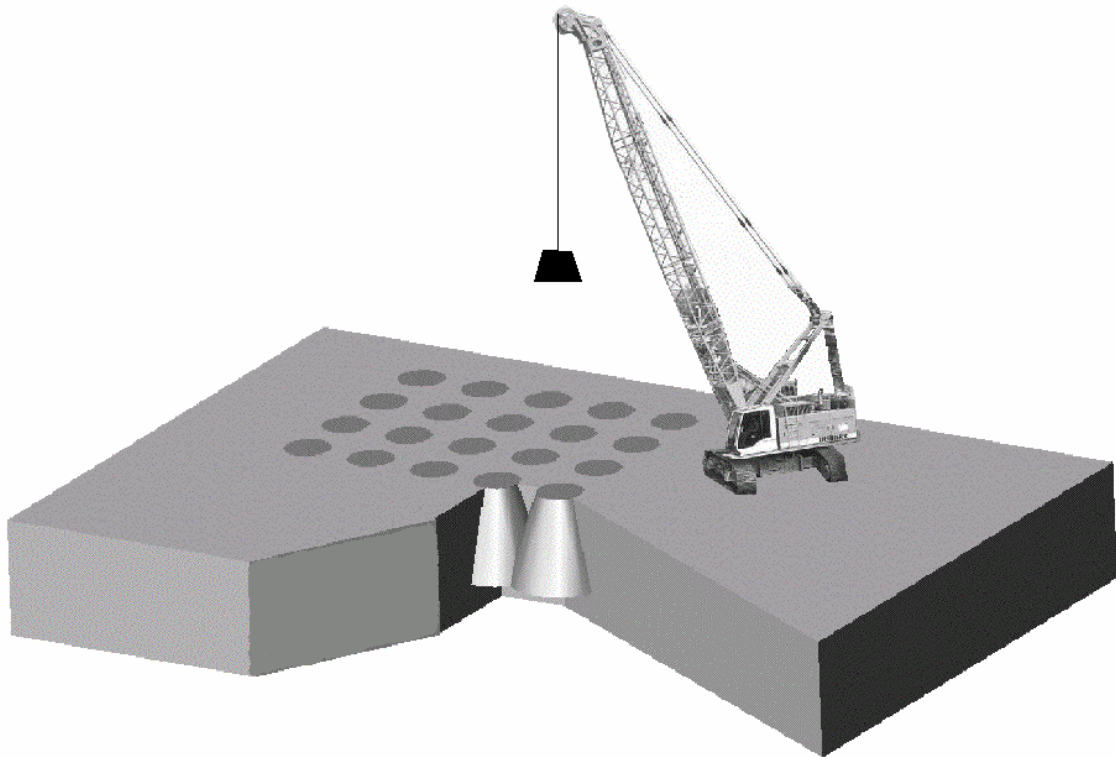
Evaluating the existing soil contributes to the safety of use, protection against subsequent liability exposure and enhanced marketability. One condition that is often encountered occurs when the subsurface includes significant granular deposits of not only natural sands and gravels, but also fill material consisting of building rubble, certain types of mine spoil, and industrial wastes such as slag and decomposed refuse. Extensive research and pioneering in the development of new techniques used to densify such fill soils to a point where they can provide support for new structures or roadways has led to the discovery of a method known as “dynamic compaction.” This process has also been termed as pounding, heavy tamping, dynamic consolidation and deep densification. Dynamic compaction is now a well proven procedure that improves the building quality of marginal sites in a cost effective and timely manner.

In order to fully understand the benefits of dynamic compaction, however, one must first understand the process of conventional compaction. Compaction is the process of forcing granular particles into a tighter arrangement subsequent to impact by another object. Typically, compaction is achieved by using heavy rollers or vibratory equipment. Conventional compaction, which first requires soil removal, is used for controlled fill placement and is undertaken in thin lifts, usually 9 to 12 inches thick. The water content of the material being densified during conventional compaction must be controlled to within a few percentage points of optimum water content by aeration or wetting. Generally speaking, this type of compaction is undertaken above the water table.

Dynamic compaction, on the other hand, is the process of densifying soils to relatively great depths by applying energy at the existing ground surface. The soils are

densified at the prevailing water content when the energy is applied. Granular soil deposits located below the groundwater table also achieve densification.

Densification results from systematically lifting and dropping a heavy steel weight from a crawler crane in pre-determined 10 to 25 feet on-center grids. The weights generally range from 6 to 30 tons, and the drop height typically ranges from 30 to 100 feet. The thickness of deposits being densified generally range between 10 and 35 feet. Following impact, craters as deep as six feet are created and later backfilled utilizing fill material. The number of times a weight must be dropped in one place is calculated during the soil analysis phase. If performed properly, dynamic compaction allows for construction of conventional spread footings with a bearing capacity of 3,000 pounds per square foot with acceptable settlement.



One of the most important considerations regarding the applicability of dynamic compaction is the type of soil being densified. In general, dynamic compaction is most beneficial on a category of soil known as granular materials. Granular materials enable excess pore water pressures that develop during the densification process to dissipate rapidly. On the other hand, a category of materials not conducive to dynamic compaction include impervious soils (either natural or fill) that are saturated. Improvements cannot be made with saturated soils unless the water content of the soil is lowered. For example, the permeability of clay soils is generally so low that excess pore water pressure generated during dynamic compaction cannot dissipate in a timely manner. Therefore, unless “escape routes” for excess water can be created then dynamic compaction would not

practical for these types of materials. Lastly, the category of soils ranging between granular materials and saturated clay are classified as semi-pervious. This particular category includes silts, clayey silts or sandy silts. Generally, dynamic compaction will be effective in these soils. However, since drainage is obviously much slower than in more granular soils, many phases of energy application are necessary.



After evaluating the soil and ascertaining that dynamic compaction would, in fact, be beneficial, determining the most efficient application of energy at the site would be the

next step. The degree of improvement achieved in any soil type is related to the amount of energy applied. If the goal of dynamic compaction is to reduce foundation settlement, then sufficient energy must be applied to achieve the desired properties of the soil to maintain the settlement to specified tolerances. If only a small amount of energy is applied, the deposit may not become as compact as desired and further settlement could occur upon loading. The maximum improvement in strength generally occurs at 10 to 15 feet below ground surface. Below this level there is diminishing degree of improvement. Surface densification is required after application of the high level of energy because deep craters are formed. This is accomplished by leveling the ground and applying a low level of dynamic compaction energy.

A structure's tolerance to settlement should be considered in the planning of the dynamic compaction operations. Borings should be made to determine the actual properties that have been achieved after densification, from which a more refined settlement prediction can be made. Analysis of both the land under consideration and a thorough understanding of the contemplated use of the land is imperative. Proper analysis calls for technical engineering knowledge and utilizing the applied skills of experienced technicians.



Brandenburg, one of the premier demolition firms in the Brownfield industry, often performs dynamic compaction after demolishing old structures. Providing such a service is beneficial to the customer because the site becomes readily available, and thus,

much more attractive to a potential buyer. As an example, Brandenburg wrecked an old warehouse terminal that was built on top of a municipal landfill. Complicating matters is the fact that the landfill was originally positioned on top of an old creek bed. Brandenburg was able to dynamically compact the site without having to remove any of the old landfill material. The site would eventually support the construction of a newspaper printing plant

In essence, dynamic compaction has proven to be an effective and economical alternative to conventional compaction. A rough estimate of the cost to implement this technique is a mere \$1.50 per square foot. It is an ideal option and has been used for a diversity of client applications, ranging from highway construction to commercial projects such as mid-rise office towers, hotels, shopping centers, and industrial parks to name a few. Simply put, dynamic compaction is a highly effective tool and should be utilized whenever feasible, and, more importantly, when the ultimate goal is to maximize the greatest and best use of land, one of the world's most precious assets.

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