TERRANOTES
A Ground Improvement Update from TerraSystems

GROUND VIBRATIONS WITH DYNAMIC COMPACTION

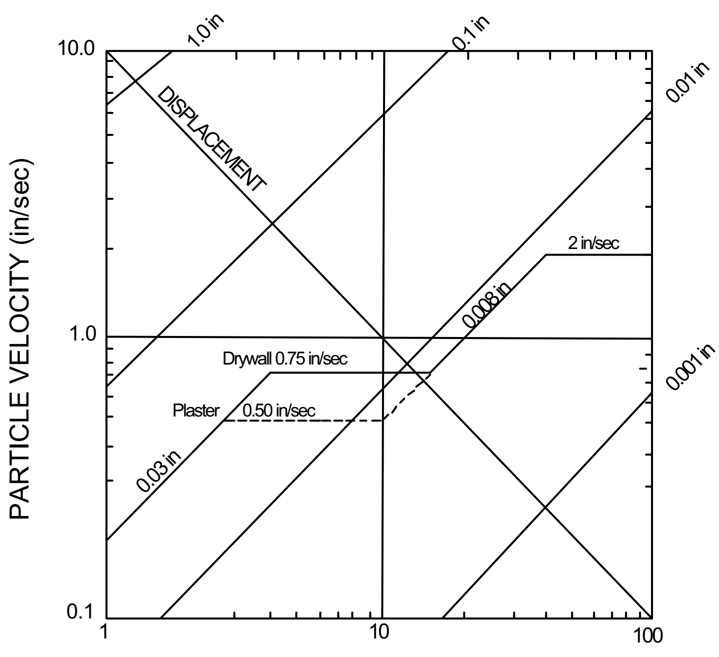
During the past 10 to 15 years, dynamic compaction has become an increasingly popular technique for densifying uncontrolled fills and loose natural deposits. Dynamic compaction is highly cost effective in urban areas with relatively high land values. The procedure involves dropping a heavy steel weight from heights of up to 80 feet over the land surface to be compacted. An undesirable feature of dynamic compaction, however, is the generation of ground vibrations caused by the dropping weight.

Ground vibrations can be potentially damaging to adjacent structures in addition to being annoying to people. It is therefore important that vibration monitoring be performed whenever dynamic compaction is performed in close proximity to structures.

For many years the limiting peak particle velocity for damage threshold was considered to be 2 inches per second. In 1980 the U.S. Bureau of Mines re-evaluated the threshold values and revised the threshold values to be frequency dependent. It was found that the lower the frequency, the lower the damage threshold. Figure 1, which was published by the Bureau, is now considered industry standard.

The vibration levels generated by dynamic compaction are low frequency vibrations, generally in the range of 5 to 20 Hz. As Figure 1 illustrates, the peak particle velocities in this frequency range should be maintained below 0.5 inches per second to prevent damage to nearby structures with plaster walls and 0.75 inches per second for drywall construction. These limiting values may be overly conservative given that the duration of vibrations induced by dynamic compaction are very short. More damage occurs when steady state vibrations, such as are caused by vibratory pile drivers, are used.

Figure 1
Frequency Dependent Vibration Criteria
(U.S. Bureau of Mines, 1980)



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Fortunately, the amplitudes of ground vibrations dampen with distance from the point of impact. Figure 2[1] is a summary of peak particle velocities from 12 dynamic compaction sites, using weights varying from 4 to 40 tons and drop heights of 5 to 100 feet. A safe upper limit from this data is:

$$PPV = \left(\frac{75}{d}\right)^{1.7}$$

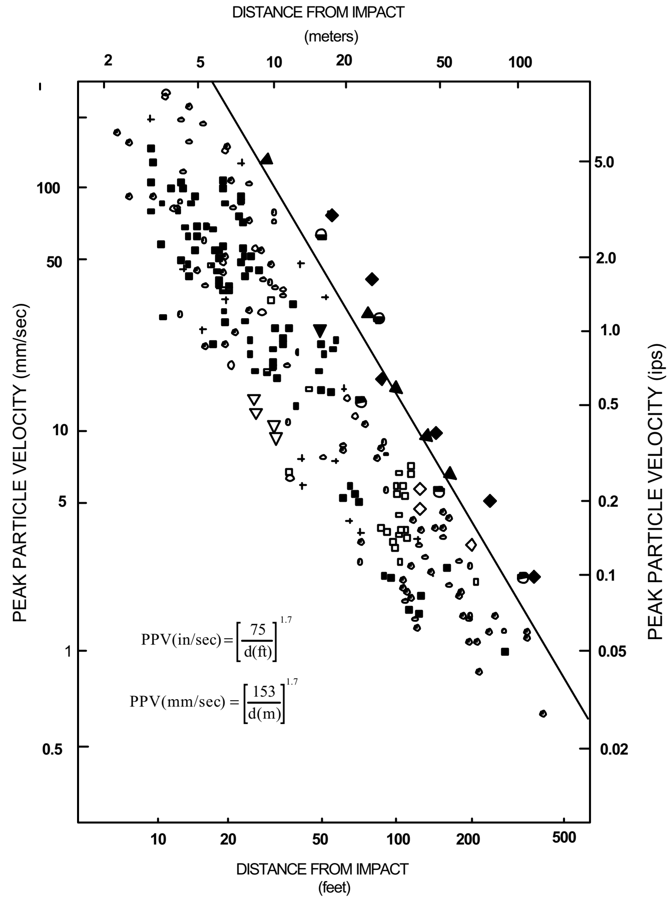
where PPV is in inches per second and d is in feet.

The same data set was used to develop a scaled distance versus the peak particle velocity. The scaled distance is defined as the ratio of the square root of the energy per drop to the distance from the point of impact. The safe upper limit expression is:

$$PPV = 8\left(\frac{\sqrt{WH}}{d}\right)^{1.7}$$

where PPV is in inches per second, d and H are in feet and W is in tons.

Figure 2
Summary of Dynamic Compaction Vibration Experience
(Mayne, 1985)



If vibration levels are anticipated to cause off-site problems, isolation trenches can be dug between the point of impact and the area to be protected. The vibration levels can be reduced by factors of 2 to 10, depending upon such factors as the soil type, the depth of the trench and the position of the weight dropping to the trench.

In summary, it is important to consider the effect of vibration produced by dynamic compaction on off-site structures. However, even in built-up areas, it is generally possible to utilize dynamic compaction with a careful program of vibration monitoring, possibly in conjunction with isolation trenches.

If you would like more information concerning dynamic compaction or if you have a site where dynamic compaction may be applicable, please give us a call.

[1]Mayne, P.W., "Ground Vibrations During Dynamic Compaction", Presented at the ASCE Soil Dynamics Committee Convention in Detroit, MI, October, 1985.

TERRASYSTEMS INCORPORATED
39565 Cottage Grove Lane
Lovettsville, VA 20180
540-882-4130
FAX: 540-882-3866