Pile Integrity Tester Model Comparison

Single Channel (PIT-QV) and Two-Channel (PIT-QFV)

The Pile Integrity Tester is available in single channel (PIT-QV) or two-channels (PIT-QFV) of data acquisition. Both models come with a Fast Fourier Transform (FFT) feature, a license of PIT-W Standard and a demonstration license of PIT-S.

This comparison is intended to help you select which model to purchase, as well as to decide if you should acquire a license of PIT-W Professional Software (PIT-W Pro) and/or a permanent license of PIT-S.

PIT-QV

The PIT-QV has **one** data input channel, used to record the **acceleration** measured on the pile. This is sufficient for many, and perhaps most, applications. The analysis of acceleration data is usually performed in the **time domain**.

PIT-QV

The PIT-W Standard software is sufficient for most time domain analyses.

The PIT-W Professional software makes it possible to assess the severity of a defect (β-Analysis) from acceleration measurements. PIT-W Pro also estimates the profile (shape) of the foundation from acceleration measurements.
Profile estimates may also be obtained by performing simplified signal matching with the PIT-S software.

It is possible to perform a simple **frequency domain analysis** with a PIT-QV in the field, by employing the FFT feature which is standard in all PIT models. This analysis may aid in determining foundation depth or distance to a major defect.

PIT-QFV

The PIT-QFV has **two** data input channels. The first input is always the **acceleration** measured on the foundation, and is required for all testing. The second input is either from an **instrumented hammer** or from a **second accelerometer**. The second input becomes necessary when additional analyses are required, either by project specification or for technical reasons. These analyses usually require PIT-W Pro.

Applications suitable for PIT-QFV with an instrumented hammer

1) An **instrumented hammer** must be used if specifications require that the **Mobility** of the foundation be determined according to the **Transient Response Method**. Mobility may also help the detection and location of defects in some situations where velocity alone does not, such as floor slabs, bridge decks or other short thickness members like tunnel liners (although there are minimum thickness restrictions).

PIT-QFV

Mobility is defined as

$\boldsymbol{M(f)} = \frac{\boldsymbol{V(f)}}{\boldsymbol{F(f)}}$ where $\mathrm{V(f)}$ is the velocity at a frequency $\boldsymbol{f}$ and $\boldsymbol{F(f)}$ is the force at a frequency $\boldsymbol{f}$.

The calculation of mobility requires an **instrumented hammer** to measure the force signal in addition to the velocity signal. The Transient Response Analysis is performed with PIT-W Pro. Figure 3 shows the Mobility plot from PIT-W Pro. The pile length may be determined from the frequency intervals of the peak mobility values as in Figure 3, and the characteristic mobility of the shaft is calculated by the program; PDI suggests, however, checking the frequency based results with the standard time domain approach.

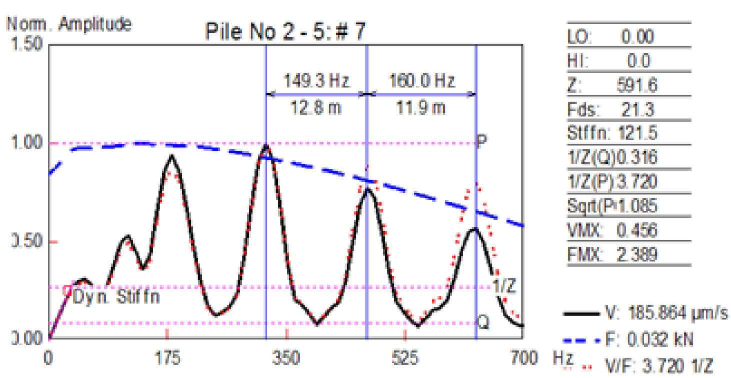

Figure 3: Mobility plot with dynamic stiffness

2) An **instrumented hammer** must be used if it is necessary to calculate the **Dynamic Stiffness**

Dynamic Stiffness is defined as

$$Z(f\text{-}o) = \frac{F(fo)}{\frac{V(fo)}{2\pi fo}} = \frac{2\pi fo}{M(fo)}$$

where $\frac{V(fo)}{2\pi fo}$ is the displacement (velocity divided by frequency) at a low frequency fo.

$Z(fo)$ may therefore be considered a pseudo-static stiffness. By comparing the stiffness of various shafts, it is possible to single out the one with the lowest stiffness. This is the weakest shaft, and therefore might have a defect.

3) An **instrumented hammer** helps to check the **integrity of a foundation near the top.** This application does not require PIT-W Pro. In this application one compares the velocity pulse width with the width of the force pulse. In intact foundations, the force pulse typically has the same width or is wider than the velocity pulse. If the velocity pulse is wider (as in Figure 4) then this may indicate an impedance reduction close to the pile top which is not easily detected when only the velocity pulse is measured (since the reflection superimposes on the input, making the apparent velocity longer). This procedure may help detect defects at depths smaller than the pulse width. Upper portion defect detection may also be achieved by comparing the velocity pulse widths on all tested shafts. Because a given hammer has a nominal pulse width, shafts with unusually wide velocity pulse widths are likely to have defects near the top.

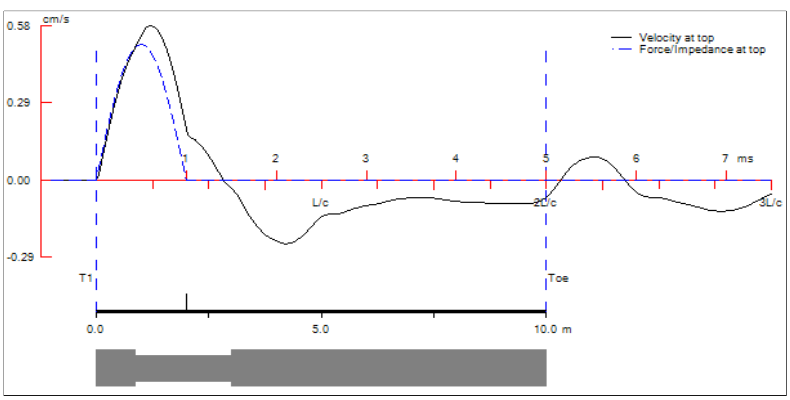

Figure 4: Velocity pulse (solid) wider than force pulse (dashed); pile with reduced impedance near top

Applications suitable for PIT-QFV with a second accelerometer

1) A PIT-QFV with a **second accelerometer** must be used to measure two velocities separated along the shaft by some known distance. This is useful in the case of **piles under existing structures**, where it is necessary to separate downwards from upwards reflections (Figure 5). The two velocity measurements are further analyzed by PIT-W Pro.

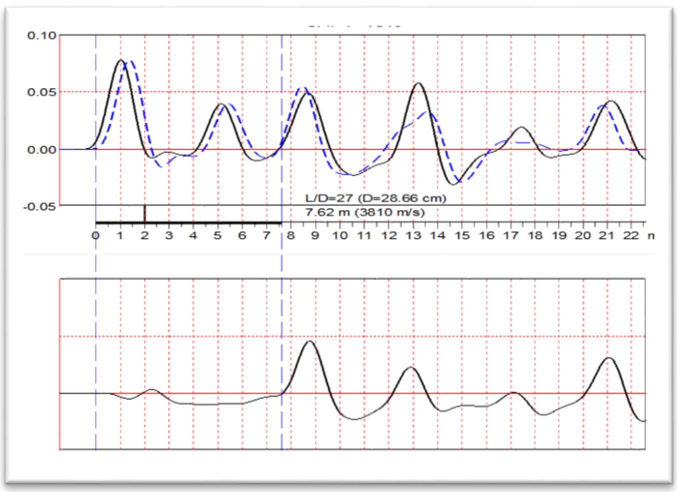

Figure 5 top: Two velocity measurements taken with 2 accelerometers at two vertically separated locations on a pile.
Figure 5 bottom: wave up velocity component (solid) calculated for the upper accelerometer location from both accelerometer measurements.

2) A PIT-QFV with a **second accelerometer** is necessary to determine the **length of existing foundations** with accuracy better than plus or minus 12.5%. This is accomplished by accurately determining wave speed from the analysis, with PIT-W Pro, of two velocity measurements.

3) A PIT-QFV **with a second accelerometer** permit the elimination of Rayleigh wave components from the PIT records of **relatively large piles**. To accomplish this record enhancement, both vertical and horizontal accelerations have to be measured at the pile top surface at the same location. Subtracting the scaled horizontal motion component from the vertical one reduces the vertical top motion to that corresponding to the compressive axial wave. Figure 6 shows that a remarkable improvement of data quality can be achieved in this manner.

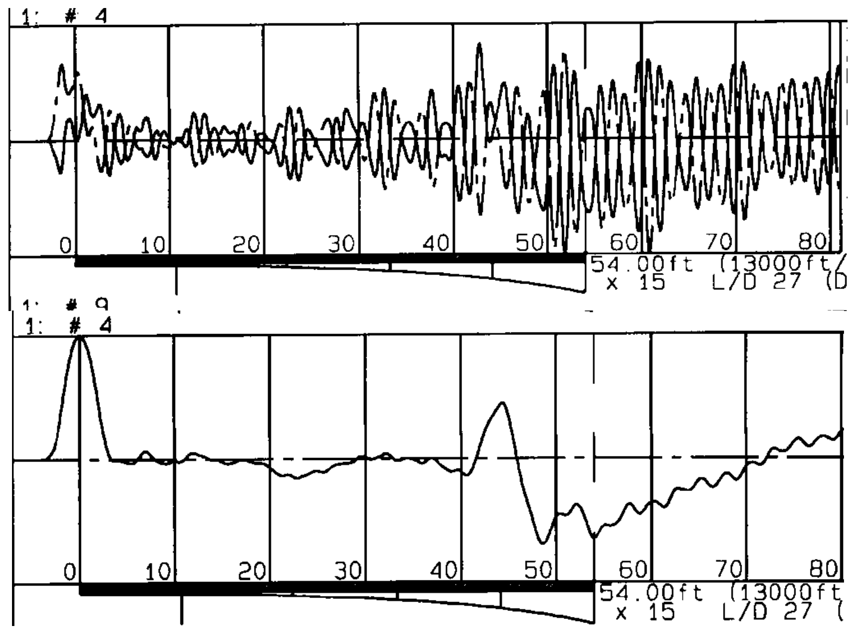

Figure 6: Vertical (Dash-dot) and horizontal (solid) pile top velocity measurements reduced to axial motion signal by Raleigh wave analysis.

30725 Aurora Road • Cleveland, Ohio 44139 USA • +1-216-831-6131 • Fax +1-216-831-0916
E-mail: info@pile.com • www.pile.com