DID YOU **KNOW?**

50 years ago a thesis by Case student Eiber prompted the PDA research.

Pile Dynamics, Inc.

GRL engineers, inc. Dynamic Measurements and Analyses

Can PIT do it all?

By Frank Rausche, PhD, PE

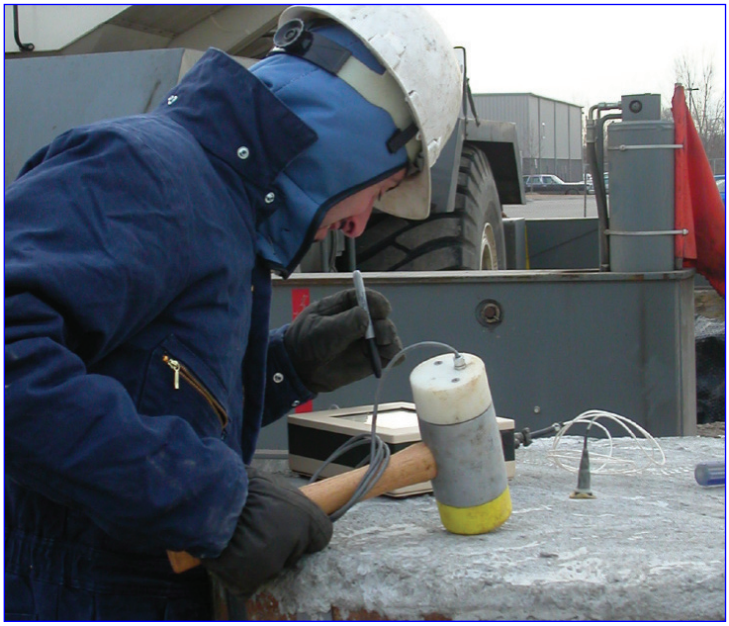
Phone call to GRL: "Can you tell me the length of a pile under a building? We don't know what type of pile; since it was driven in the 1930s, it may be a step tapered pile. No, we cannot access the side of the pile and we don't know exactly where it is located except under a pile cap." GRL's test engineers frequently get such inquiries. The structures in question are buildings, bridges, retaining walls, sheet pile walls etc. We readily admit that it might be easier to fly to the moon than to answer these simple questions. But dynamic testing may be able to help.

The Pile Integrity Tester (PIT), which performs the Low Strain or Pulse Echo Method, has been available since the 1980s to indirectly determine length and search for major defects. This method has a number of advantages over other indirect methods primarily because it can be quickly applied to any drilled shaft, precast concrete or auger cast-in-place pile without much preparation. In many European and Asian countries, construction specifications require a large percentage or all cast-in-situ shafts or piles to be pulse-echo tested. Also, in many countries, if construction problems cast doubts on the quality of a deep foundation, a first response is usually to perform the pulse echo test. And for existing "unknown" deep foundations, PIT is the first non destructive testing (NDT) tool that comes to mind.

It is quite amazing that a light hammer tap generates a stress wave that can travel 50 m or more down the foundation, reflect at its bottom, travel back to the top and there, upon arrival, generate a measurable, quick movement. Actually, the light hammer impact moves the top only a fraction of a millimeter and therefore does not generate much soil resistance. This is one of the reasons why the Low Strain method works. However, the very small motions require a very careful test execution including proper pile top preparation and use of the most sensitive equipment with an extremely high digital resolution. The more demanding the job is, the greater the care required.

GRL Colorado's Project Engineer Anna Klesney, recently successfully determined the length of drilled shafts buried under a cap with a column already in place. The top of the column was accessible for impact and measurement. Senior Engineer Jorge Beim performed the very complex data interpretation with the help of the wave propagation simulation program PIT-S (download it free from www.pile.com).

Absolute depth, relative length (Length/Diameter) and number of major cross sectional or concrete quality variations constrain PIT results, causing some foundation engineers to altogether reject trying this method. Cross Hole Sonic Logging (CSL) and Single Hole Sonic Logging (SHSL) do perform better for long and complex piles, but at a higher cost and requiring access holes inside the foundation. The Parallel Seismic Test (PST) and the Length Inductive Test Equipment (LITE, see page 2) only provide length information and require a borehole in the immediate vicinity of the existing foundation. To assess pile caps or slabs of less than 1 m thickness, an Acoustic Concrete Tester (ACT) may be helpful. Length or thickness limits for these methods are shown in Table 1.



GRL Cleveland office manager C. Michael Morgano applies PIT to a 4ft diameter drilled shaft

Ultimately, we really would like to evaluate not just the foundation length or quality but also its bearing capacity. In that case only a High Strain Test according to ASTM D4945 will help. It requires the impact by a drop weight of about 2% of the ultimate test capacity and is the dynamic testing method that provides the greatest wealth of information. No NDT method yields length results with 100% certainty and 100% precision, and GRL's professionals are open and honest about this. However, very often it is quite surprising how much information can be gathered, particularly if experienced test engineers employ a combination of dynamic testing methods.

NDT Method	Application	Length or Thickness Limit
PIT (Pulse Echo) ASTM D5882	Concrete Piles; Concrete Filled Pipes; Pile Caps; Slabs	0.3m < L< 50+ m and L < 60 D
PIT	Timber Piles	L < 15 m
PIT	H-Steel Piles in soft soils; not for open pipe piles	L < 15 m
ACT ASTM C1383	Concrete Slabs, Pile Caps, tunnel liners, floors	0.1 < t < 1 m
CSL, SHSL ASTM D6760	Concrete shafts or piles with access holes	Unlimited
PST	Concrete, masonry foundations with parallel borehole	L < 15 m
LITE	Steel piles/pipes; steel sheet pile walls with parallel borehole	Unlimited

Table 1- NDT Method Comparison