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Pile Integrity Evaluations - Depth Penetration

All pile integrity evaluations are subject to a finite depth penetration. This is a physical limitation.

As a vibration wave propagates along the pile shaft, it is progressively attenuated by the action of dynamic load shedding to the surrounding soil. The rate of attenuation is logarithmic with depth and the amplitude of the propagating vibration wave very soon becomes only a small proportion of its initial value at the pile head.

The ability of test systems to resolve faint reflections returning from depth depends upon the dynamic range of the testing system and the signal-to-noise ratio of the measurement. The dynamic range of testing systems is usually 40dB-60dB. This means they can resolve a signal of 1 part in 100 or 1 part in 1000, respectively, depending upon the quality of the measuring transducers and system electronics. Testing systems which utilise signal processing techniques such as ensemble averaging, auto correlation or cross spectral averaging to improve the signal-to-noise ratio of the measurement can resolve fainter reflections than systems which rely on inspection of the raw signal data only.

All systems, however, have finite capabilities which limit the effective penetration depth of the test. In loose sands, alluvium etc, the penetration depth of the most sophisticated systems is of the order 40-50 pile diameters. In London clay, this reduces to 25-30 pile diameters. In hard chalks, mudstone etc, the penetration of the tests may be less than 10 pile diameters.

Additional penetration limits are imposed where piles are of irregular form. For instance, a pile containing a 'bulb' in pile section will result in a reflection (and, in turn, a reduction in the amplitude) of the downward travelling vibration wave. A 'bulb' which represents, say, a doubling of the effective area of the pile will result in a partial reflection (about 50%) of the downward travelling vibration wave. A bulb which represents an area change of 4 or greater will result in all of the vibration wave being reflected back to the pile top. In this case, the vibration wave cannot penetrate past the bulb and no integrity assessment of the underlying pile shaft would be possible. The same rules apply for piles which contain relative reductions in their properties.