Ductile Iron Piles
Vibrations and Sound

Traditional driven piles use large hammers (drop, air/steam, diesel, etc) that generate high amplitude and low frequency vibrations that travel long distances and can greatly exceed vibration limits particularly in urban settings. The driven Ductile Iron Pile system is unique compared with traditional driven pile foundations by producing significantly reduced vibration levels.

Ductile Iron Piles are installed using an excavator-mounted medium-sized *percussion* hammer fitted with a special drive adapter that advances the pile into the ground using a combination of percussive (ramming) energy from the hammer and excavator crowd force as necessary (Figure 1). The percussion hammer delivers *high frequency* driving energy to advance the pile. The high frequency vibration waves created by the pile installation are significantly lower amplitude compared with traditional driven pile operation. Additionally, the high frequency waves dissipate rapidly with distance from the energy source. Furthermore, the displacement of the soil generated by pile advancement is often much less because of the smaller cross-sectional area of the Ductile Iron Piles compared with driven H-piles, pipe piles or precast concrete piles. The end result is a driven pile system that results in minimal levels of vibration during driving.

Figure 1:
Ductile Iron Pile Installation

Though driven, low vibration levels are actually an extremely important advantage of the Ductile Iron Pile system compared with other deep foundations. Experience highlighted in Figure 2 shows that peak particle velocities are well below 2 inches per second for installations of the 118 mm diameter piles with frequency levels typically ranging from 20 Hz to greater than 100 Hz. These vibrations diminish rapidly because of the high-frequency of the vibrations compared with traditional pile driving operations. As shown

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in Figure 2, 2 inches/second often represents a damage threshold criteria for high frequency vibrations (USBM, 1980). Measurements of vibration levels during installation of 118 mm diameter Ductile Iron Piles typically less than 1 in/sec at distances as close as 2 feet from the installation location. These low vibration levels further diminish rapidly with distance from the energy source and are typically less than 0.5 in/sec at distances of 5 feet from installation and less than 0.2 in/sec at distances of 10 feet based on field measurements, as shown in Figure 3.

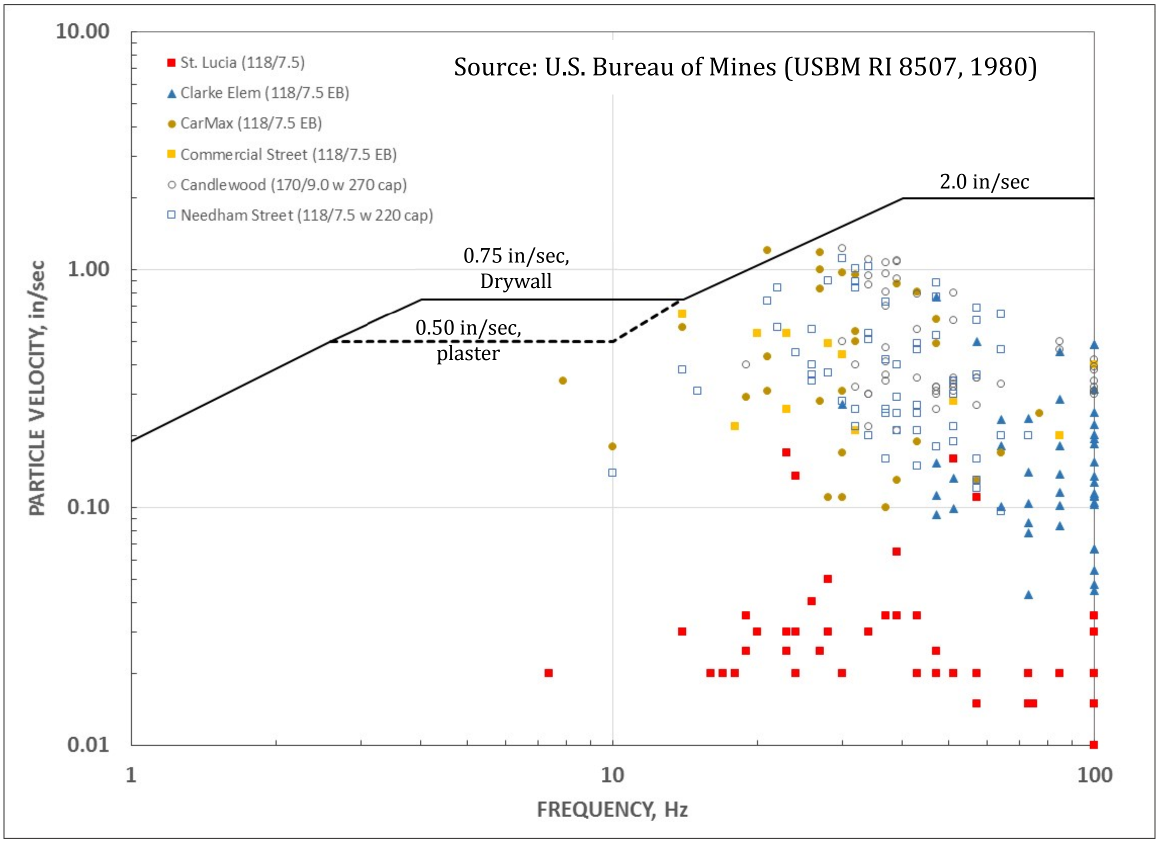

Figure 2: Typical Vibration Results versus Criteria

Vibration levels associated with the larger 170 mm Ductile Iron Piles or friction piles with oversized conical caps (220 mm to 370 mm) increase as a result of the increased areas of penetration. At the tested sites, the maximum values at distances of 5 feet away from the source are in the range of 0.5 to 1.0 in/sec and still fall well below the 2 in/sec threshold for vibration damage as shown in Figure 3.

Ductile Iron Piles are ideally-suited for urban conditions where vibrations are a concern. The system has been used successfully for building additions and adjacent to sensitive structures. Installations as close as about 18 inches to existing buildings are possible. The restriction of 18 inches is primarily due to clearance requirements to get the hammer into the tight work space adjacent to existing construction. Building overhangs and other aspects need to also be considered for clearance constraints. ***Since the generation of vibrations does depend on ground conditions and specific pile design, site-specific vibration monitoring using seismograph equipment is recommended when vibrations are a concern for a project.***

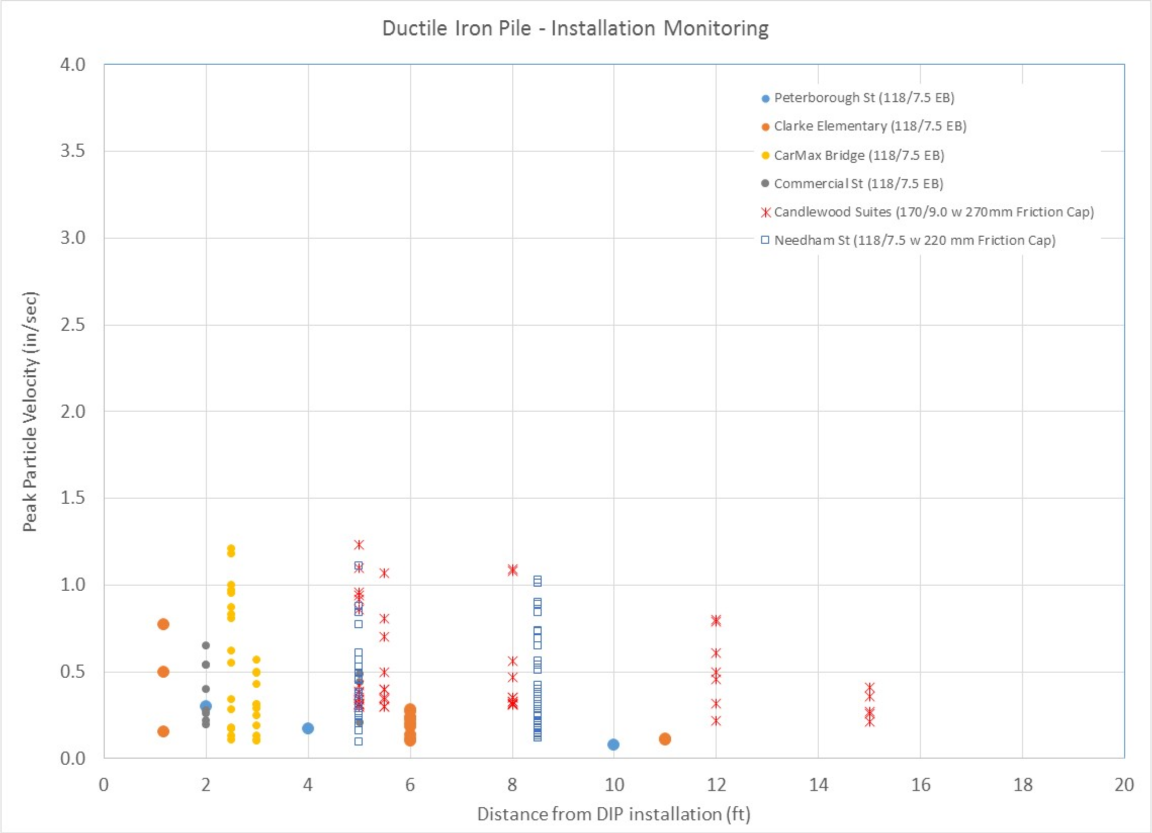

Figure 3: Typical Vibration Results with Distance from Driving

The sound levels generated from the hydraulic hammers installing Ductile Iron Piles is typically on the order of 110 to 112 dB at a distance of about 30 feet. The greatest amplitude of sound is generated during the initial driving when the majority of the pile is out of the ground. The sound levels can rapidly drop below 100 dB during penetration of the pile. Reduced values of sound levels are observed with the grouted piles because of the damping effect of the grout. Adequate hearing protection needs to be used by installation crews for safety. Furthermore, sound abatement devices may be used to reduce the sound levels generated during driving particularly near the metal-metal contact at the driving shank/pile connection. The abatement devices may consist of rubber belting or similar material that can be attached to the hammer on three sides and hangs down approximately 3 to 5 feet. The material further dampens the sound levels during driving.