NDT CORPORATION
Nondestructive & Geophysical Testing

Nondestructive Testing For Accelerated Bridge Construction Projects

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Nondestructive Testing for Accelerated Bridge Construction (ABC) Projects

Accelerated bridge construction (ABC) typically involves replacing a bridge superstructure and deck. This construction relies on the existing foundations (abutments, piers and subsurface piles) to support the new structure. Often bridge foundation information is not available or is questionable. Knowing the condition of the existing foundations is an important component of successful ABC projects. Nondestructive testing in ABC projects can determine:

- The condition of the existing reinforced concrete piers and abutments
- As-built details – reinforcing layers, depth of cover and spacing
- Thickness of abutment walls
- The length of pile foundations

Sonic/ultrasonic pulse velocity and impact echo, tomographic imaging, ground penetrating radar (GPR), pile pulse echo testing and borehole magnetic gradiometer testing are some of the nondestructive testing methods that engineers use to evaluate bridge foundations.

The replacement of bridge superstructures and decks as part of accelerated bridge construction (ABC) relies on the existing foundations to support the new structure. This requires engineers to assess the existing condition of the foundations, confirm as-built details and if as-built plans do not exist, determine how the foundations are constructed. Nondestructive testing is an accurate and effective means used by engineers to obtain this information. Sonic/ultrasonic pulse velocity and impact echo, tomographic imaging, ground penetrating radar (GPR), pile pulse echo testing and borehole magnetic gradiometer testing are some of the nondestructive testing methods used to evaluate bridge foundations.

To determine length of piles, sonic reflection measurements are taken from exposed ends of timber, sheet, precast, auger cast or H piles. The length or height of timber, concrete or pipe piles or caissons are determined by measuring the time required for a sonic/ultrasonic wave transmitted at the top of the pile to propagate to the end of the pile and be reflected back to the top of the pile.

NDT field crew acquiring parallel seismic data from a barge next to a pier in a river.

A geotechnical boring can also be used in determining steel pile lengths utilizing measurements from a down-hole magnetic gradiometer or parallel seismic measurements can be taken to determine timber pile lengths (Diagram A). Ferrous metal objects (steel sheet, pipe or "H" piling) have an associated magnetic field that is measureable with a borehole magnetic gradiometer. This instrument measures the strength of the magnetic field at two sensors. Steel piling acts like a dipole in the earth's magnetic field and consequently has a high magnetic gradient at the top and bottom ends. When the gradiometer passes by the bottom end of the steel pile, high amplitude positive and negative magnetic fields are recorded. When the gradiometer is below the end of the pile, the recorded magnetic gradient will be close to zero because there is no ferrous iron nearby. NDT field crew acquire parallel seismic data from a barge next to a pier in a river. Timber piles are high velocity while the surrounding soil materials are much lower velocity. Because the timber velocity values are higher than the surrounding soils, wave arrivals measured in a nearby borehole reveal the depth of the end of the pile.

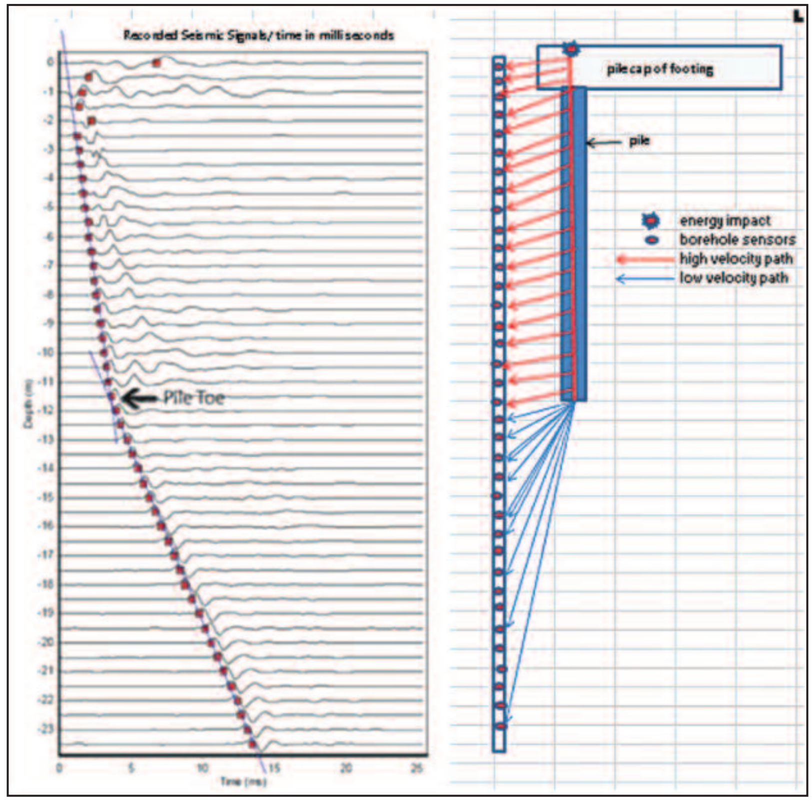

Diagram A: Parallel seismic measurements made in a borehole next to a timber pile to determine the length of the pile. These measurements use the timber pile as a waveguide and measure the time required for a wave generated on the pile cap to travel from the top of the pile to the end of the pile.

Nondestructive sonic/ultrasonic pulse velocity, impact echo and GPR measurements are used to determine average concrete strength, identify weak areas, determine reinforcing spacing and depth of cover and determine best locations for traditional coring of reinforced concrete piers and abutments. Sonic/ultrasonic pulse velocity measurements (the velocity of stress waves propagated through concrete) are used to evaluate concrete condition. Measured compressional and shear wave velocity values are the basis of calculations for material moduli values and average dynamic compressive strength values, as well as identifying and mapping low-velocity areas indicative of deteriorated, delaminated weak concrete. Impact echo data acquired simultaneously with pulse velocity data reveal delaminations, determine abutment thicknesses and identify areas of internal voiding or honeycombing. With access to two or more sides of a structure pulse velocity data can be acquired and evaluated with tomography imaging software. This software uses all the travel times acquired through a structure to make a best-fit velocity model of the data to produce a 2D velocity cross section (Diagram B) or a 3D velocity image of the interior of the structure. This testing is very effective in identifying internal areas of weakened (cracked, voided, honeycombed, etc.) concrete.

Ground penetrating radar (GPR) can be used to evaluate reinforcing schedules, as well as determine the approximate thickness of concrete and masonry abutments. GPR uses a transmitted, pulsed electromagnetic signal that reflects from a “target” (re-bar, wire, moisture etc.) back to the point of transmission. The wave transmission and reflection is dependent on the electrical properties (dielectric constant and conductivity) of the material(s) under evaluation. These electrical properties are highly dependent on moisture content in the concrete and saturated or moist conditions reflect energy and cause high attenuation. Accordingly, moisture entrapment in delaminations caused by corroded (swelling) reinforcing will produce high amplitude GPR reflectors. Metal reinforcing is also highly conductive and produces high amplitude (strong) reflectors of GPR signals. Nondestructive testing methods provide engineers with a valuable tool to assist in evaluating the construction and condition of bridge foundations. These testing methods determine:

- Pile length
- Reinforcing schedule
- Dynamic strength and condition of concrete elements

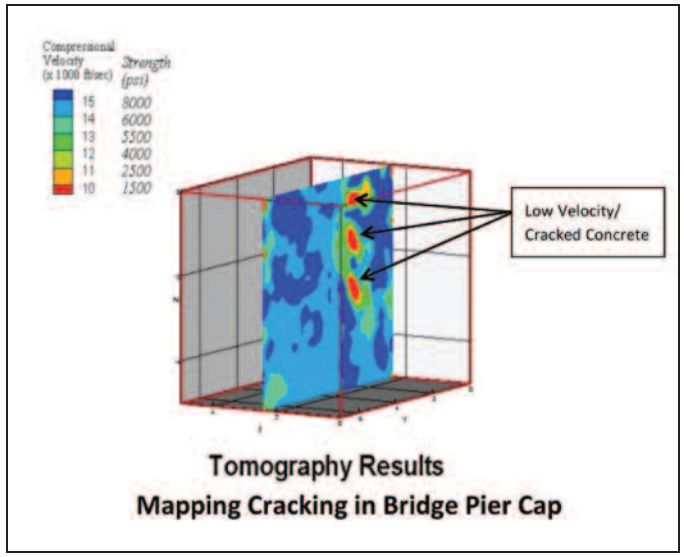

Diagram B: With access to two or more sides of a structure pulse velocity data can be acquired and evaluated with tomography imaging software. This software uses all the travel times acquired through a structure to make a best-fit velocity model of the data to produce a 2D velocity cross section or a 3D velocity image of the interior of the structure. This testing is very effective in identifying internal areas of weakened (cracked, voided, honey-combed, etc.) concrete.