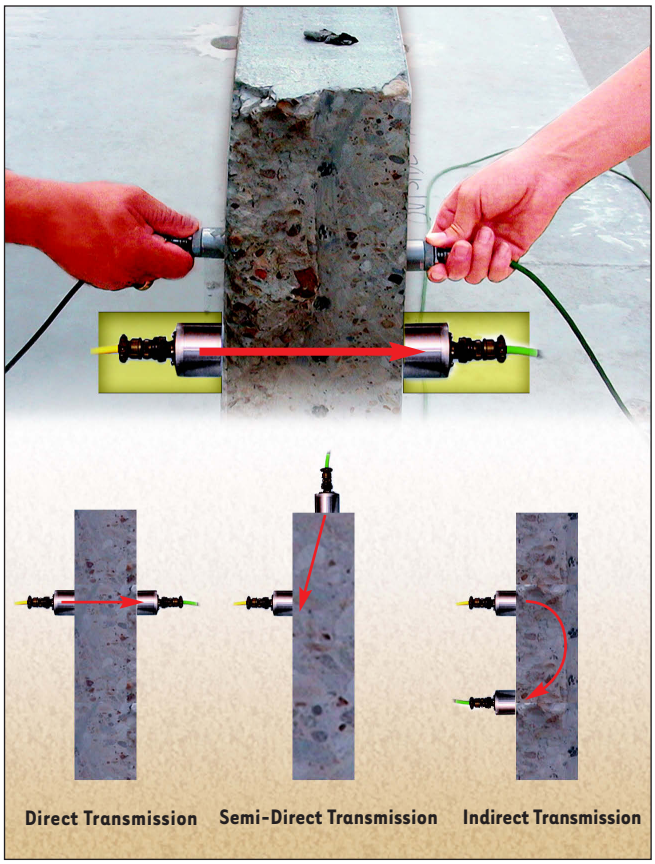
APPLICATION

Ultrasonic Pulse Velocity tests are performed to assess the condition of structural members with two-sided access such as elevated slabs, beams, and columns. Voids, honeycomb, cracks, delaminations, and other damage in concrete, wood, masonry, stone, ceramics, and metal materials can be identified and mapped with the method. UPV tests are also performed to predict strength of early age concrete. The UPV test relies on direct arrival of compressional waves. Sources and receivers used in the tests have resonant frequencies ranging from 50 to 150 kHz. The higher resonant frequency receivers are typically used with thinner structural members for higher resolution and smaller anomaly identification. In the basic UPV test, the first arrival times of the ultrasonic energy are registered by a V-meter. Olson Engineering records the full waveform with a digital oscilloscope card for troubleshooting of material condition.



STANDARDS

Standards for the UPV method include ASTM C597-02 Standard Test Method for Pulse Velocity through concrete, ASTM E494-95 for measuring ultrasonic velocity in materials, BSI 98/105795 DC for determining the ultrasonic velocity of concrete, and ACI 228.2R for NDE applications.

- **See end of document for full references.**

12401 W. 49th Ave., Wheat Ridge, CO 80033-1927 USA 303.423.1212

FIELD INVESTIGATION

ACCESS

Two surfaces are required to perform the test. Depending on the orientation of the two surfaces, the test is referred to as direct transmission test or semi-direct transmission test (see figure on previous page).

COLLECTION OF DATA

In a UPV test, a piezoceramic source is electrically pulsed to generate ultrasonic waves which travel in the structural element, and are sensed by the matching receiver on the opposite side of the test member. The source and receiver signals are recorded by an Olson Instruments Freedom Data PC Ultrasonic Pulse Velocity System (UPV-1) and stored for further analysis. Knowing the travel distance and travel time, the ultrasonic compressional wave velocity is calculated.

UPV scanning measurements are also possible with an Olson Instruments scanner source. Typically, the scanner source is moved along one of the accessible surfaces of the structural element, and a fixed receiver is placed on the opposite side to capture ultrasonic waves traveling at different angles. UPV scanning provides a fast, detailed check on interior concrete conditions. By collecting UPV scanner data at multiple angled raypaths, Tomographic Imaging (TI) can quickly be performed. The TI data collection pattern is shown on the previous page (cover of technical brief).

DATA REDUCTION

PROCESSING TECHNIQUES

The receiver output is recorded by a digital oscilloscope card in a PC. Three parameters are used in the interpretation of data: 1) arrival of compressional waves, 2) signal strength and 3) distortion of the transmitted signal. These parameters are automatically identified in the Olson Instruments UPV-1 system software.

INTERPRETATION OF DATA

In defect areas, the compressional wave velocity is slower than in sound areas and signal amplitude is often lower. For structural members containing large, severe voids, signal transmission may be completely lost. In some defect areas, such as honeycombs, the compressional wave velocity may be almost the same as in sound areas, but distortion of the signal (filtering of high frequencies) may be used as an indication of a honeycomb defect.

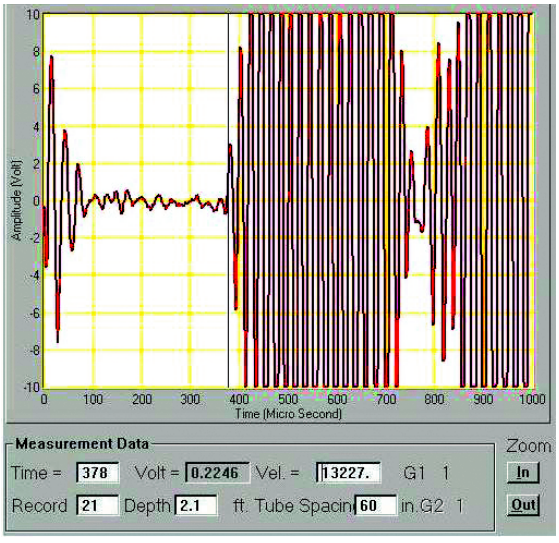
EFFECTIVENESS

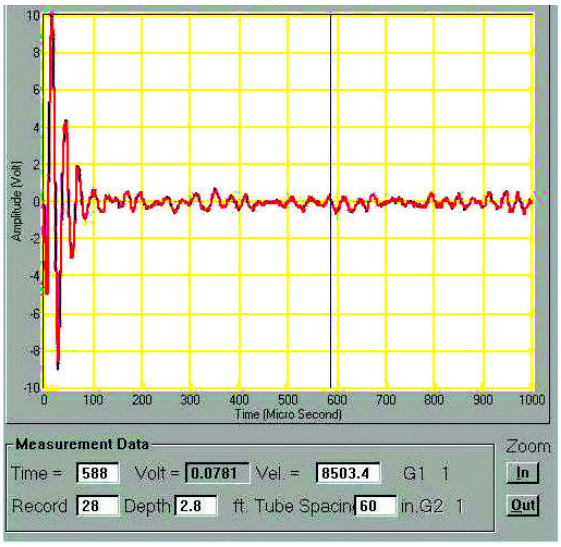
The method requires access to two surfaces, preferably two parallel surfaces such as the top and bottom surfaces of a slab or the inside and outside surfaces of a wall. UPV signals are sampled with a digital time period of 1 to 2 us.

EXAMPLE RESULTS

STRUCTURAL — CONCRETE COLUMN

To illustrate the concepts of UPV tests, example results from tests on a square concrete column (6 ft x 6 ft) are presented below. The first figure presented shows a strong signal where testing was performed through sound concrete. The second figure presented shows a very weak signal indicative of poorly consolidated concrete or wave travel through void conditions.





REFERENCES

Standards and Governmental Reports

- ACI 228.2R, "Nondestructive Test Methods for Evaluation of Concrete in Structures", *ACI Manual of Concrete Practice, Part 2, Construction Practices and Inspection*, Pavements, ACI International.
- ASTM C597-02, "Standard Test Method for Pulse Velocity Through Concrete", Book of Standards Volume 04.02, ASTM International.
- ASTM E494-95 (2001), "Standard Practice for Measuring Ultrasonic Velocity in Materials", Book of Standards Volume 03.03, ASTM International.
- BSI 98/105795 DC, "prEN 13296. Testing Concrete. Determination of ultrasonic pulse velocity", British Standards.

OLSON ENGINEERING, INC.

CORPORATE OFFICE:

12401 W. 49th Ave.
Wheat Ridge, CO 80033-1927 USA
Phone: 303.423.1212
Fax: 303.423.6071

- www.olsonengineering.com
- www.olsoninstruments.com
- info@olsonengineering.com