



## REMR TECHNICAL NOTE CS-ES-1.1

# SYSTEM FOR RAPID ASSESSMENT OF QUALITY OF CONCRETE IN EXISTING STRUCTURES

**PURPOSE:** To provide information on an ultrasonic pulse-velocity system for use in nondestructive testing of concrete in existing structures.

**APPLICATION:** Making rapid assessments of concrete quality and delineating areas of cracked concrete, inferior quality concrete, and deteriorated concrete. The method does not provide a precise measurement of the quality of concrete.

**ADVANTAGES:** The technique is nondestructive, expedient, and avoids use of expensive coring procedures.

**LIMITATIONS:** Two sides of the structure to be tested must be accessible. Moisture variations and the presence of reinforcing steel can affect the results, and skilled personnel are required to analyze the results.

**AVAILABILITY:** The Waterways Experiment Station maintains the capability to perform ultrasonic investigations of field structures. There are also some commercial testing laboratories that perform this service. Equipment for ultrasonic testing can be purchased from commercial suppliers if desired. At present, the only known source for ultrasonic equipment for testing concrete is James Instruments, Inc., 4048 North Rockwell St., Chicago, IL 60618.

**COSTS:** Costs of an ultrasonic investigation will be job-specific, depending on such factors as size of the structure, on-site support furnished to the surveying team, transportation of equipment and personnel, etc. The cost of standard ultrasonic testing equipment is approximately \$5500.

- REFERENCES:**
- a. Development of procedures for nondestructive testing of concrete structures; present practices. H. T. Thornton, Jr. US Army Engineer Waterways Experiment Station, Vicksburg, MS, Sep 1977. Miscellaneous Paper C-77-11, Report 1. (NTIS No. AD A046 113).
  - b. Ultrasonic velocity measurements in concrete, Lock and Dam No. 24, Mississippi River. H. T. Thornton, Jr., D. Glass. US Army Engineer Waterways Experiment Station, Vicksburg, MS, Apr 1980. Miscellaneous Paper SL-80-2. (NTIS No. AD A084095).
  - c. Standard test method for pulse velocity through concrete. In: 1984 Annual Book of ASTM Standards, Vol 04.02, American Society for Testing and Materials, Philadelphia, PA, Sep 1984. Designation C 597-83.

FIELD PERFORMANCE: The ultrasonic pulse-velocity system has been successfully used to evaluate concrete in many Corps of Engineers' locks, dams, and other types of structures across the US.

BACKGROUND: The procedure is given in ASTM C 597-83 (Ref c) . The ultrasonic pulse-velocity method involves measurement of the time-of-travel of electronically pulsed compressional waves through a known distance of concrete. From known time and distance, the pulse velocity through the concrete can be calculated. This method is used extensively in the field for determining the general quality of concrete, locating cracked and inferior concrete, and providing input to condition surveys of concrete structures. The equipment used is portable, has sufficient power to penetrate 50 to 70 ft of good continuous concrete, and has a high data acquisition-to-cost ratio. Standard transducers and those used in boreholes are available and serve to eliminate most problems of access to surfaces, including those underwater. Empirical correlations between pulse velocities and compressive strengths have proved very useful for specific structures and concretes and can be established with limited coring.

DESCRIPTION OF SYSTEM: The ultrasonic pulse-velocity system is an acoustic device. Energy is generated by a piezoelectric ceramic element and received by a piezoelectric crystal. A cathode tube displays the start of the generated signal and the arrival time of the received signal. Various time ranges are available. A cursor can be moved to coincide with the received signal, and the time is read off of an adjustable dial. Time can be measured to the nearest microsecond. The travel distance is divided by the time to determine the velocity. The following tabulation is a good general guide to the condition of concrete and the range of the corresponding velocity:

<u>Velocity, fps</u>	<u>Concrete Quality</u>
above 15,000	Excellent
12,000 to 15,000	Generally good
10,000 to 12,000	Questionable
7,000 to 10,000	Generally poor
below 7,000	Very poor

These values should be considered only as rule-of-thumb values. Concrete velocities will vary from mixture to mixture.