



Standard Test Method for Measuring the P-Wave Speed and the Thickness of Concrete Plates Using the Impact-Echo Method¹

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1. Scope

1.1 This test method covers procedures for determining the thickness of concrete slabs, pavements, bridge decks, walls, or other plate-like structure using the impact-echo method.

1.2 The following two procedures are covered in this test method:

1.2.1 *Procedure A: P-Wave Speed Measurement*—This procedure measures the time it takes for the P-wave generated by a short-duration, point impact to travel between two transducers positioned a known distance apart along the surface of a structure. The P-wave speed is calculated by dividing the distance between the two transducers by the travel time.

1.2.2 *Procedure B: Impact-Echo Test*—This procedure measures the frequency with which the P-wave generated by a short-duration, point impact is reflected between the parallel (opposite) surfaces of a plate. The thickness is calculated from this measured frequency and the P-wave speed obtained from Procedure A.

1.2.3 Both Procedure A and Procedure B must be performed at each point where a thickness determination is made.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

2. Referenced Documents

2.1 ASTM Standards:

C 597 Test Method for Pulse Velocity Through Concrete²

E 1316 Terminology for Nondestructive Examinations³

3. Terminology

3.1 Definitions:

3.1.1 *acoustic impedance*—the product of P-wave speed and density that is used in computations of characteristics of stress wave reflection at boundaries.

3.1.2 *amplitude spectrum*—a plot of relative amplitude versus frequency that is obtained from the waveform using a Fourier transform technique.

3.1.3 *Fourier transform*—a numerical technique used to convert digital waveforms from the time domain to the frequency domain.

3.1.3.1 *Discussion*—The peaks in the amplitude spectrum correspond to the dominant frequencies in the waveform.

3.1.4 *impact-echo method*—a send-receive nondestructive test method based on the use of a short-duration mechanical impact to generate transient stress waves and the use of a broadband receiving transducer placed adjacent to the impact point.

3.1.4.1 *Discussion*—Waveforms are converted to the frequency domain and the resulting amplitude spectra are analyzed to obtain the dominant frequencies in the structure's response to the impact. These frequencies are used to determine the thickness of the structure or the presence of flaws.

3.1.5 *impact duration*—the time that the impactor used to generate stress waves is in contact with the test surface. Also referred to as contact time.

3.1.5.1 *Discussion*—The impact duration is a critical aspect in the success of the two procedures covered by this method. Recommended impact durations are given. In practice, the impact duration will depend on the type of impactor and the condition of the concrete at the point of impact. Smooth, hard surfaces will result in shorter impact durations than rough, soft surfaces. The user should verify that the impact durations are within the recommended ranges. An approximate measure of the impact duration can be obtained from the portion of the waveform corresponding to the surface wave arrival.⁴ Fig. 1 shows an example of the surface-wave portion of a waveform and the approximate contact time is indicated.

3.1.6 *P-wave*—the dilatational (longitudinal or primary) stress wave which causes particle displacement parallel to the direction of wave propagation. This wave produces normal

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² Annual Book of ASTM Standards, Vol 04.02.

³ Annual Book of ASTM Standards, Vol 03.03.

⁴ Sansalone, M. and Streett, W.B., *Impact-Echo: Nondestructive Evaluation of Concrete and Masonry*, Bullbrier Press, Ithaca, NY and Jersey Shore, PA, 1997.