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Non-destructive testing — Acoustic emission testing — Measurement method for acoustic emission signals in concrete

Essais non destructifs — Contrôle par émission acoustique — Méthode de mesure pour les signaux d'émission acoustique dans le béton

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This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 9, *Acoustic emission testing*.

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Introduction

Acoustic emission (AE) techniques have been investigated in concrete engineering for more than a half century. Nowadays, results of AE research are put to practical use for infrastructures, not only concrete structures, but also masonry structures.

Concrete structures can deteriorate due to heavy traffic loads, fatigue, chemical reactions and unpredictable disasters, although concrete structures have long been referred to as maintenance-free. Eventually, retrofit and rehabilitation of the structures are in heavy demand all over the world. It results in the need for the development of advanced and effective inspection techniques prior to repair work. In this regard, AE techniques have been extensively studied in concrete engineering.

Focusing on crack detection and damage evaluation, it is known that AE techniques are prospectively applicable to concrete and concrete structures. Therefore, basic aspects on the measurement method for AE signals in concrete are prescribed. AE is an inspection technique, by which elastic waves due to cracking and damage in concrete are detected. Since AE phenomena are to be observed under in-service conditions, AE measurement can be conducted not only in a laboratory, but also on site.

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Non-destructive testing — Acoustic emission testing — Measurement method for acoustic emission signals in concrete

1 Scope

This document establishes a measurement method for acoustic emission signals in concrete.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12713, *Non-destructive testing — Acoustic emission inspection — Primary calibration of transducers*

ISO 12714, *Non-destructive testing — Acoustic emission inspection — Secondary calibration of acoustic emission sensors*

ISO 12716, *Non-destructive testing — Acoustic emission inspection — Vocabulary*

ISO/TR 13115, *Non-destructive testing — Methods for absolute calibration of acoustic emission transducers by the reciprocity technique*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12716 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
acoustic emission
AE
transient elastic waves generated by the release of energy within a material

3.2
AE signal
electrical signal detected at a sensor, which is converted through the detection of *AE wave* (3.3) (elastic wave)

3.3
AE wave
wave that can be detected in the form of *hits* (3.5) on one or more *channels* (3.4)

3.4
channel
one line of *AE signal* (3.2) detected by *AE* (3.1) sensor and processed by the other devices

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3.5
hit
given *AE* (3.1) *channel* (3.4) that has detected and processed one AE transient

3.6
event
group of *AE* (3.1) *hits* (3.5) received from a single source by two or more *channels* (3.4), of which spatial coordinates can be located

3.7
array
spatial arrangement of *AE* (3.1) sensors for spatially locating AE sources

3.8
attenuation
observed loss of a signal as it travels through a medium

3.9
noise
signal produced by causes other than *AE* (3.1) phenomena

Note 1 to entry: Elimination of noises is essential for effective detection of *AE signals* (3.2).

4 Detection of AE waves

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Microscopic fracture in concrete takes place with the release of stored strain energy as nucleating micro-cracks and generating elastic waves. These waves due to crack nucleation are referred to as AE waves, which propagate inside a material and are detected by an AE sensor as shown in Figure 1.

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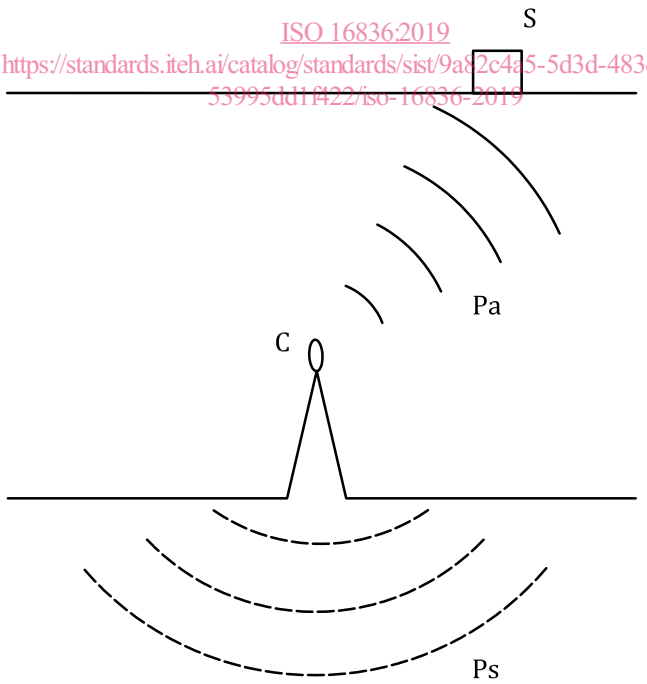

Key

S detection of AE waves by an AE sensor
Pa propagation of AE waves
C nucleation of a crack
Ps propagation of sound waves in air

Figure 1 — Detection of AE waves

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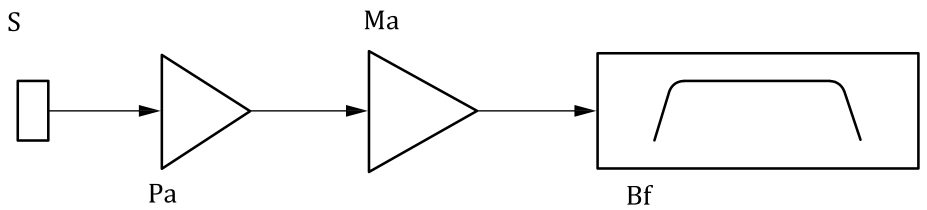
5 Measuring system

5.1 General

A basic system is illustrated in Figure 2, where only analog devices are shown. Following this system, a digital signal-processor is usually applied.



Key
S AE sensor
Pa pre-amplifier
Ma main amplifier
Bf band-pass filter

Figure 2 — AE measurement system

5.2 Sensor

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AE sensors shall be sensitive enough to detect AE signals generated in the target structure, taking acoustic coupling into consideration. They convert elastic waves (motions) on the surface of a material into electric signals, preferably, without any distortions. A resonance-type sensor is most sensitive around the resonant frequency, while a broad-band sensor has approximately flat response in the range but is less sensitive than the resonance-type. AE sensor shall be robust enough against temperature change, moisture condition and mechanical vibrations in the environments.

Refer to Annex A for recommended types of sensors to be used in the concrete.

Sensitivity calibration of AE sensors shall be performed by employing the standard source, in addition to the calibration methods prescribed in ISO 12713 and ISO 12714. A simulated AE source due to pencil-lead break is defined in ASTM E976. This standard source is illustrated in Figure 3, where a guide ring is recommended to be employed.

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