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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 32073.1-2025

Replacing GB/T 32073-2015

Non-destructive testing - Ultrasonic method for measuring residual stress - Part 1: Critically refracted longitudinal wave method

无损检测 测量残余应力的超声检测方法 第1部分：临界折射纵波法

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1 Scope

GB/T 32073.1-2025 is the Chinese national standard covering measuring residual stress with sound - a longitudinal wave travelling just under the surface changes speed by a few parts in ten thousand with the stress it passes through, and that shift is the measurement. It is non-destructive, unlike hole drilling, which is why it is worth the difficulty. It replaces GB/T 32073-2015, splitting it into parts with Part 2. It was issued on 31 December 2025 and has been in force since 31 December 2025, replacing GB/T 32073-2015. The document is under the responsibility of the Standardization Administration of China. This page is published from the official record of the 2025 edition; the clause text of a standard this recent is not yet in circulation, and the figures, limits and tables it contains are those of the document itself, delivered in full with the English translation.

This document describes the ultrasonic testing method for testing residual stress based on critical refraction longitudinal wave, specifies the testing system, testing procedures, temperature compensation and correction, and testing report for the critical refraction longitudinal wave method. This document applies to the testing of residual stress and load stress in metallic materials with a sound transmission rate of not less than 6 dB/m sound path attenuation. Other non-metallic materials shall be handled with reference to this method.

2 Normative references

The following referenced documents are indispensable for the application 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.

GB/T 228.1 Metallic materials - Tensile testing - Part

3 Terms and definitions

For the purpose of this document, the terms and definitions defined in GB/T 12604.1 apply.

4 Testing overview

When an ultrasonic longitudinal wave excited by a transmitting transducer is obliquely incident on the surface of the component under test at the first critical angle, according to the law of refraction, an ultrasonic critical refraction longitudinal wave can be generated inside the material of the component under test, and can be received by a receiving transducer. The principle of transmitting and receiving ultrasonic critical refraction longitudinal waves and the residual stress testing area are shown in Figure 1. According to the principle of acoustoelasticity, residual stress in the material affects the propagation speed of ultrasonic waves. When the direction of residual stress is consistent with the direction of the longitudinal wave, tensile stress slows down the propagation speed of the ultrasonic longitudinal wave or prolongs the propagation time t, while compressive stress speeds up the propagation speed of the ultrasonic longitudinal wave or shortens the propagation time t. Therefore, under the condition that the distance between the transmitting and receiving transducers (probe spacing) remains constant, if the ultrasonic propagation time t0 corresponding to the reference zero stress sigma0 and the ultrasonic propagation time t corresponding to the stress sigma of the component under test are measured, the absolute value of the residual stress sigma in the component under test can be calculated according to formula (1) or formula (2) based on the time difference, i.e.. where. Deltasigma - the change in residual stress (stress difference), Deltasigma = sigma - sigma0; Deltat - the change in propagation time (acoustic time difference), Deltat = t - t0; K - the stress coefficient, which is related to the material of the component under test, the coupling state, and the probe spacing, and can be obtained through tensile test calibration (see 6.3). Figure 1 -- Ultrasonic critical refraction longitudinal wave transmission and reception principle and residual stress testing area The stress measured by the method specified in this document is the average residual stress along the direction of sound wave propagation within a three-dimensional spatial region inside the material beneath the surface of the component under test.

5.1 Ultrasonic testing instrument

5.1.1 General requirements The residual stress ultrasonic testing instrument shall have at least the following functions.

a) frequency setting;

c) ultrasonic excitation voltage control;

d) ultrasonic receiving gain control;

e) calculation of ultrasonic critical refraction longitudinal wave propagation time and residual stress value.

5.1.2 Testing instrument calibration The testing instrument shall be periodically calibrated to confirm the accuracy of its test values. The performance calibration method is specified in JJF (machinery) 1056.The calibration interval shall not exceed one year.

5.2 Probe

5.2.1 It shall enable the transmission and reception of ultrasonic critical refraction longitudinal waves.

5.2.2 The probes used for testing (containing at least two transducers) shall be tested according to the method specified in GB/T 18852, and their performance parameters shall be identical.

5.2.3 The probes used for testing shall be the same probes used for stress coefficient calibration and reference zero-stress calibration.

5.2.4 The probe contact surface shall be well coupled to the surface of the component under test. If the surface of the component under test is curved, the coupling state shall comply with the provisions of

7.3.4 in GB/T 11345-2023.

5.3 Coupling agent An appropriate coupling agent shall be used to ensure stable and reliable ultrasonic coupling between the probe and the surface of the component under test within the operating temperature range. The same coupling agent shall be used and the same coupling state shall be maintained during stress coefficient calibration, reference zero- stress calibration, and testing.