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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 34370.12-2024

**Nondestructive testing of amusement equipments - Part 12:
Phase-array ultrasonic testing methods for bolts**

游乐设施无损检测 第12部分：螺栓相控阵超声检测

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1 Scope

GB/T 34370.12-2024 is Part 12 of the Chinese series on non-destructive testing of amusement equipment, and gives the phased array ultrasonic method for bolts. Amusement rides are special equipment in China, inspected on a fixed cycle, and a fatigue crack in a structural bolt is one of the few failures that can drop a car full of people; the bolt cannot usually be removed, so the crack has to be found through the head, in place. Phased array makes that practical by steering the beam down the shank and imaging the reflectors. The standard describes the testing principle, the safety and personnel requirements, the equipment - the instrument, the probes, the combined system performance, the reference

blocks and the couplant - and the testing and evaluation of crack indications. It applies to steel bolts of 10 to 100 mm outside diameter and up to 1000 mm long, and took effect on 1 December 2024.

This Document describes the phase-array ultrasonic testing and result evaluation method for crack defects in bolts of amusement facilities. This Document is applicable to the in-situ ultrasonic testing of steel bolts with an outer diameter of no less than 10 mm and no more than 100 mm and a length of no more than 1 000 mm for amusement facilities. The phase-array ultrasonic testing of steel bolts and shafts (pins) for amusement facilities, cableways and other mechanical equipment shall be implemented as a reference.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 12604.1 Non-destructive testing - Terminology - Terms used in ultrasonic testing

GB/T 20306 Amusement devices terminology

GB/T 34370.1 Nondestructive testing of amusement equipment - Part 1: General requirement

GB/T 34370.5 Nondestructive testing of amusement equipment - Part 5: Ultrasonic testing

GB/T 41114 Non-destructive testing - Ultrasonic testing - Specification for a calibration block for phased array testing (PAUT)

GB/T 42399.1 Non-destructive testing instruments - Characterization and verification of ultrasonic phased array equipment - Part 1: Instruments

GB/T 42399.2 Non-destructive testing instruments - Characterization and verification of ultrasonic phased array equipment - Part 2: Probes

GB/T 42399.3 Non-destructive testing instruments - Characterization and verification of ultrasonic phased array equipment - Part 3: Combined system

3 Terms and Definitions

For the purposes of this Document, the terms and definitions given in GB/T 12604.1, GB/T 20306, GB/T 34370.1, GB/T 34370.5 and the following terms and definitions apply.

3.1 Circumferential planar array A plurality of wafers on the same plane are arranged circumferentially to form a single-layer annular planar array probe.

3.2 Circumferential scan The scanning method that the aperture center of the excitation

sound beam steps around the center of the probe; and the sound beam is dynamically focused on the sound beam of the corresponding cylindrical busbar.

3.3 Cylindrically B-scan view The sound field image formed on the circular section parallel to the sound beam and perpendicular to the scanning surface of the cylindrical workpiece under test is displayed in a color or grayscale manner to represent the amplitude of the ultrasonic signal.

3.4 Circumferential C-scan view The sound field image formed on the cross section parallel to the bolt scanning surface is displayed in color or grayscale to represent the amplitude of the ultrasonic signal within the preset time window.

4 Principle of Testing

According to the set delay law, some array elements of the circumferential planar array probe are excited. The synthetic sound beam has the functions of radial small-angle deflection, circumferential focusing and continuous scanning of the sound beam. The ultrasonic signal received by each array element is then processed in a circumferential scanning manner according to the same delay law or dynamic focusing, and the discontinuous information inside the bolt is displayed by A-scan, cylindrical B-scan or circumferential C-scan, as shown in Figure 1.

7.1 Basic requirements

7.1.1 Ultrasonic testing equipment shall at least include probe, phase-array ultrasonic detector, standard test block, comparison test block, coupling agent. If there are rust stains or raised lettering on the tested surface, grinding tools shall be prepared.

7.1.2 The probe, phase-array ultrasonic detector, standard test block, and comparison test block in the ultrasonic testing equipment shall have a product quality certificate or qualified certification documents.

7.1.3 The calibration, verification, periodic verification, and inspection of ultrasonic testing equipment and instruments shall be carried out in accordance with the requirements of GB/T 34370.1 and GB/T 34370.5.

7.2 Testing instruments In addition to meeting the requirements of GB/T 42399.1, ultrasonic detectors shall also meet the following requirements:

a) The measured value of the transmitted pulse repetition frequency of the phase-array ultrasonic detector shall not exceed 10% from the nominal value; the measured value of the transmitted pulse voltage shall not exceed 20% from the nominal value; the measured value of the transmitted pulse width shall not exceed 10% from the nominal value; and the transmit pulse rise time shall be less than

0.25 times the nominal frequency cycle time of the highest probe that may be used;

b) The operating frequency of the phase-array ultrasonic detector shall be measured at -3 dB and include at least a range of

0.5 MHz to 15 MHz; and the error between the measured value and the nominal value of the upper and lower limits of each frequency band shall not exceed 10%;

c) The phase-array ultrasonic detector shall have no less than 16/64 receiving excitation channels and shall have a circumferential scanning function;

d) The gain range is 0 dB to 80 dB; and the minimum adjustment step is no greater than 0.5 dB;

e) The scanned image has A-scan view, cylindrically B-scan view, and circumferential C-scan view functions.

7.3 Probe In addition to meeting the requirements of GB/T 42399.2, the phase-array probe shall also meet the following requirements.

a) The ultrasonic phase-array detection probe shall be a circumferential planar array probe, and shall also include a linear array probe.

7.4 System combination performance of ultrasonic testing instrument and probe

7.4.1 In addition to meeting the requirements of GB/T 42399.3, the system combination performance of ultrasonic testing instrument and probe shall also meet the following requirements:

a) Vertical linearity: deviation is no greater than 5%;

b) Horizontal linearity: deviation is no greater than 1%;

c) Sensitivity margin: at the maximum detection sound range, when detecting a 1 mm artificial groove, the sensitivity margin is no less than 10 dB;

d) The probe frequency matches the instrument bandwidth, and the error is no greater than 10%;

e) Longitudinal resolution: when using a 5 MHz probe, it is no greater than 2 mm.

7.4.2 The system combination performance of the testing instrument and probe shall be measured in the following situations:

a) Newly purchased ultrasonic testing instruments and (or) probes;

b) After the testing instrument and probe have been repaired or the main components have been replaced; By manually adjusting the time gain compensation (TCG) curve, the echo height of the artificial groove at different sound paths on the bolt comparison block is adjusted to 80% of the screen height as the reference sensitivity; and then the gain 6 dB again as the detection sensitivity.