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Nondestructive testing of amusement equipment - Part 10:

Magnetic memory testing

游乐设施无损检测 第 10 部分: 磁记忆检测

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Table of Contents

Foreword.....	3
1 Scope.....	4
2 Normative references.....	4
3 Terms and definitions.....	5
4 Method overview	5
4.1 Magnetic memory phenomenon	5
4.2 Principle of magnetic memory testing	5
4.3 Advantages and characteristics	6
4.4 Limitations	7
5 Safety requirements	7
6 Personnel requirements	7
7 Testing equipment	7
7.1 Testing instruments	7
7.2 Working principle of testing instrument	8
7.3 Probe	8
7.4 Standard magnetic field	8
7.5 Instrument measurement parameter performance requirements	8
7.6 Calibration of testing instruments	9
8 General testing procedures.....	9
9 Preparation before testing	10
9.1 Obtaining basic information on the equipment under inspection	10
9.2 Surface conditions.....	10
9.3 Preparation of testing equipment and technical documentation	11
9.4 Limiting factors.....	11
10 Testing procedures	12
10.1 Determination of interference factors	12
10.2 Scanning speed	12
10.3 Inspection of base materials of inspected components	12
10.4 Inspection of welds	13
10.5 Analysis and processing of test data	13
11 Evaluation of test results	13
11.1 Evaluation of stress concentration	13
11.2 Verification of test results.....	14
12 Test records and reports	15
12.1 Test records	15
12.2 Test report	15

Nondestructive testing of amusement equipment - Part 10:

Magnetic memory testing

1 Scope

This part of GB/T 34370 specifies the magnetic memory testing and result evaluation methods for amusement rides.

This part is applicable to the magnetic memory testing of ferromagnetic material components and welds of amusement rides, and austenitic stainless steel components and welds that are magnetic under certain conditions.

2 Normative references

The following documents are essential for the application of this document. For any referenced document with a date, only the version with the date applies to this document. For any referenced document without a date, the latest version (including all amendments) applies to this document.

GB/T 12604.11 Non-destructive testing - Terminology - Terms for X-ray digital radioscopic testing

GB/T 20306 Amusement devices terminology

GB/T 26641 Non-destructive testing - Magnetic memory testing - General requirements

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

GB/T 34370.2 Nondestructive testing of amusement equipment - Part 2: Visual examination

GB/T 34370.3 Nondestructive testing of amusement equipment - Part 3: Magnetic particle testing

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

3 Terms and definitions

The terms and definitions defined in GB/T 12604.11, GB/T 20306, GB/T 26641 and GB/T 34370.1 apply to this document.

4 Method overview

4.1 Magnetic memory phenomenon

In a weak magnetic field environment, ferromagnetic metal materials produce irreversible residual magnetism in local areas under the influence of external environmental factors (such as load, temperature, and mechanical processing or collision), which is manifested as the local magnetic field changes on the surface of the ferromagnetic material still remain after the external environmental factors are eliminated.

4.2 Principle of magnetic memory testing

The principle of magnetic memory testing is based on the magneto-mechanical effect of non-uniform stress and strain. The uneven organization or stress in the material will lead to uneven magnetization intensity, thus forming a leakage magnetic field on the surface of the material. This principle is used in magnetic memory testing; magnetic field mutation signals are obtained by measuring the distribution of the inherent leakage magnetic field on the surface of the test piece without applying an artificial excitation magnetic field and used to detect possible stress concentration, material degradation or material damage on the test piece. The basic principle of the magnetic memory testing method is shown in Figure 1. The magnetic memory signal is the magnetic field component of the magnetic field on the surface of the test piece (usually the components in the normal and scanning directions, or multi-dimensional components).

- g) Particularly suitable for carbon steel components subjected to alternating loads.

4.4 Limitations

The limitations of the magnetic memory testing method are as follows:

- a) Not applicable to non-ferromagnetic materials;
- b) It is difficult to determine the nature and size of defects in the material;
- c) Susceptible to artificial magnetization.

5 Safety requirements

This chapter does not list all safety requirements when performing tests. Users of this part shall establish safety criteria before testing.

The safety requirements during the testing process are at least as follows:

- a) The testing personnel shall comply with the safety requirements at the site and wear protective work clothes and relevant protective equipment according to the requirements of the testing location;
- b) Care shall be taken to avoid various safety hazards, such as bumps, electric shocks, falls, squeezing, shearing, entanglement, slips, and drowning;
- c) When the inspection is carried out during and after the equipment operates, attention shall be paid to the operating status and temperature status of the test piece to avoid damage to the equipment and burns to personnel.

6 Personnel requirements

Personnel engaged in magnetic memory testing of amusement rides shall comply with the relevant provisions of GB/T 34370.1.

7 Testing equipment

7.1 Testing instruments

The testing instrument shall have a screen to display the test parameter graph, a microprocessor recording device, a storage unit, and a dedicated scanning probe device. The ability to transfer data from the instrument to the computer shall be ensured. The

software package supplied with the instrument is used to process the test results on the computer.

The testing instrument shall have at least the following functions:

- a) It can detect the magnetic flux density on the surface of the object being tested;
- b) It can eliminate the influence of external environmental magnetic field;
- c) It can display the magnetic flux density value and the curve changing with time and space in real time;
- d) It can store test data and transfer it to a computer.

7.2 Working principle of testing instrument

The working principle of the instrument is to place the magnetic sensitive element on the surface of the test object to detect and record the spatial magnetic field signal.

7.3 Probe

The type of magnetic field probe is determined by the detection method and object. The probe has at least two magnetic field measurement sensors, one for measuring the magnetic field on the surface of the component and one for detecting and offsetting the external earth magnetic field. The probe housing shall also have an electronic amplification unit for the measured magnetic field and a displacement sensor for measuring the length of the inspected area.

7.4 Standard magnetic field

The standard magnetic field is used for the calibration of magnetic memory testing instruments. The standard magnetic field can be generated by the instrument or by a permanent magnet. The standard magnetic field shall generally be in the range of 40 A/m~2000 A/m and can be adjusted.

7.5 Instrument measurement parameter performance requirements

The measurement parameter performance of the instrument shall meet the following requirements:

- a) The relative error of magnetic field measurement shall not exceed $\pm 5\%$;
- b) The relative error of length measurement shall not exceed $\pm 5\%$;

- i) Timing of testing;
- j) Testing process and data analysis and interpretation;
- k) Evaluation of test results;
- l) Archiving of test records, reports and information;
- m) Preparation, review and approval personnel;
- n) Date of preparation.

9 Preparation before testing

9.1 Obtaining basic information on the equipment under inspection

Before testing, it is necessary to obtain some basic information through data review and on-site inspection, which shall at least include the following elements:

- a) Qualifications of testing personnel;
- b) Inspection plan;
- c) Previous history of metal magnetism and demagnetization factors;
- d) Metal corrosion and structural inhomogeneity;
- e) The outer surface condition of the test object;
- f) Composition or grade of base material;
- g) Type of weld filler metal;
- h) The location and range of the weld to be inspected;
- i) Weld surface geometry;
- j) Surface condition;
- k) Coating type and thickness;
- l) Other information that is helpful for defect judgment.

9.2 Surface conditions

The surface must be clean and free of dirt. No magnetic bonding layer is allowed. The

10 Testing procedures

10.1 Determination of interference factors

The determination of interference factors shall at least consider the following elements:

- a) Confirm the original surface magnetic field of the component under test. It is recommended to keep a distance of 20 mm from the component under test;
- b) Confirm the intensity of the interference magnetic field around the component under test. If the intensity of the interference magnetic field exceeds 5 times the intensity of the earth's magnetic field, it is recommended to eliminate the interference source;
- c) Confirm the sensitivity and range of the sensor.

10.2 Scanning speed

The scanning speed during detection shall not exceed 0.5 m/s.

10.3 Inspection of base materials of inspected components

The inspection of the base material of the inspected component shall at least consider the following factors:

- a) Determine the surface condition of the inspected component, set the probe and scan the coverage area;
- b) Place the probe vertically on the surface of the component to be inspected;
- c) Determine the scanning direction and perform multiple horizontal scans to ensure 100% coverage of the inspected area; two adjacent scans shall ensure that the probe coverage area has a 10% overlap;
- d) Continuously or discontinuously scan and detect on the surface of the inspected component and record the normal component and (or) tangential component of the surface magnetic field;
- e) Determine the abnormal part of the magnetic memory signal and the location of the zero-value line of the magnetic field on the surface of the test piece, and mark them;
- f) If necessary, conduct a vertical scanning inspection on the above-mentioned

parts.

10.4 Inspection of welds

The inspection of welds shall at least consider the following factors:

- a) Place the probe vertically on the surface of the weld area to be inspected.
- b) Horizontal scan along the center line of the weld and the heat-affected zone on both sides of the weld (if the single scanning probe cannot cover 100% of the inspected area, multiple scanning shall be performed) and record the normal component and/or tangential component of the surface magnetic field.
- c) Deviate a certain distance from the center line of the weld, perform vertical scanning inspection on the weld, and record the normal component and/or tangential component of the surface magnetic field.
- d) Determine the abnormal part of the magnetic memory signal and the location of the zero-value line of the magnetic field on the weld and mark them.

NOTE: If the actual heat-affected zone of the weld has been measured and recorded, the starting point of the scan is at least 10 mm outside the actual heat-affected zone; if the actual heat-affected zone of the weld is unknown, the starting point of the scan is at least 25 mm outside the weld fusion line.

10.5 Analysis and processing of test data

During the test, the graphs of magnetic field intensity changing with the probe scanning distance and the graphs of magnetic field gradient changing with the probe scanning distance shall be analyzed. Any part with sudden changes in magnetic field intensity and gradient is defined as an abnormal part of the magnetic memory signal; the surface of the part shall be observed. After eliminating the influence of surface geometry on the magnetic memory signal, the part shall be marked on the test piece.

11 Evaluation of test results

11.1 Evaluation of stress concentration

11.1.1 The degree of stress concentration at the abnormal part of the magnetic memory signal can be evaluated by determining the gradient k_i of the abnormal magnetic memory signal H_P (vertical component or tangential component):

12 Test records and reports

12.1 Test records

The test data and related information shall be recorded in accordance with the requirements of the test process procedures; in addition, the content of the test report shall be at least included. The preservation of all records shall comply with the requirements of relevant laws, regulations, standards and (or) contracts.

12.2 Test report

The content of the test report shall be formulated according to the test requirements and shall at least include the following:

- a) Name of the testing organization (if applicable);
- b) Equipment under inspection;
- c) Inspected components;
- d) Material and heat treatment status of the inspected components;
- e) Welds and types of inspected components;
- f) The stress state of the inspected component;
- g) Description of surface condition;
- h) The inspected parts indicated by a diagram;
- i) Testing conditions;
- j) Detection probes and instruments;
- k) Detection and analysis software;
- l) Calibration report of detection probes and instruments;
- m) Location and section name of the stress concentration zone;
- n) The value of the magnetic field H_P and its gradient k_i in the stress concentration zone;
- o) Supplementary test results of other non-destructive testing methods in the stress concentration zone (if necessary);

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