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**Non-destructive Testing - Ultrasonic Testing - Technique of
Testing Claddings Produced by Welding, Rolling and
Explosion**

无损检测 超声检测

焊接、轧制和爆炸复合覆层检测技术

(ISO 17405:2014, MOD)

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Non-destructive Testing - Ultrasonic Testing - Technique of Testing Claddings Produced by Welding, Rolling and Explosion

1 Scope

This document specifies the technique of manual ultrasonic testing of claddings formed by welding, rolling and explosion with steel as the base material using single or double crystal probes.

This document is applicable to the testing of planar or volumetric discontinuities of the claddings and interfaces.

This document does not stipulate the clauses for acceptance inspection, nor does it define the scope of testing.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in the text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 12604.1 Non-destructive Testing - Terminology - Ultrasonic Testing (GB/T 12604.1-2020, ISO 5577:2017, MOD)

GB/T 19799.1 Non-destructive Testing - Ultrasonic Testing - Specification for Calibration Block No.1 (GB/T 19799.1-2015, ISO 2400:2012, IDT)

ISO 22232-1 Non-destructive Testing - Characterization and Verification of Ultrasonic Test Equipment - Part 1: Instruments

ISO 22232-2 Non-destructive Testing - Characterization and Verification of Ultrasonic Test Equipment - Part 2: Probes

ISO 22232-3 Non-destructive Testing - Characterization and Verification of Ultrasonic Test Equipment - Part 3: Combined Equipment

3 Terms and Definitions

What is defined in GB/T 12604.1, and the following terms and definitions are applicable to this

document.

3.1 test object

Test object refers to the component under test.

4 Ultrasonic Testing System

4.1 General Rules

The testing adopts ultrasonic pulse reflection technique. For planar and volumetric discontinuities parallel to the test surface, a straight probe (single crystal or double crystal) and longitudinal waves shall be adopted for the testing.

For discontinuities in other directions, longitudinal-wave double crystal angle probe or transverse-wave angle probe may be adopted for the testing.

The nominal frequency of the probe shall be selected in accordance with the testing purpose and material characteristics.

The probe frequency should be 2 MHz ~ 6 MHz. If the test verifies that the sensitivity satisfies the requirements, probes with other frequencies can also be used.

The performance of the ultrasonic testing instrument shall comply with the requirements of ISO 22232-1. The performance of the probe shall comply with the requirements of ISO 22232-2.

The combined performance of the testing system shall be regularly inspected in accordance with ISO 22232-3.

4.2 Requirements for Probes

4.2.1 Longitudinal-wave single crystal straight probe

The depth range of optimal sensitivity depends on the dimensions of the crystal plate. The depth range should be determined based on the area where discontinuities are expected to be detected.

4.2.2 Longitudinal-wave double crystal straight probe

The depth range of optimal sensitivity (see Appendix A) depends on the dimensions of the crystal plate and the roof angle. The depth range should be determined based on the area where discontinuities are expected to be detected.

4.2.3 Longitudinal-wave double crystal angle probe

The longitudinal-wave refraction angle should be between 65° ~ 80° . The selection of the tilt angle, shape and dimensions of the crystal plate shall ensure that the depth range of optimal sensitivity (see Appendix A) can cover the area where discontinuities are expected to be detected.

Description of indexes:

1---probe;

2---focal zone length;

3---focal length;

X---reflector depth;

Y---echo height.

NOTE: when using the reference test block in the Figure, it should be ensured that all reference reflector echoes with unmarked dimensions are effectively identified.

Figure 2 -- Reference Test Block for the Determination of Focal Zone Length of Double Crystal Angle Probe

4.4.2 Sensitivity settings

For sensitivity settings, the reference reflector (shape and dimensions) should be selected based on the type of discontinuities expected to be detected.

The reference test block with the same or similar compound process as the test object shall be selected to adjust the sensitivity. The cladding thickness, surface state and shape of the reference test block shall be the same as those of the test piece (see Chapter 5). If the probe is surface matched with the test surface of the test object, the reference test block shall have a curved surface state that matches the probe, as shown in 4.2.5.

For the testing of volumetric discontinuities, the reflector is a transverse hole, for example, a transverse hole with a specification of $\phi 3 \text{ mm} \times 30 \text{ mm}$ located near the interface of the base material can be used (see Figure 3).

For claddings connected by fusion welding, one transverse hole shall be perpendicular to the direction of the weld and the other transverse hole shall be parallel to the direction of the weld. For claddings connected by two or more layers of fusion welding, corresponding transverse holes shall be machined on each cladding.

For the testing of discontinuities parallel to the test surface, when using a straight (single crystal or double crystal) probe, flat-bottomed holes should be used to set the sensitivity.

For planar discontinuities perpendicular to the test surface, an angle probe should be used to set the sensitivity on the reflector groove.

Position 1, Position 2 and Position 3 shown in Figure 3 represent the mode of generating reference reflector echoes when the ultrasonic testing instrument is used to set the testing sensitivity. The echo amplitude should be adjusted to 80% of the full screen.

Description of indexes:

1---Position 1;

2---Position 2;

3---Position 3;

4---cladding;

a---thickness of test block;

b---width of test block;

c---length of test block;

d---the distance between the reflector and the edge of the test block;

e---the distance between the reflector and the edge of the test block;

A---self-transmitting and self-receiving straight probe;

B---one-transmitting and one-receiving angle probe.

NOTE: the selection of *a*, *b*, *c*, *d* and *e* dimensions should ensure good coupling between the probe and the test object, and the shape of the test block does not affect the gain setting.

Figure 3 -- Sensitivity Settings of Reference Test Block with Cladding

5 Test Preparation

If it is specified that discontinuities generated in a certain particular stage of the manufacturing process shall be tested, then, the testing shall be performed after the completion of that stage.

Before the testing, the size of the test area shall be determined.

In the test area, the test surface should be well prepared for the testing, so that the probe and the workpiece are well coupled. The surface condition shall satisfy the signal-to-noise ratio requirements specified in 4.4.2.

6 Test Procedures

6.1 General Rules

When selecting the testing technique (probe, coupling area and probe scanning method), the type and direction of the typical discontinuities that may be present shall be considered based on the type of cladding.

b) Basic information of test:

- 1) Testing personnel;
- 2) Testing date;
- 3) Testing instrument;
- 4) Probes;
- 5) Instrument gain;
- 6) Reference test block;
- 7) Test object (compound type, base material and cladding material);
- 8) Testing type (test area);
- 9) Condition of test surface;
- 10) Testing range;
- 11) Reference sensitivity (reference reflector / dB value), the sensitivity when the echo height of the reference reflector used in the testing is 80% of the screen height; display of sensitivity used to generate reference reflector echo that is 80% of screen height and recorded sensitivity used in the testing;
- 12) Signal-to-noise ratio (the difference between the echo height and the noise level that shall be recorded, expressed in dB).

c) Information of discontinuities under test:

- 1) Position of discontinuities of the test object, which is recorded with coordinates (longitudinal / transverse);
- 2) Discontinuity depth and echo height (reference sensitivity $\pm$ dB);
- 3) Discontinuity length and width measured by the -6 dB method;
- 4) Unavoidable typical displays during the testing. (for example, caused by the surface conditions or the process structure or dimensions of the test object)

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