

YB

Black Metal Industry Standard of the People's Republic of China

YB/T 4083—2020

Replace YB/T 4083—2011

Measurement method of comprehensive properties for automatic eddy current testing system for steel tubes and steel bars

钢管、钢棒自动涡流检测系统综合性能测试方法

(English Translation)

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工业和信息化部标准报批公示

Forward

SAC/TC 183 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with the rules given in the GB/T 1.1 - 2009.

This standard was proposed by China Iron and Steel Association.

This standard was prepared by SAC/TC 183 (Technical Committee 183 on Steel of Standardization Administration of China).

This standard replaces YB/T 4083-2011 "Measurement method of comprehensive properties for automatic eddy current testing system for steel tubes", Compared with YB/T 4083-2011, the main technical changes are as follows:

—The name of the standard is changed to "Measurement method of comprehensive properties for automatic eddy current testing system for steel tubes and steel bars";

—Added the reference of GB/T 11260 "round steel—the inspection method for eddy current test" (see 5.2);

—The reference sample and sample diagram of steel bar are added (see 5.2, Fig. 3 and Fig. 4);

—The measurement method of comprehensive properties of steel bars is added (see Chapter 6);

—The requirement of residual magnetic flux density is added (see 6.7);

—Delete informative Appendix A (see Appendix A of 2011 Edition).

The previous versions of this standard are as follows:

—YB/T 4083-1992、YB/T 4083-2000、YB/T 4083-2011。

Measurement method of comprehensive properties for automatic eddy current testing system for steel tubes and steel bars

1 Scope

This standard specifies the test conditions, reference samples, measurement items, methods, and measurement reports of the comprehensive properties of the automatic eddy current testing system which generally composed of eddy current testing instrument, testing coil, magnetic saturation device, mechanical transmission device, etc. for steel tubes and bars .

This standard is applicable to the measurement of comprehensive properties of the automatic eddy current testing systems for tubes and bars using through type or rotating-point probe/pancake coil and fixed-point probe/pancake coil. The comprehensive properties of the automatic eddy current testing systems for tubes and bars using other types of testing coils (such as array type) may also be measured refer to this standard.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 7735 *Automated eddy current testing of seamless and welded(except submerged arc-welded) steel tubes for detection of imperfections*

GB/T 11260 *Round steel—the inspection method for eddy current test*

GB/T 12604.6 *Non-destructive testing - Terminology - Terms used in eddy current testing*

YB/T 143 *Measurement method of the error of signal amplitude for eddy current flaw detector*

YB/T 145 *Steel tubes—Measurement method of sizes of standard artificial defect for flaw detection*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in GB/T 12604.6 apply.

4. Measurement conditions

4.1 The linearity and stability of the testing signal amplitude of eddy current testing instrument shall be calibrated every year.

4.2 The amplitude error of the eddy current testing signal should meet the requirements specified in YB/T 143.

4.3 The measurement speed of the system shall be the speed in normal use. When each one of multi-channel instrument is measured, the line speed of circumferential scanning shall be constant and the measurement speed shall be no less than the ratio of the normal testing speed to the number of channels. During the test, the parameters such as excitation frequency, gain, phase, filtering, magnetizing current or voltage, speed, probe type and specifications shall be recorded.

4.4 For the instrument with linear gain control, the adjusted amplitude of pulse echo shall be converted into decibel value during the measurement.

5. Reference samples

5.1 Reference tubes

The reference tubes for measurement shall be made according to the product specifications. Their lengths should meet the requirements of the testing method and equipment, and their curvatures shall not exceed 1.5mm/m. The reference standards are classified into two kinds: through hole and longitudinal notch. The manufacturing method, grade, size and permissible variation of the through hole or longitudinal notch shall meet the requirements of GB/T 7735. The quantity and positions of reference standards on the tubes for through type with through holes are shown in Figure 1, and those on the reference tubes for rotating pancake coils and rotating tubes with longitudinal notches (or through holes) are shown in Figure 2. The undetectable area at the end of tubes shall not include the lengths of the through hole and longitudinal notch.

5.2 Reference bars

The reference bars for measurement should be made according to the product specifications. Their length shall meet the requirements of the testing method and equipment, and their curvatures shall not exceed 1.5mm/m. The reference standards are classified into two kinds: borehole (or transverse notch) and longitudinal notch. The manufacturing method, grade, size and permissible variation of the borehole (or transverse notch) or longitudinal notch shall meet the requirements of GB/T 11260. The quantity and positions of reference standards on the reference bars for through type with boreholes (or transverse notches) are shown in Figure 3, and those on the reference bars for rotating pancake coils and rotating steel bars with longitudinal notches are shown in Figure 4. The dead zone at the end of tubes shall not include the lengths of the borehole (or transverse notch) and longitudinal notch.

5.3 Requirements for reference standards

The reference samples shall be used only after the standard on them are calibrated. The calibration certificate shall record the number, steel type, dimension and surface condition of the sample, size of each standard and the distance between the standard at the end and the sample end, which indicates the length of the end dead zone of the system. The sizes of the standards may be measured with optical, mechanical or replica method specified in YB/T 145, etc.; the hole size may be measured by reading microscope and other methods.

5.4 Dimension of reference samples for measurement

The reference samples for measurement shall be made separately according to the maximum and the minimum diameter of the tubes or bars which the system can test.

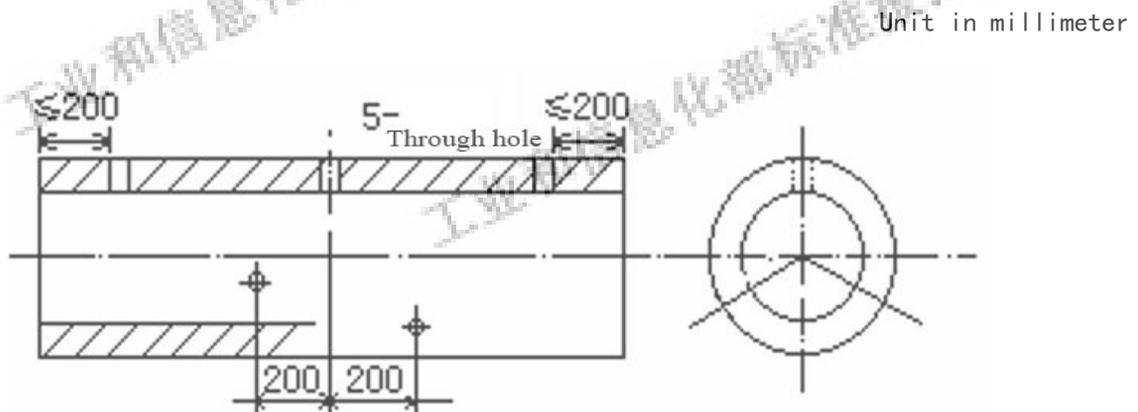


Figure 1 Reference tube (with through holes) for measurement of system's comprehensive properties

Unit in millimeter

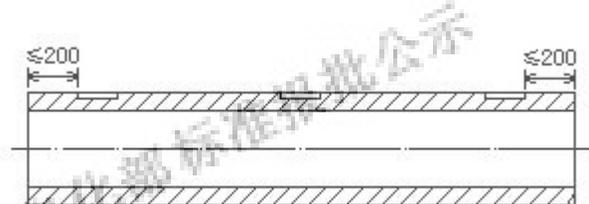


Figure 2 Reference tube (with longitudinal notches) for measurement of system's comprehensive properties

Unit in millimeter

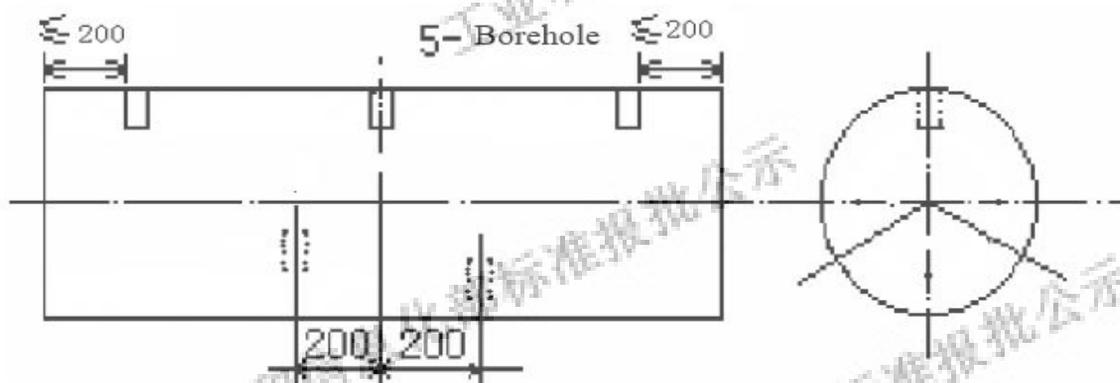


Figure 3 Reference bar (with boreholes) for measurement of system's comprehensive properties

Unit in millimeter

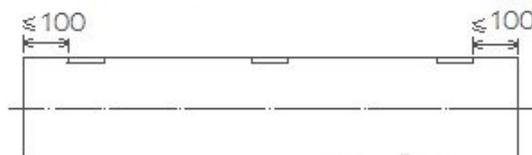


Figure 4 Reference bar (with longitudinal notches) for measurement of system's comprehensive properties

6 Measurement items and methods

6.1 Measurement items

The Measurement shall be carried out dynamically with the reference samples whose diameters are respectively equal to the maximum and minimum ones of tubes or bars which the system can test. For the comprehensive properties testing of the automatic eddy current testing systems using rotating tubes, bars/pancake coil, the circumferential sensitivity difference (CSD) or circumferential sensitivity fluctuation (CSF), signal-to-noise ratio (SNR) and stability shall be measured for each channel. If the results are different, the worst value should be taken.

6.2 Measurement of CSD and CSF

6.2.1 Eddy current testing system using through type coil

Adjust the testing system to normal testing state, adjust the sensitivity at normal speed, use

the reference sample shown in Figure 1 or 3 to let the 3 standards in the middle just trigger the alarm, and record the dB value of the gain or attenuator at this time; adjust the testing sensitivity, and record the dB value when the alarms of all the 3 standards just disappear. The maximum difference between these dB values is the GSD. For steel tubes and bars with diameters less than 100mm, whose absolute value shall be no greater than 3dB. For those with diameters no less than 100mm, whose absolute value shall be no greater than 4dB. Carry out the test 3 times in succession. If the results are different, the worst value shall be taken.

6.2.2 Eddy current testing system using rotating-point probe/pancake coil

For the testing system whose probes rotates and pieces to be tested advance straight, use the reference sample shown in Figure 2 or 4 to let the standard in the middle to pass repeatedly through the system. First, set 0° position for the sample, adjust gain control of each channel, record the dB value when the standard just triggers the alarm, Second, rotate the sample to carry out the measurement in the same way at the 120° and 240° positions and record the dB value when the standard just triggers the alarm. The maximum difference between these dB values is the CSD. For tubes and bars with diameters less than 100mm, whose absolute value shall be no greater than 3dB. For those with diameters no less than 100mm, whose absolute value shall be no greater than 4dB. Each channel shall be measured 3 times. If the results are different, the worst value shall be taken.

6.2.3 Eddy current testing system using fixed-point probe/pancake coil

For the testing system whose probes fix and pieces to be tested advance spirally, or the probes move axially and pieces rotate in its place, the CSF shall be measured. The reference sample shown in Figure 2 or 4 is used to let the standard in the middle to pass repeatedly through the system for 3 times. Record the dB value when the standard just triggers the alarm. Adjust the testing sensitivity, test the sample 3 times in succession, and record the dB value of the gain or attenuator when the alarm just disappears. The maximum difference between these dB values is the CSF. For tubes and bars with diameters less than 100mm, the absolute value of this difference shall be no greater than 3dB. For those with diameters no less than 100mm, the absolute value shall be no greater than 4dB. Carry out the test 3 times in succession. If the results are different, the worst value should be taken.

6.3 Measurement of SNR

6.3.1 The reference sample is used to pass repeatedly through system, adjust the sensitivity of the instrument, and record the dB value when each standard triggers the alarm that is the DDS. Each channel is measured 3 times in succession. If the results are different, the worst value shall be taken.

6.3.2 The reference sample is used to pass repeatedly through just system, adjust the sensitivity of the instrument, and record the dB value when any noise signal just triggers the alarm. The difference between this value and the DDS is the SNR of the system and it shall be no less than 8dB. Carry out the test 3 times in succession. If the results are different, the worst value shall be taken.

6.3.3 For the bars and tubes with diameters no greater than 60mm, the SNR shall be no less than 8dB; for those with diameters greater than 60mm, the SNR shall be no less than 6dB.

6.4 Measurement of missed test rate and false alarm rate

The gains of all channels may be increased by 2dB on the basis of DDS. The reference sample is tested continuously for 25 times at the highest speed in normal use, and the number of missed alarms and false alarms for the standards is recorded respectively. For the multi-channel system, if no channel gives an alarm when a standard passes, it will be called as a missed test. If any channel gives an alarm when no standard passes, it will be called as a false alarm. If there

are 1 or more false alarms during each measurement, it will be counted as 1 time false alarm. If there are too many missed tests and false alarms within the number measured above, the number may be increased to 50 times. The missed test rate (MTR) of the system shall be no greater than 1.5%, and the false alarm rate (FAR) shall be no greater than 3%. The missed test rate and false alarm rate are calculated respectively by Formula (1) and (2):

$$\text{MTR} = \frac{\text{the number of standards missed alarm}}{\text{the number of standards on reference sample} \times \text{the number of measurement}} \times 100\% \quad (1)$$

$$\text{FAR} = \frac{\text{the number of false alarm}}{\text{the number of measurement}} \times 100\% \quad (2)$$

6.5 Measurement of the dead zone at the end

The dead zone at the end shall be measured on the basis of 6.4. The standards at both ends of the reference sample shall be reliably alarmed in three successive measurements. The dead zone at the end shall be no greater than 200mm. For the eddy current testing method using pancake coil, the dead zone at the end shall be no greater than 100 mm.

6.6 Measurement of stability

6.6.1 The CSD or CSF is measured again according to 6.2 after the system works continuously for 2h. The CSD or CSF between 2 hours ago and later shall be no greater than 2 dB, and shall meet the requirements of 6.2.

6.6.2 The DDS are measured according to 6.3 after the system works continuously for 2h. The DDS difference in the same channel between 2 hours ago and later shall be no greater than 2 dB.

6.6.3 Retest the signal-to-noise ratio of the system according to 6.3 and it shall meet the requirements of 6.3.

6.6.4 The measurement stability is only applicable for the maximum diameter reference sample.

6.7 Residual magnetic flux density

For the automatic eddy current testing systems for tubes and bars, the performance of the attached demagnetizer shall be tested. With normal testing speed, let the reference sample repeatedly pass through the automatic eddy current testing system. After demagnetization, use a teslameter (or magnetometer) to measure the residual magnetic flux density at both ends of the reference sample and it shall not exceed 20Gs.

7 Measurement report

The measurement report shall include at least the following information:

- a) CSD or CSF, DDS, SNR, MTR, FAR, dead zone at the end, stability, residual magnetic flux density;
- b) manufacturer names, models and numbers of the testing equipment and instrument;
- c) steel type, specification, status and number of the reference sample and reference standards in it;
- d) parameters such as frequency, gain, phase, filtering, magnetizing current or voltage used for magnetic saturation testing, speed, probe type and dimension, alarm threshold, etc.;
- e) name of tester and test date;
- f) test location, environmental conditions, etc.