

Method for magnetic particle testing of ferromagnetic materials and classification of magnetic particle indication

1. Scope

This Japanese Industrial Standard specifies the method for magnetic particle testing, hereinafter referred to as the "test", of ferromagnetic materials and their products, hereinafter referred to as the "test body", and classification of magnetic particle indications.

Remarks: Applicable Standards to this Standard are shown in the following:

JIS C 2503-Soft Magnetic Iron Bars

JIS C 2504-Soft Magnetic Iron Plates

JIS K 2203-Kerosine

JIS Z 2300-Glossary of Terms Used in Nondestructive Testing

2. Purpose

The purpose of the test is to detect cracks and other flaws on the surface of test body and near its surface.

3. Definitions

For the purposes of this Standard, main definitions are in accordance with JIS Z 2300.

4. Testing engineer

The person to perform the test shall have the qualifications necessary for the task or have sufficient knowledge, technique and experience equivalent thereto.

5. Apparatus

5.1 Test apparatus The test apparatus shall be as follows:

- (1) The test apparatus is, as a rule, capable of performing the four operations to the test body, i.e., the magnetization, application of magnetic particles, observation and demagnetization. However, if unnecessary, the apparatus need not be capable of demagnetization.
- (2) The test apparatus must be capable of testing efficiently and safely with suitable sensitivity, according to the shape, dimensions, quality of material, surface condition and nature of flaws (class, size, position and direction) of test bodies.

(3) For magnetizing apparatus, there are those of electric current using system and permanent magnet using system, and the former system is classified by the type of magnetizing current into the d.c., rectifying, a.c. and impulse current types.

(4) The magnetizing apparatus using electric current must be capable of giving a suitable magnetic field density for detecting flaws the test body. For this purpose, the apparatus must be provided with an ammeter which expresses the magnetizing current by the crest value. However, the apparatus of electromagnet type may not include this instrument.

(5) The magnet system apparatus must be indicated clearly with the maximum magnetic flux capable of inducing in the test body. However, the electromagnet system apparatus is appended with the type of electric current and frequency.

(6) The apparatus for applying suspension in the wet method must be equipped with a stirrer in the suspension tank to facilitate stable application of the suspension which is uniformly dispersing magnetic particles and must not disturb the magnetic particle indication generated.

(7) The apparatus for applying magnetic particles in the dry method must always be capable of stably applying well dried magnetic particles to the test body, in uniformly dispersed condition, without disturbing the magnetic particle indication.

(8) For the test using fluorescent magnetic particles, a black light is used. The black light must be equipped with a filter which passes the near ultraviolet rays of mainly 320 to 400 nm, and must have ultraviolet ray intensity for clearly identifying fluorescent magnetic particle indication in service condition (not less than 800 $\mu\text{W}/\text{cm}^2$ at the distance of 38 cm from the filter surface of black light).

(9) The demagnetizing apparatus must be capable of reducing the residual magnetism to the required limit corresponding to the use of the test body.

5.2 Magnetic particles and suspension The magnetic particles and suspension shall be as follows:

(1) Magnetic particles are classified into the ones for dry method use and the ones for wet method use by the difference of carrier fluid used at the time of application and further classified into the fluorescent ones and nonfluorescent ones by the difference of observation method.

(2) The magnetic particles must have suitable magnetism, particle size, dispersibility, suspensibility and colour tone, corresponding to the quality of material, surface condition and nature of flaws of the test body.

- (3) The size of magnetic particles is determined by measuring the diameters of particles in a fixed direction by microscopic measurement and is expressed by the range of particle sizes showing 20% and 80% on the built-up sieve.
- (4) For the wet method, the suspension composed of kerosine specified in JIS K 2203, water, etc. as the carrier fluid, added with suitable rust-preventive and surface-active agents as required, is used.
- (5) The concentration of magnetic particles dispersing in the suspension is expressed by the mass of magnetic particles (g) contained in a unit volume (1 l) of the suspension at the location where it is actually applied or by the precipitated volume (ml) of magnetic particles contained in a unit volume (100 ml), and it is set with taking into consideration the class and the size of the magnetic particles.

Particularly in the case of fluorescent magnetic particles, the dispersion concentration of magnetic particles must be determined with taking into consideration the applying time and applying method of magnetic particles in addition to their particle size to avoid excessive concentration.

- (6) The performances of suspension and magnetic particles must be confirmed, as required, by using a suitable standard test block or the like.

5.3 Maintenance and checking of test apparatus and the like

5.3.1 Ammeter The ammeter to be used for setting the magnetizing current shall be checked periodically.

5.3.2 Timer The timer for controlling the holding time of magnetizing current shall be checked periodically.

5.3.3 Black light The ultraviolet ray intensity of black light shall be measured by using an ultraviolet-ray intensity meter, and in case where it is less than $800 \mu\text{W}/\text{cm}^2$ at a position apart by 38 cm from the filter surface or the leakage of mercury lamp exists, it shall be repaired or discarded.

5.3.4 Checking frequency The checking of ammeter, timer, and black light shall be performed at least once per year, and in case where it is not used for not less than one year, the check shall be carried out at the time of use and that conforming with the performance shall be used.

6. Standard test block and reference block

6.1 Type A standard test block The type A standard test block is used for examining the performances of apparatus, magnetic particles and suspension, as well as the strength and direction of effective magnetic field on the surface of the test body, effective area for flaw detection and conformity of testing operation in the continuous method and shall have been verified by the authorized organization.

- (1) The type A standard test block shall be as shown in Table 1 and Fig. 1.

Table 1. Type A standard test block

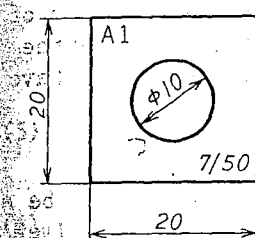
Designation			Quality of material
A1-7/50 (Circular shape, linear shape)	A1-15/50 (Circular shape, linear shape)	-	JIS C 2504-class 1 annealed (kept in an inert gas atmosphere at 600°C for 1 h and gradually cooled in the atmosphere down to 100°C)
A1-15/100 (Circular shape, linear shape)	A1-30/100 (Circular shape, linear shape)	-	
A2-7/50 (Linear shape)	A2-15/50 (Linear shape)	A2-30/50 (Linear shape)	JIS C 2504-class 1, as cold-rolled
A2-15/100 (Linear shape)	A2-30/100 (Linear shape)	A2-60/100 (Linear shape)	

- Remarks 1. In the designation of test block, the numeral at the left of oblique line indicates the depth of artificial flaw, that at the right of oblique line indicates the thickness of plate, and the unit of dimensions is μm .
2. The tolerance of depth of artificial flaw is $\pm 2 \mu\text{m}$ in the case of $7 \mu\text{m}$, $\pm 4 \mu\text{m}$ in the case of $15 \mu\text{m}$, $\pm 8 \mu\text{m}$ in the case of $30 \mu\text{m}$ and $\pm 15 \mu\text{m}$ in the case of $60 \mu\text{m}$.
3. In the designation of test block, the word(s) in () indicates the shape of artificial flaw.

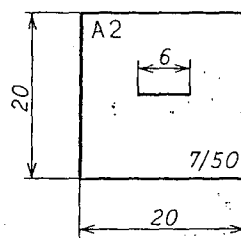
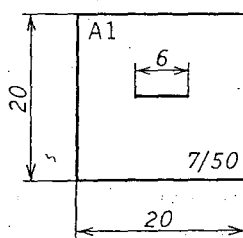
Fig. 1. Type A standard test block

Unit: mm

(1) Circular shape



(2) Linear shape



- (2) In A2 of type A standard test block, magnetic particle indication appears in a higher effective magnetic field than A1 and the smaller is the fractional value in the designation, the higher is the effective magnetic field where the magnetic particle indication appears.
- (3) As to type A standard test block, a class appropriate to the specifications or object of magnetic particle testing is chosen for use and it is confirmed that the magnetic particle indication in the direction of flaws to be detected appears without fail. When specifying in the specifications the designation of type A standard test block to be used, the magnetic characteristics of test body, type and size of flaws to be detected are considered.

When a higher effective magnetic field exceeding the regulated range of magnetic field strength of type A standard block is required, it is expressed by a multiple of designation of standard test block.

Example: (A2-7/50 × 2 indicates that the test is performed by a magnetizing current twice that obtained of magnetic particle indication on A2-7/50.

- (4) The type A standard test block is attached on the test surface with a suitable pressure sensitive adhesive tape in such a manner that the face of the block having the artificial flaw contact closely with the test surface. In this case, no part of pressure sensitive adhesive tape must cover the part of artificial flaw of standard test block.
- (5) The application of magnetic particle to type A standard test block is performed according to continuous method.
- (6) The type A standard test block which has caused of change in shape, dimensions and magnetic characteristics from the initial must not be used.

6.2 Type C standard test block The type C standard test block is used instead of type A standard test block in the case where the application of type A standard test block is difficult for dimensional reasons as in the testing of a narrow part such as the groove face of a weld, and shall have been verified by the authorized organization.

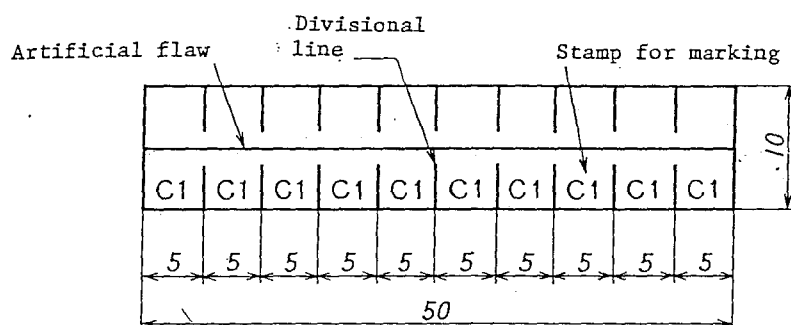
- (1) Designation and materials of type C standard test block shall be as given in Table 2 and the shape and dimensions thereof be as given in Fig. 2. The thickness of plate shall be 50 μm.

Table 2. Type C standard test block

Designation	Quality of material
C1	JIS C 2504-class 1, annealed (kept in the inert gas atmosphere at 600°C for 1 h and gradually cooled in the atmosphere down to 100°C or under).
C2	JIS C 2504-class 1 as cold rolled.

Fig. 2. Type C standard test block (In the case of C1 in marking)

Unit: mm



- (2) Dimensions of artificial flaw of type C standard test block shall be $8 \pm 1 \mu\text{m}$ in depth and $50 \pm 8 \mu\text{m}$ in width.
- (3) C1 of type C standard test block produces magnetic particle indication in an effective magnetic field of nearly A1-7/50, and C2 in A2-7/50 respectively.
- (4) The type C standard test block shall be cut along the divisional lines into small segments of $5 \text{ mm} \times 10 \text{ mm}$, and each piece is used closely placed on the test surface with its face given artificial flaws with suitable double-face pressure-sensitive adhesive tape or adhesives. In this case, the thickness of the double-face pressure-sensitive adhesive tape or the like shall be not more than $100 \mu\text{m}$.
- (5) The application of magnetic particles to the type C standard test block shall be performed by the continuous method.
- (6) The type C standard test block which has caused change in shape, dimensions and magnetic characteristics from the initial shall not be used.