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**Method for Charpy pendulum impact test
of metallic materials**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry based on the provision of Article 14, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act in response to a proposal for revision of Japanese Industrial Standard with a draft being attached, submitted by The Japan Iron and Steel Federation (JISF), an accredited standards development organization. This edition replaces the previous edition (**JIS Z 2242** : 2020), which has been technically revised.

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Method for Charpy pendulum impact test of metallic materials

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 148-1** : 2016, Edition 3, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the Charpy (V-notch and U-notch) pendulum impact test method for determining the energy absorbed in an impact test of metallic materials. This Standard does not cover instrumented impact testing, which is specified in **JIS B 7755**.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 148-1 : 2016 *Metallic materials — Charpy pendulum impact test — Part 1 : Test method* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

Editor's note : Note ¹⁾ is omitted.

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7722 *Metallic materials — Charpy pendulum impact test — Verification of testing machines*

NOTE Corresponding International Standard : ISO 148-2 *Metallic materials — Charpy pendulum impact test — Part 2 : Verification of testing machines*

JIS G 0202 *Glossary of terms used in iron and steel (Testing)*

JIS Z 8401 *Rounding of numbers*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those giv-

en in **JIS G 0202** apply.

3.1 Definitions pertaining to energy

3.1.1

initial potential energy, potential energy, K_p

potential energy of the pendulum hammer prior to its release for the impact test, as determined by direct verification

3.1.2

absorbed energy, K

energy required to break a test piece with a pendulum impact testing machine, after correction for friction loss

Note 1 to entry The letter V or U is used to indicate the notch geometry, that is KV or KU . The number 2 or 8 is used as a subscript to indicate the radius of the striker, for example KV_2 (see Table 1).

Note 2 to entry The absorbed energy may be obtained according to the following formula.

$$K = M(\cos\beta - \cos\alpha) - p_\beta$$

$$M = F \times l_2$$

where,

K : absorbed energy (J)

M : moment equal to F (N) $\times$ l_2 (m) (N·m)

F : force measured at a position l_2 while the pendulum is held horizontally (N)

l_2 : distance to the point of application of the force F from the axis of rotation (m)

α : angle of fall of the pendulum (°)

β : angle of rise of the pendulum (°)

p_β : correction of energy loss by friction (J)

3.1.3

nominal initial potential energy, nominal energy, K_N

potential energy assigned by the manufacturer of the Charpy pendulum impact testing machine, as a nominal value of energy that can be effectively tested by the testing machine

3.2 Definitions pertaining to test piece

3.2.1

width, W

distance between the notched face and the opposite face

Note 1 to entry See Figure 1.

Note 2 to entry In previous versions of this Standard (edition 2005 and prior), the

distance between the notched face and the opposite face was specified as “height”. Changing this dimension to “width” makes this Standard consistent with the terminology used in other JIS fracture standards.

3.2.2

thickness, B

dimension perpendicular to the width and parallel to the notch

Note 1 to entry See Figure 1.

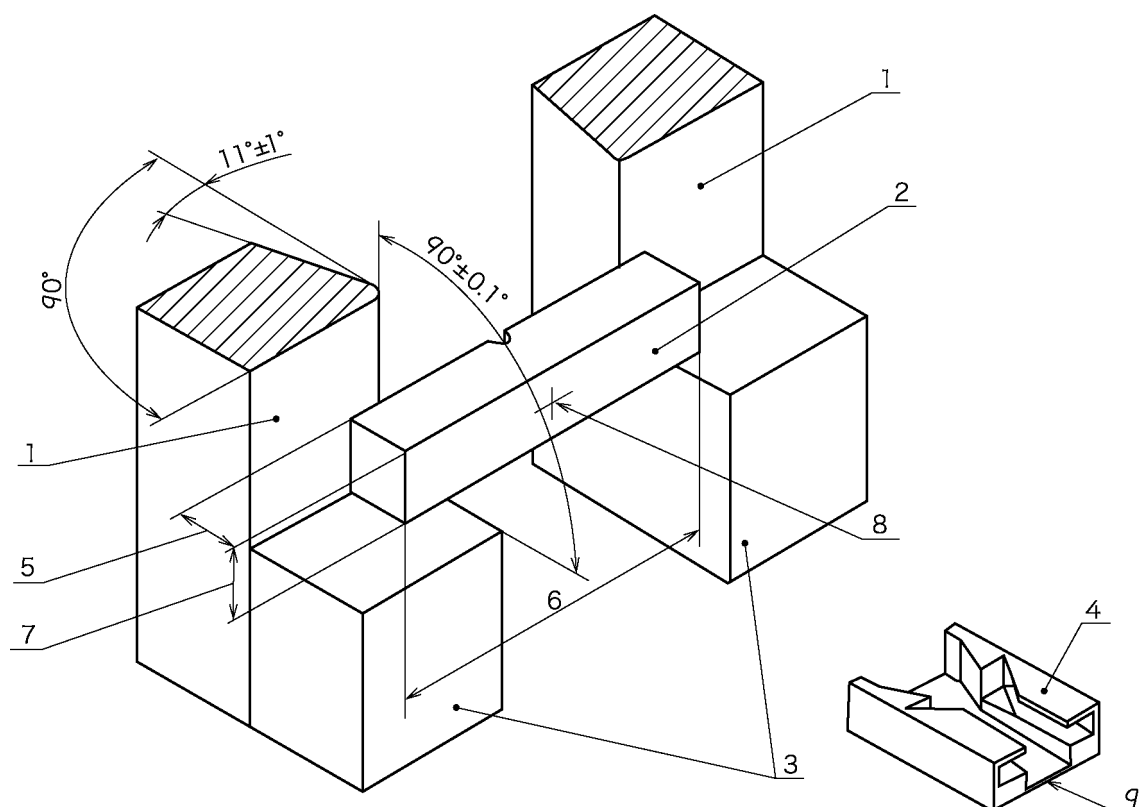
Note 2 to entry In previous versions of this Standard (edition 2005 and prior), the dimension perpendicular to the width that is parallel to the notch was specified as “width”. Changing this dimension to “thickness” makes this Standard consistent with the terminology used in other JIS fracture standards.

3.2.3

length, L

largest dimension perpendicular to the notch

Note 1 to entry See Figure 1.



Key

- 1 anvil
- 2 standardized test piece
- 3 test piece supports
- 4 shroud
- 5 width of test piece, W
- 6 length of test piece, L
- 7 thickness of test piece, B
- 8 centre of strike
- 9 direction of pendulum swing

Figure 1 Configuration of test piece supports and anvils of a pendulum impact testing machine

4 Symbols, units and designations

The symbols, units and designations applicable to this Standard are indicated in Tables 1 and 2. The symbols for dimensions of test piece are illustrated in Figure 2.

Table 1 Symbols, units and designations/definitions

Symbol	Unit	Designation/definition
B	mm	thickness of test piece
BFA	%	percent brittle fracture
α	°	angle of fall of the pendulum
β	°	angle of rise of the pendulum
β_1	°	angle of rise when the machine is operated in the normal manner without a test piece in position
β_2	°	angle of rise when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism (without using the indicating pointer)
β_3	°	angle of rise after eleven successive half swings (after five rounds) without a test piece in position
L	mm	length of test piece
LE	mm	lateral expansion
K	J	absorbed energy (expressed as KV_2 , KV_8 , KU_2 and KU_8 , to identify specific notch geometries and the radius of the striking edge)
K_1	J	indicated absorbed energy when the machine is operated in the normal manner without a test piece in position
K_2	J	indicated absorbed energy when the machine is operated in the normal manner without a test piece in position and without resetting the indicating mechanism (without using the indication pointer)
K_3	J	indicated absorbed energy after the 11th half swing (after five rounds) without a test piece in position
K_N	J	nominal initial potential energy
K_p	J	initial potential energy (potential energy)
K_T	J	total absorbed energy
KV_2	J	absorbed energy for a V-notch test piece using a 2 mm striker
KV_8	J	absorbed energy for a V-notch test piece using a 8 mm striker
KU_2	J	absorbed energy for a U-notch test piece using a 2 mm striker
KU_8	J	absorbed energy for a U-notch test piece using a 8 mm striker
M	N·m	moment equal to the product $F \cdot l_2$ F is a force measured at a distance l_2 while the pendulum is held horizontally. l_2 is a distance to the point of application of the force F from the axis of rotation
p	J	energy loss by friction caused by indicating pointer
p'	J	energy loss caused by bearing friction and air resistance
p_β	J	correction of energy loss by friction
SFA	%	percent shear fracture
T_i	°C	transition temperature
W	mm	width of test piece
T_{127}	°C	transition temperature defined at a specific value of absorbed energy; for example, 27 J
$T_{150 \%US}$	°C	transition temperature defined at a particular percentage of the absorbed energy of the upper shelf; for example, 50 %
$T_{150 \%SFA}$	°C	transition temperature defined at a particular percentage of percent shear fracture; for example, 50 %
$T_{10.9}$	°C	transition temperature defined at a particular amount of lateral expansion; for example, 0.9 mm

5 Principles of the test

This test consists of breaking a notched test piece with a single blow from a swinging pendulum, under the conditions defined in Clauses 6, 7 and 8. The notch in the test piece has a specified geometry and is located in the middle between two supports, opposite to the location which is impacted in the test. The energy absorbed by the test piece is determined. Also, the lateral expansion and the fracture appearance can be obtained (in accordance with Annexes B and C).

Because the absorbed energy of many metallic materials varies with temperature, tests shall be carried out at a specified temperature. When this temperature is other than ambient, the test piece shall be heated or cooled to that temperature, under controlled conditions.

NOTE In this test, the test piece may be completely broken or only partially broken (see 8.6).

In research, design, or academic settings, the measured energy values are studied in more detail, in which case it can be highly relevant whether the test piece is broken or not. Where the test is used in routine, high-throughput pass/fail acceptance tests in industrial setting, it may not be important whether the test piece is completely broken, partially broken, or simply plastically deformed and dragged through the anvils.

It is important to note that not all Charpy pendulum impact test results can be directly compared. For example, the test can be performed with hammers having strikers with different radii, or with different test piece shapes. Tests performed with different strikers may give different results [7], and test results obtained with differently shaped test pieces can as well. This is why not only the adherence to this Standard but also a clear and complete reporting of the type of instrument, the test piece and the details of the post-test test pieces are crucial for comparability of results.

6 Test pieces

6.1 General

The standard test piece shall be 55 mm long and of square section, with 10 mm sides. In the centre of the length, there shall be either a V-notch or a U-notch, as defined in 6.2.1 and 6.2.2, respectively. If the standard test piece cannot be obtained from the material, one of the subsize test pieces, having a thickness of 7.5 mm, 5 mm or 2.5 mm (see Figure 2 and Table 2), shall be used, if not otherwise specified.

NOTE 1 Direct comparison of results is only of significance when made between test pieces of the same form and dimensions.

NOTE 2 For low energies, the use of shims to better position subsize test pieces relative to the centre of strike is important to avoid excess energy absorption by the pendulum. For high energies, this might not be as important. Shims can be placed on or under the test piece supports, with the result that the mid-thickness of the test piece is 5 mm above the upper face of the supports. Shims can be temporarily fixed to the sup-

ports using tape or another means.

When a heat-treated material is being evaluated, the test piece shall be finish-machined and notched after the final heat treatment, unless it can be demonstrated that machining before heat treatment does not affect test results.

6.2 Notch geometry

6.2.0A Preparation of notch

The notch shall be carefully prepared so that the root radius of the notch is free of machining marks which could affect the absorbed energy.

The plane of symmetry of the notch shall be perpendicular to the longitudinal axis of the test piece (see Figure 2).

6.2.1 V-notch

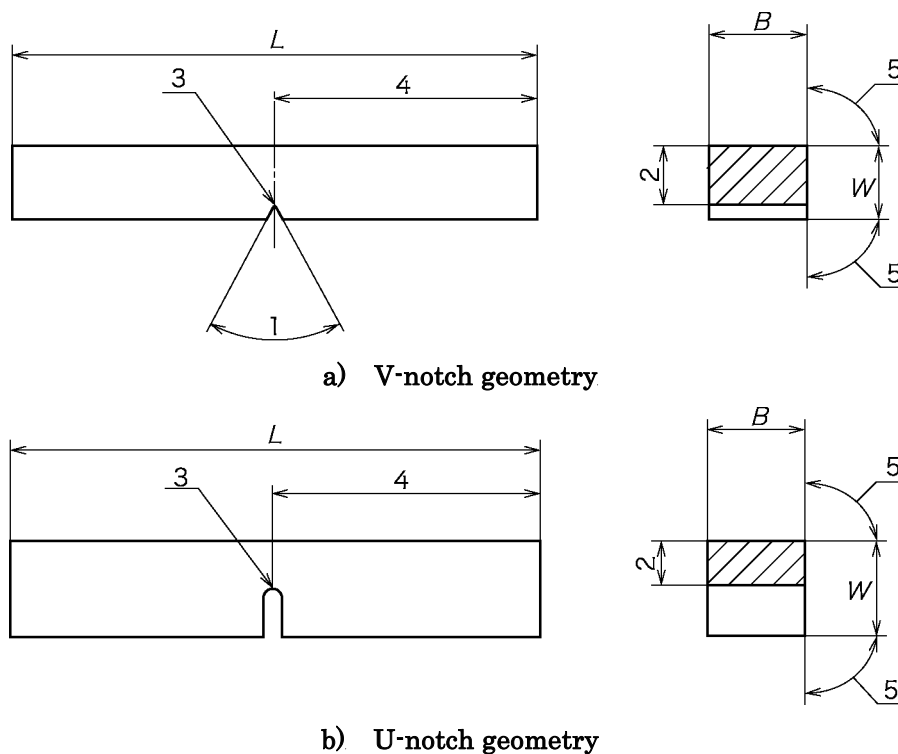
The V-notch shall have an included angle of 45°, a depth of 2 mm and a root radius of 0.25 mm [see Figure 2 a) and Table 2].

6.2.2 U-notch

The U-notch shall have a depth of 5 mm and a root radius of 1 mm [see Figure 2 b) and Table 2]. Upon the specification of product standard or an agreement, it may have a depth of 2 mm and a root radius of 1 mm.

6.3 Tolerance of the test pieces

The tolerances on the specified test piece and notch dimensions are shown in Figure 2 and Table 2.



NOTE For the symbols L , W , B and the numbers 1 to 5, see Table 2.

Figure 2 Charpy pendulum impact test piece

6.4 Preparation of test pieces

Preparation shall be executed in such a way that any alteration of the test piece, for example due to heating or cold working, is minimized.

6.5 Marking of the test pieces

The test piece may be marked on any face not in contact with supports, anvils or striker and at a position where plastic deformation and surface discontinuities caused by marking do not affect the absorbed energy (see 8.8).

Table 2 Dimensions and tolerances on specified test piece

Designation		Symbol and No. ^{a)}	V-notch test piece		U-notch test piece	
			Nominal dimension	Tolerance	Nominal dimension	Tolerance
Length		<i>L</i>	55 mm	±0.60 mm	55 mm	±0.60 mm
Width		<i>W</i>	10 mm	±0.075 mm	10 mm	±0.11 mm
Thick- ness ^{b)}	(standard test piece)	<i>B</i>	10 mm	±0.11 mm	10 mm	±0.11 mm
	(subsize)		7.5 mm	±0.11 mm	7.5 mm	±0.11 mm
			5 mm	±0.06 mm	5 mm	±0.06 mm
			2.5 mm	±0.05 mm	—	—
Angle of V-notch		1	45°	±2°	—	—
Ligament		2	8 mm	±0.075 mm	5 mm ^{c)}	±0.09 mm
Notch radius		3	0.25 mm	±0.025 mm	1 mm	±0.07 mm
Notch position (centre)		4	27.5 mm	±0.42 mm ^{d)}	27.5 mm	±0.42 mm ^{d)}
Angle between plane of symmetry of notch and longitudinal axis of test piece		—	90°	±2°	90°	±2°
Angle between adjacent longitudinal faces of test piece		5	90°	±2°	90°	±2°
Surface roughness ^{e)}		—	< 5 µm	—	< 5 µm	—
Note ^{a)} See Figure 2 for symbols and numbers. Note ^{b)} If another thickness (2 mm or 3 mm) is specified, the corresponding tolerances shall also be specified. Note ^{c)} Upon the specification of product standard or an agreement, it may be 8 mm. Note ^{d)} For machines with automatic positioning of the test piece, it is recommended that the tolerance be taken as ±0.165 mm instead of ±0.42 mm. Note ^{e)} The test pieces shall have a surface roughness better than <i>Ra</i> 5 µm except for the ends (see JIS B 0601 [8] for <i>Ra</i>).						

7 Test equipment

7.1 General

The measurements of the instrument and test piece details shall be traceable to national or international standards. Equipment used for measurements shall be calibrated within suitable intervals.

7.2 Installation and verification

The testing machine shall be installed and verified in accordance with **JIS B 7722**.

7.3 Striker

The striker geometry shall be specified as being either the 2 mm striker or the 8 mm