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**Pendulum-type impact-testing machines
for non-metallic materials — Verification
of testing machines**

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In the event of any doubts arising as to the contents,
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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Testing Machinery Association (JTM)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently, **JIS B 7739:1989** is replaced with this Standard.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public or utility model right. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public or utility model right.

Pendulum-type impact-testing machines for non-metallic materials — Verification of testing machines

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of ISO 13802 published in 1999 without any modifications of the technical contents; however, the “pendulum-type testing machines of impact shear strength of adhesive bonds” not given in the corresponding International Standard is added as JIS.

The portions given dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JC. Furthermore, Annex JA and Annex JB are the matters not stated in the corresponding International Standard.

Warning

Persons using this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

1 Scope

This Standard specifies the verification methods of the pendulum-type impact-testing machines used for the Charpy impact test, the Izod impact test and the tensile-impact test specified in JIS K 7111-1, JIS K 7111-2, JIS K 7110 and JIS K 7160, respectively. Also, Annex JA specifies the verification method of pendulum-type impact-testing machines used for the impact shear strength test of adhesive bonds specified in JIS K 6855.

This Standard is applicable to the pendulum-type impact-testing machines. The impact energy W (see 3.12) absorbed in impacting a specimen is taken as being equal to the difference between the potential energy E (see 3.11) of the pendulum and the energy remaining in the pendulum after impacting the specimen.

On the calculation of the impact energy, the impact energy is corrected for the friction loss and the air-resistance loss (see table 2 and 5.6).

The verification methods of geometrical and physical properties of different parts of the testing machine are specified.

The verification of some geometrical properties is difficult to conduct on the assembled instrument. It is therefore assumed that the manufacturer is responsible for the verification of such properties and for providing reference planes on the instrument that enable proper verification in accordance with this Standard.

These verification methods are for use when the testing machine is being installed, is being repaired, has been moved or is undergoing periodic checking.

This Standard is also applicable to pendulum-type impact-testing machines of different capacities or designs with the geometrical and physical properties defined in clause 5.

A pendulum-type impact-testing machine verified in accordance with this Standard and assessed as satisfactory is considered suitable for the impact-testing with un-notched and notched specimens of different types.

Annex A describes the relation among the pendulum length, the potential energy and the moment of inertia of the pendulum.

Annex B describes how to calculate the ratio of frame mass to pendulum mass required to avoid errors in the impact energy.

Annex C describes, for Charpy impact testing, the change in pendulum velocity just after impact as a function of impact energy and gives the measurement range of impact energies on which the pendulum of specified capacity is used.

Annex D describes the stiffness of the foundation of the frame necessary to avoid resonance in the frame due to the reaction force caused by the movement of the pendulum.

Annex E describes the shape and dimensions of a gauge plate suitable for the verification of Charpy impact-testing machines.

Annex JA describes the verification method of pendulum-type impact testing machines for shear strength of adhesive bonds.

Annex JB describes the gauge for shape inspection.

Annex JC is the comparison table between JIS and corresponding International Standard.

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

ISO 13802 : 1999 *Plastics — Verification of pendulum impact-testing machines — Charpy, Izod and tensile impact-testing* (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**.

2 Normative references

The following standards contain provisions which, 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 0601 *Geometrical Product Specifications (GPS) — Surface texture : Profile method — Terms, definitions and surface texture parameters*

JIS B 0651 *Geometrical Product Specifications (GPS) — Surface texture : Profile method — Nominal characteristics of contact (stylus) instruments*

JIS B 0659-1 *Geometrical Product Specifications (GPS) — Surface texture : Profile method; Measurement standards — Part 1 : Material measures*

JIS B 7503 *Mechanical dial gauges*

JIS B 7510 *Precision levels*

JIS B 7517 *Vernier, dial and digital height gauges*

JIS B 7518 *Vernier, dial and digital depth gauges*

JIS B 7725 *Vickers hardness test — Verification and calibration of testing machines*

JIS K 6855 *Testing methods for impact shear strength of adhesive bonds*

JIS K 7110 *Plastics — Determination of Izod impact strength*

NOTE : Corresponding International Standard : ISO 180 : 2000 *Plastics — Determination of Izod impact strength* (MOD)

JIS K 7111-1 *Plastics — Determination of Charpy impact properties — Part 1 : Non-instrumented impact test*

NOTE : Corresponding International Standard : ISO 179-1 : 2000 *Plastics — Determination of Charpy impact properties — Part 1 : Non-instrumented impact test* (MOD)

JIS K 7111-2 *Plastics — Determination of Charpy impact properties — Part 2 : Instrumented impact test*

NOTE : Corresponding International Standard : ISO 179-2 : 1997 *Plastics — Determination of Charpy impact properties — Part 2 : Instrumented impact test* (IDT)

JIS K 7160 *Plastics — Determination of tensile-impact strength*

NOTE : Corresponding International Standard : ISO 8256 : 1990 *Plastics — Determination of tensile-impact strength* (IDT)

3 Terms and definitions

For the purposes of this Standard, the following terms and definitions apply.

3.1 verification

test conducted with the use of calibrated standards or standard materials so that the calibration of an instrument is proved to be acceptable

3.2 calibration

set of operations that establish, under specified conditions, the relation between values indicated by a measuring instrument or measuring system and values corresponding to appropriate standards or known values derived from standards

3.3 period of swing of the pendulum T_P

period (unit : s) of the single swing (to and from) of the pendulum oscillating at angles of not more than 5° to respective vertical planes

3.4 centre of percussion

point on a pendulum at which a perpendicular impact in the plane of swing does not cause the reaction force at the rotation axis of the pendulum

3.5 pendulum length L_P

distance (unit : m) between the rotation axis of the pendulum and the centre of percussion (see 3.4), which is the length to the centre of percussion where an equivalent theoretical mass concentrated at the point which gives the same period of swing of oscillation with its T_P (see 3.3) as the actual pendulum (see Annex A)

3.6 gravity length L_M

distance (unit : m) between the rotation axis of the pendulum and the centre of gravity of the pendulum (see Annex A)

3.7 gyration length L_G

distance (unit : m) between the rotation axis of the pendulum and the point at which the pendulum mass m_P is to be concentrated to give the same moment of inertia as the pendulum (see Annex A)

3.8 impact length L_I

distance (unit : m) between the rotation axis of the pendulum and the impact point at the centre of striker edge facing to the specimen

3.9 starting angle α_0

angle (unit : $^\circ$) between the starting point of swing and the vertical position

NOTE : Usually, the specimen is impacted at the lowest point of the pendulum swing ($\alpha_i = 0^\circ$). In this case, the starting angle is same as the angle of fall [see figure 1 b)].

3.10 impact velocity v_i

velocity (unit : m/s) of the pendulum at the moment of impact

3.11 potential energy E

energy (unit : J) of the pendulum stored when raised from the impact position to its starting position

3.12 impact energy W

energy (unit : J) required to deform, break and push away the specimen

3.13 frame

part of the testing machine carrying the pendulum bearing, the support base and clamp, the measuring instruments and the mechanism for holding and releasing the

pendulum

The mass of the frame is expressed by m_F (unit : kg).

3.14 period of oscillation of the frame T_F

period of the decaying oscillation of the frame in the horizontal direction

This is the oscillation characteristics (unit : s^{-1}) of the frame vibrating against the stiffness of the test bench and/or its foundation (which may include damping material) (see Annex D).

3.15 mass of the heaviest pendulum used $m_{P,max}$

heaviest mass (unit : kg) of the pendulum to be used

3.16 angle of rise (without specimen) α_R

angle (unit : $^\circ$) between from the vertical position to the point at which the swing of pendulum reverses

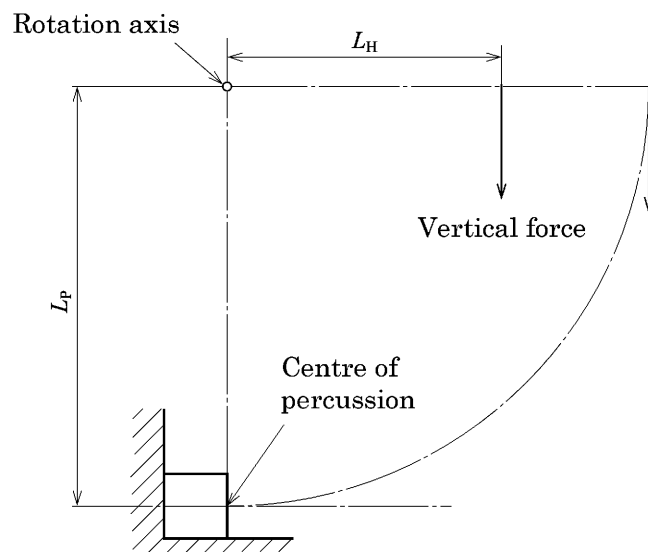
3.17 absorbed energy W

calculated value of impact energy (unit : J) indicated by the scale on the calibration of the scale for the impact energy

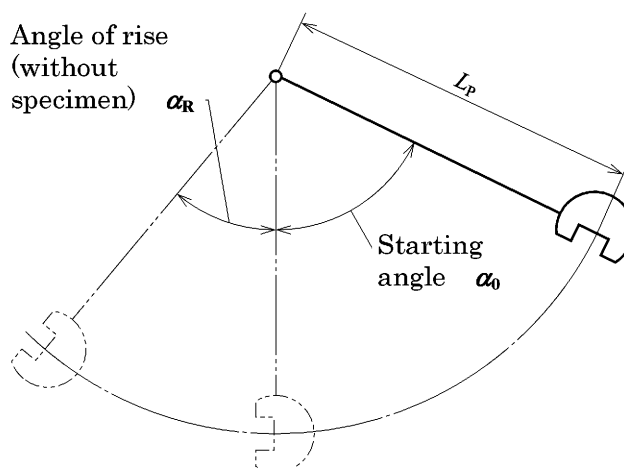
4 Measuring instruments

According to this Standard, the straight edges, vernier callipers, squares, levels, dynamometers, load cells or scales and timing devices are necessary for checking the conformity of the geometrical and physical properties of the components of the testing machine to the requirements given in respective standards. Also, measuring instruments capable of substituting the functions of those mentioned above may be used.

These measuring instruments shall be accurate enough to measure the parameters of the testing machine within the tolerance limits given in clause 5.



a) Quantities necessary to determine horizontal moment of pendulum



b) Quantities necessary for scale calibration and for potential-energy measurements

Figure 1 Quantities necessary for potential energy verification

5 Verification of testing machine

5.1 Components of testing machine

5.1.1 Pendulum

5.1.1.1 Pendulum rod

5.1.1.2 Striker

That with striking edge for bending impact tests (see JIS K 7111-1 and JIS K 7110), or with striking faces or clamps for tensile impact testing (see JIS K 7160).

5.1.2 Frame

5.1.2.1 Specimen support base for Charpy impact test (see JIS K 7111-1)

5.1.2.2 Vice for Izod impact testing (see JIS K 7110)

5.1.2.3 Clamp for tensile-impact testing (see JIS K 7160)

5.1.2.4 Mechanism for holding and releasing pendulum

5.1.3 Energy indicating device

5.1.4 Crosshead for tensile-impact testing

5.2 Pendulum

5.2.1 Pendulum length L_P

The pendulum length shall be calculated from the period of swing of the pendulum T_P according to equation (1).

$$L_P = \frac{gT_P^2}{4\pi^2} \dots\dots\dots (1)$$

where, g : acceleration of gravity (m/s²)

T_P : period of swing of pendulum (s)

The value of T_P shall be with the accuracy of 0.2 %

The period of swing of the pendulum T_P shall be determined so that the total duration nT_P is measured four times and the mean value thereof shall be determined with the accuracy of 0.1 s. Together with the accuracy demanded above of L_P , this results in a minimum number n of oscillation given by $n \geq 100 / T_P$.

The use of a timing device accurate to not less than 0.1 s allows the number of oscillations n to be reduced accordingly (see table 1).

Table 1 Example of minimum number of oscillations for measuring T_P

L_P m	T_P s	Accuracy of time measurement s	Minimum number of oscillations n
0.225	0.95	0.1	105
		0.01	11
0.390	1.25	0.1	80
		0.01	8

5.2.2 Impact length L_I

The impact length (see 3.8) shall be within 1 % error of the pendulum length L_P as determined from the period of swing of the pendulum T_P [see equation (1) and figure 1 a)].

5.2.3 Potential energy E

The potential energy shall not differ by not less than ± 1 % from the value thereof given in table 2. The potential energy shall be determined by the following procedure or by any other method capable of determining within the accuracy of ± 1 %.

- a) The pendulum shall be supported at an arbitrary length L_H from the rotation axis on a balance or dynamometer. The axis line from the rotation axis to the centre of gravity of the pendulum shall be ensured to be horizontal [see figure 1 a)].
- b) The length L_H (unit : m) and the vertical force F_H (unit : N) at L_H shall be measured to an accuracy of $\pm 0.2 \%$.
- c) The horizontal moment M_H (unit : N·m) of the pendulum on the rotation axis shall be determined according to equation (2).

$$M_H = F_H L_H \dots\dots\dots (2)$$

- d) The starting angle α_0 shall be measured to the accuracy of $\Delta\alpha_0$ [see figure 1 b)], which corresponds to the relative accuracy of 1/400 of the potential energy E and, if applicable, the impact angle α_1 to not more than 0.25° . For example, for the starting angles of 140° , 150° and 160° , $\Delta\alpha_0$ shall be 0.39° , 0.54° and 0.81° , respectively.
- e) The potential energy E shall be calculated according to equation (3).

$$E = M_H (\cos \alpha_1 - \cos \alpha_0) \dots\dots\dots (3)$$

where, E : potential energy of pendulum (J)

M_H : horizontal moment of pendulum (N·m) [see equation (2)]

α_0 : starting angle ($^\circ$)

α_1 : impact angle ($^\circ$)

NOTE 1 Most pendulum-type impact-testing machines use an impact angle of 0° , for which $\cos \alpha_1 = 1$.

NOTE 2 In certain cases, it may be necessary to remove the pendulum from the testing machine to determine its moment M_H by the method described.

Table 2 Basic characteristics of Charpy, Izod and tensile-impact testing machine

Potential energy E J	Type of test	Impact velocity v_i m/s	Maximum permissible value due to friction loss without specimen % of E
0.5	Charpy		4
1.0	Charpy		2
2.0	Tensile/Charpy	Tensile : $2.9 (\pm 10 \%)$	1
4.0	Tensile/Charpy	Charpy : $2.9 (\pm 5 \%)^a)$	0.5
5.0	Charpy		0.5
7.5	Tensile/Charpy		
15	Tensile/Charpy	Tensile : $3.8 (\pm 10 \%)$	0.5
25	Tensile/Charpy	Charpy : $3.8 (\pm 5 \%)^a)$	
50	Tensile/Charpy		
1.0	Izod		2
2.75	Izod		1
5.5	Izod	$3.5 (\pm 10 \%)$	0.5
11	Izod		0.5
22	Izod		0.5
Note ^{a)} The error for the impact velocity of Charpy impact testing machine shall be $\pm 5 \%$.			

5.2.4 Impact velocity v_I

5.2.4.1 Numerical value

The impact velocity v_I shall have the value given in table 2 for Charpy, Izod and tensile-impact testing machines, respectively.

5.2.4.2 Determination method

The impact velocity shall be determined according to equation (4).

$$v_I = \sqrt{2g L_I (\cos \alpha_1 - \cos \alpha_0)} \quad \dots\dots\dots (4)$$

where, v_I : impact velocity (m/s)
 g : acceleration of gravity (m/s²)
 L_I : impact length (m) (see 5.2.2)
 α_0 : starting angle (°)
 α_1 : impact angle (°) (see NOTE 1 of 5.2.3)

5.2.5 Types of pendulum-type impact-testing machine

Three types of testing machines are covered by this Standard.

Properties of Charpy impact testing machine are listed in table 3, and an example is shown in figure 2.

Properties of Izod impact testing machine are listed in table 4, and an example is shown in figure 3.

Properties of tensile-impact testing machine are listed in table 5, and examples are shown in figure 4 and figure 5.

Other types of pendulum impact-testing machines are acceptable, if they meet the requirements of this Standard.

Table 3 Properties of Charpy impact testing machine (see figure 2)

Name (component of testing machine)	Symbol in figure 2	Numerical value
Pendulum		
Angle of striker tip	θ_1	$30^\circ \pm 1^\circ$
Radius of striker tip	R_1	2 mm $\pm$ 0.5 mm
Frame and pendulum position		
Parallelism between long axis of specimen and reference plane (if present)	p_1	$\pm 4/1\ 000$
Distance between striking edge and centre of gravity of striker	D_1	± 0.5 mm
Gap between support base and striking edge in midplane	D_2	± 0.5 mm
Specimen support base		
Radius of curvature of support base	R_2	1 mm $\pm$ 0.1 mm
Angle of taper of support base	θ_2	$10^\circ \pm 1^\circ$
Angle of slope of support base	θ_3	$5^\circ \pm 1^\circ$
Angle of support base	θ_4	$90^\circ \pm 0.1^\circ$
Distance between specimen support bases (see table 1 of JIS K 7111-1)	L	62 ^{+0.5} ₀ mm

Table 4 Properties of Izod impact testing machine (see figure 3)

Name (component of testing machine)	Symbol in figure 3	Numerical value
Striking edge		
Radius	R_1	0.8 mm $\pm$ 0.2 mm
Angle relative to long axis of specimen	θ_1	90° $\pm$ 2°
Parallelism with face of specimen (overall length)	p_1	$\pm$ 0.025 mm
Frame and pendulum position		
Horizontality of top surface of vice	p_2	$\pm$ 3/1 000
Squareness between locating groove and top surface of vice	θ_2	90° $\pm$ 0.5°
Distance between top surface of vice and striker tip	D_1	22 mm $\pm$ 0.2 mm
Vice for specimen		
Parallelism between support block and clamping block	p_3	$\pm$ 0.025 mm
Radius of edge of support block of supporting side about which bending takes place	R_2	0.2 mm $\pm$ 0.1 mm
NOTE : The parallelism between the level face and the vice is taken as the horizontality.		

Table 5 Properties of tensile-impact testing machine (see figure 4 and figure 5)

Name (component of testing machine)	Symbol in figure 4 and figure 5	Numerical value
Pendulum		
Parallelism between striker face and crosshead face, and that between anvil face and crosshead face	p_1	$\pm$ 4/1 000
Squareness between striker face or anvil face and plane of swing	p_2	90° $\pm$ 1°
Symmetry of striker and anvil faces with respect to plane of swing	S_1	$\pm$ 0.5 mm
Specimen position		
Symmetry with respect to plane of swing	S_2	$\pm$ 0.5 mm
Angle relative to plane of swing	p_3	$\pm$ 0.2°
Crosshead		
Mass of crosshead (see table 1 of JIS K 7160)	—	—
NOTE : The properties of pendulum impact-testing machines which depend on the specimen position shall be measured using the metallic gauge which are exactly rectangular. Injection-moulded gauges are not suitable due to their draft angles.		

Unit : mm

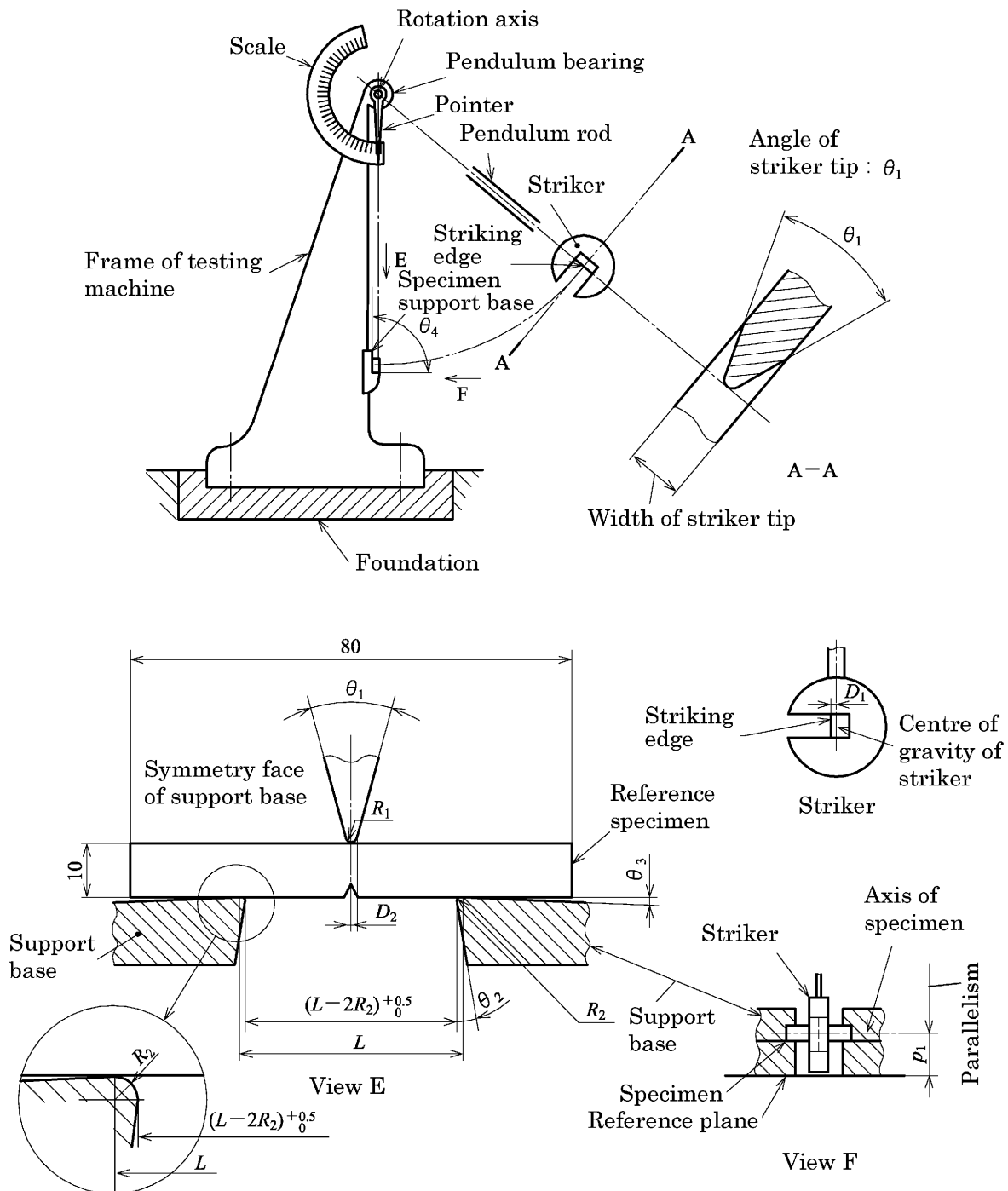
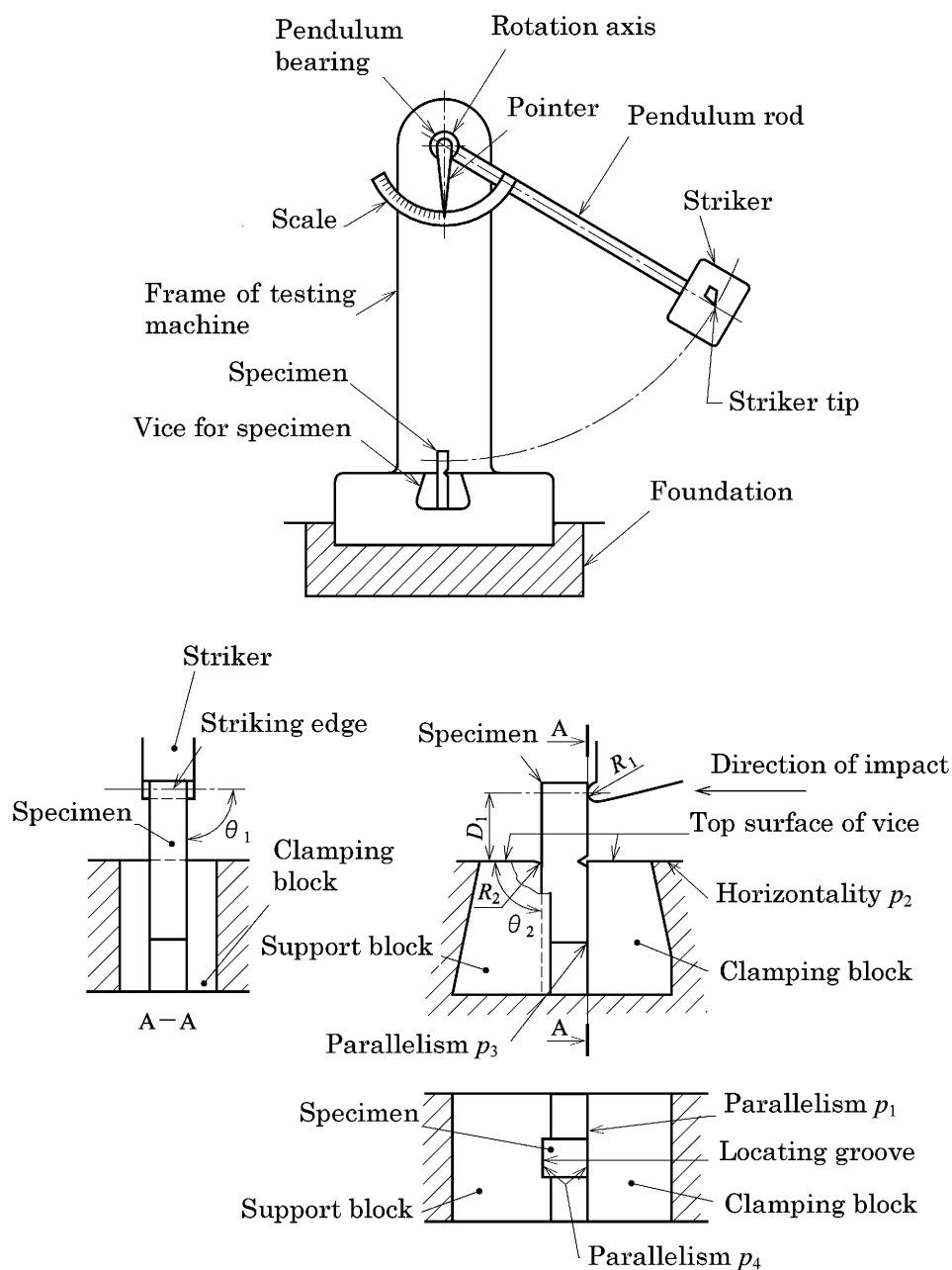


Figure 2 Details of Charpy impact testing machine (for dimensions, see table 3)



NOTE : The support block and the clamping block together form the vice for specimen.

Figure 3 Details of Izod impact testing machine (for dimensions, see table 4)

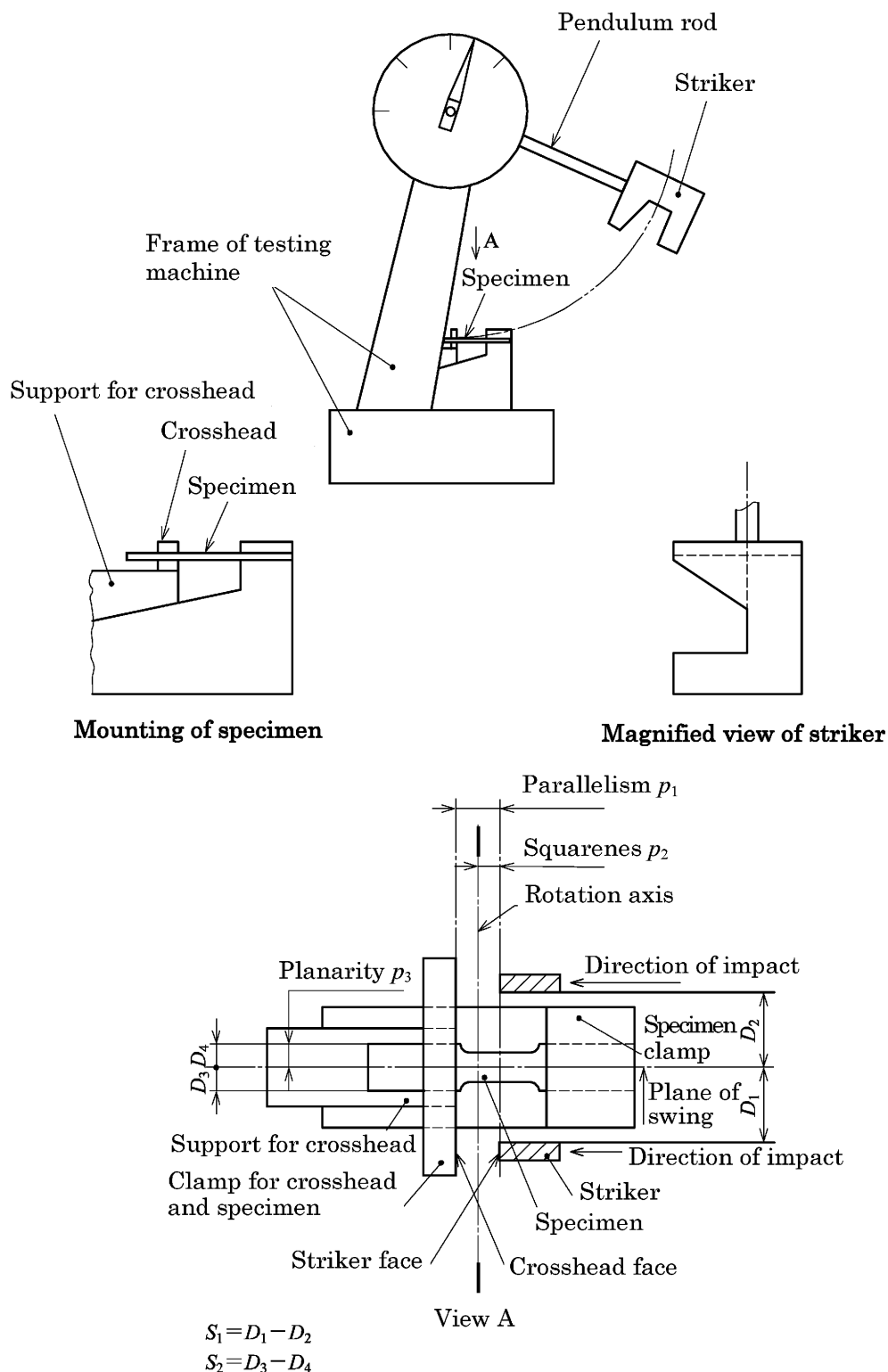


Figure 4 Diagram showing relation of pendulum to specimen clamp of tensile-impact testing machine in method A of JIS K 7160 (for dimensions, see table 5)

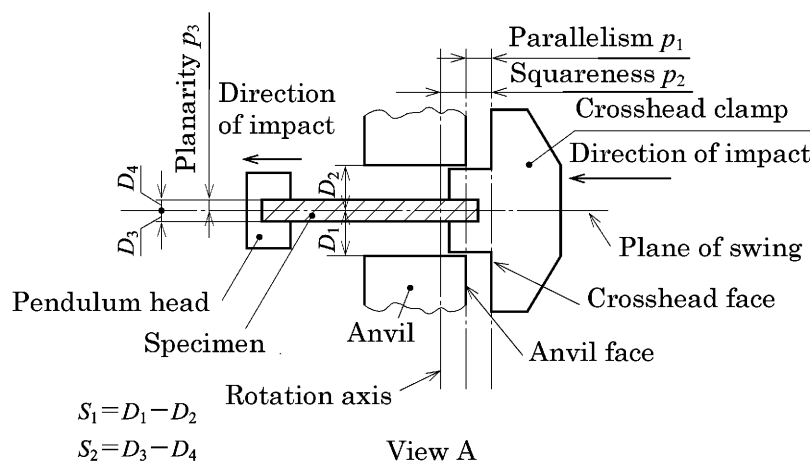
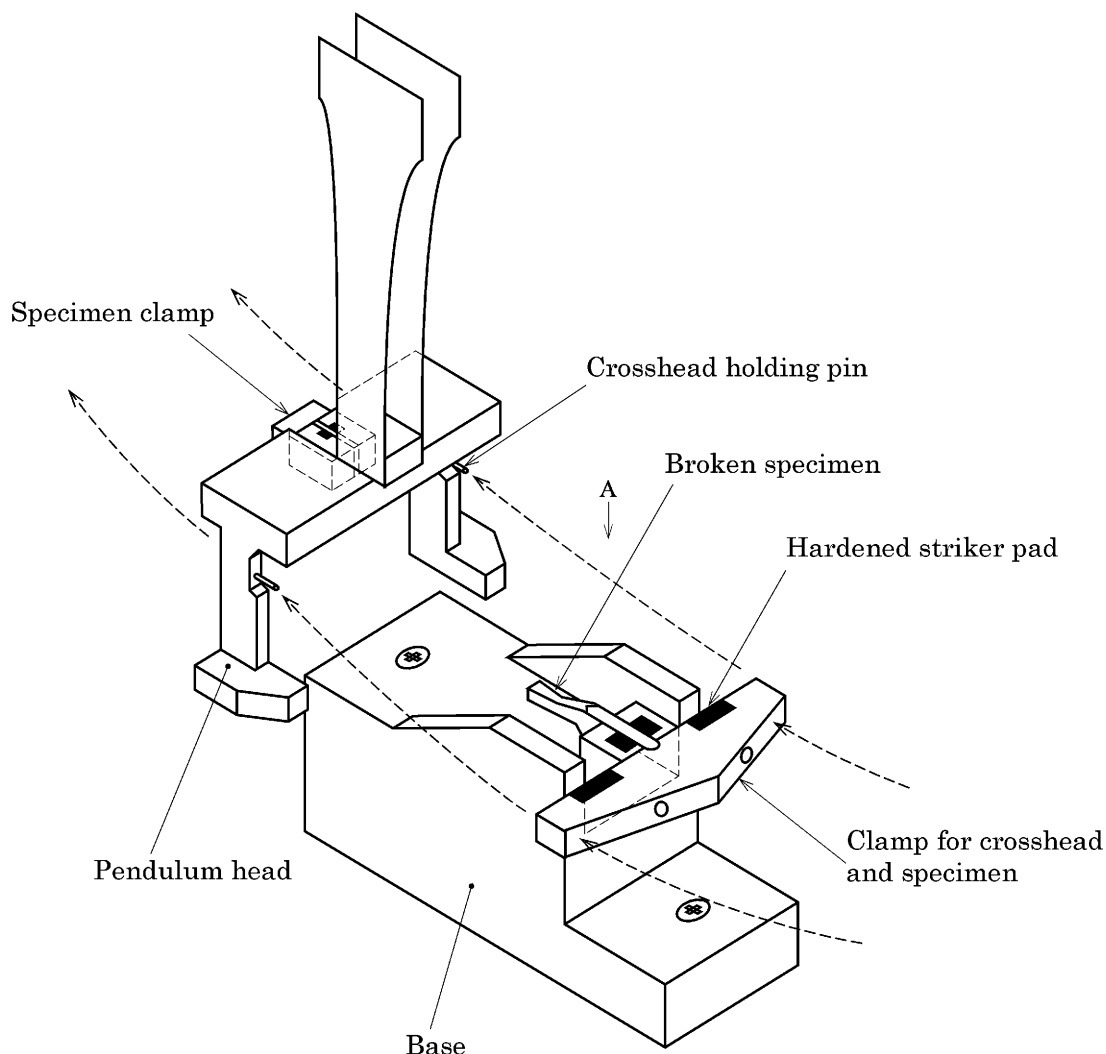


Figure 5 Diagram showing relation of pendulum to specimen clamp of tensile-impact testing machine in method B of JIS K 7160 (for dimensions, see table 5) after breakage of specimen