INTERNATIONAL STANDARD

ISO 13802

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Plastics — Verification of pendulum impact-testing machines — Charpy, Izod and tensile impact-testing

Plastiques — Vérification des machines d'essai de choc pendulaire — Essais de choc Charpy, Izod et choc-traction

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Contents

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 13802 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

Annexes A to E of this International Standard are for information only.

Plastics — Verification of pendulum impact-testing machines — Charpy, Izod and tensile impact-testing

1 Scope

This International Standard specifies methods for the verification of pendulum impact-testing machines used for the Charpy impact test, Izod impact test and tensile impact test described in ISO 179-1, ISO 180 and ISO 8256, respectively.

The test machines covered by this International Standard are of the pendulum type. The impact energy W (see 3.12) absorbed in impacting a test 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. The impact energy is corrected for friction and air-resistance losses (see Table 2 and 5.6).

Methods are described for verification of the geometrical and physical properties of the different parts of the test machine. The verification of some geometrical properties is difficult to perform 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 International Standard.

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

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

A pendulum impact-testing machine verified in accordance with this International Standard, and assessed as satisfactory, is considered suitable for impact testing with unnotched and notched test specimens of different types.

Annex A describes the relationships between the various characteristic pendulum lengths, the potential energy and the moment of inertia of the pendulum.

Annex B explains 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 changes in pendulum velocity just after impact as a function of impact energy and gives the ranges of impact energies for the measurement of which pendulums of specified capacity have to be used.

Annex D discusses the stiffness of the base of the frame necessary to avoid resonant oscillations in the frame due to reaction forces caused by the moving pendulum.

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

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 179-1:—[1)], *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*.

ISO 179-2:1997, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*.

ISO 180:—[2)], *Plastics — Determination of Izod impact strength.*

ISO 8256:1990, *Plastics — Determination of tensile-impact strength.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1
verification
proof, with the use of calibrated standards or standard reference materials, that the calibration of an instrument is acceptable

3.2
calibration
set of operations that establish, under specified conditions, the relationship 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 oscillation of the pendulum
T_P
period, expressed in seconds, of a single complete oscillation (to and fro) of the pendulum, oscillating at angles of oscillation of less that 5° to each side of the vertical

3.4
centre of percussion
point on a pendulum at which a perpendicular impact in the plane of swing does not cause reaction forces at the axis of rotation of the pendulum

3.5
pendulum length
L_P
distance, expressed in metres, between the axis of rotation of the pendulum and the centre of percussion (3.4); it is the length of an equivalent theoretical pendulum mass concentrated at the point which gives the same period of oscillation with its T_P (3.3) as the actual pendulum

3.6
gravity length
L_M
distance, expressed in metres, between the axis of rotation of the pendulum and the centre of gravity of the pendulum

3.7
gyration length
L_G
distance, expressed in metres, between the axis of rotation of the pendulum and the point at which the pendulum mass m_P would have to be concentrated to give the same moment of inertia as the pendulum

[1)] To be published. (Revision of ISO 179:1993)

[2)] To be published. (Revision of ISO 180:1993)

3.8
impact length
L_I
distance, expressed in metres, between the axis of the rotation of the pendulum and the point of impact of the striking edge at the centre of the specimen face

3.9
starting angle
α_0
angle, expressed in degrees, relative to the vertical, from which the pendulum is released

NOTE Usually the test specimen is impacted at the lowest point of the pendulum swing (α_I = 0°). In this case, the starting angle will also be the angle of fall [see Figure 1b)].

3.10
impact velocity
v_I
velocity, expressed in metres per second, of the pendulum at the moment of impact

3.11
potential energy
E
potential energy, expressed in joules, of the pendulum in its starting position, relative to its position at impact

3.12
impact energy
W
energy, expressed in joules, required to deform, break and push away the test specimen

3.13
frame
that part of the machine carrying the pendulum bearings, the supports, the vice and/or clamps, the measurement instruments and the mechanism for holding and releasing the pendulum; the mass of the frame, m_F, is expressed in kilograms

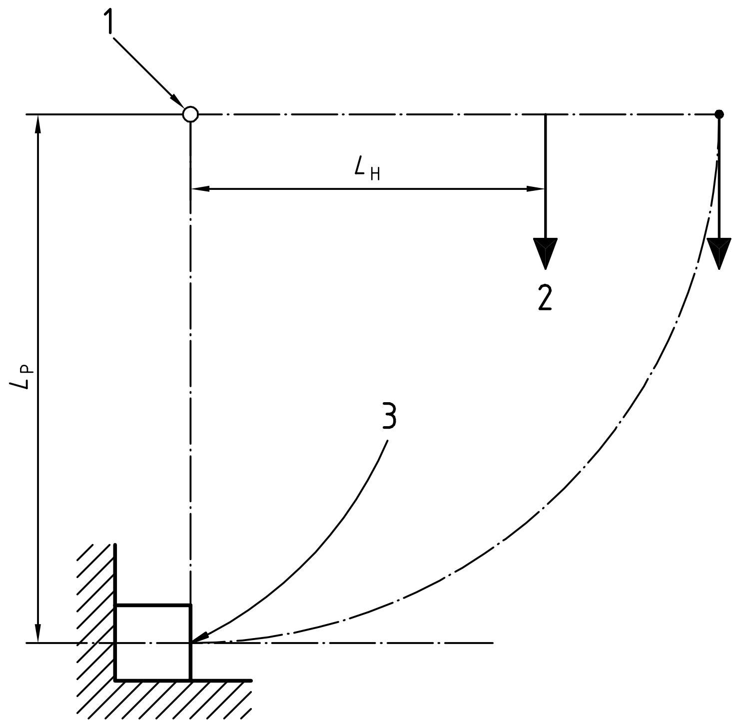
3.14
period of oscillation of the frame
T_F
period, expressed in seconds, of the freely decaying, horizontal oscillation of the frame; it characterizes the oscillation of the frame vibrating against the stiffness of the (resilient) mounting, e.g. a test bench and/or its foundation (which may include damping material for instance) (see annex D)

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

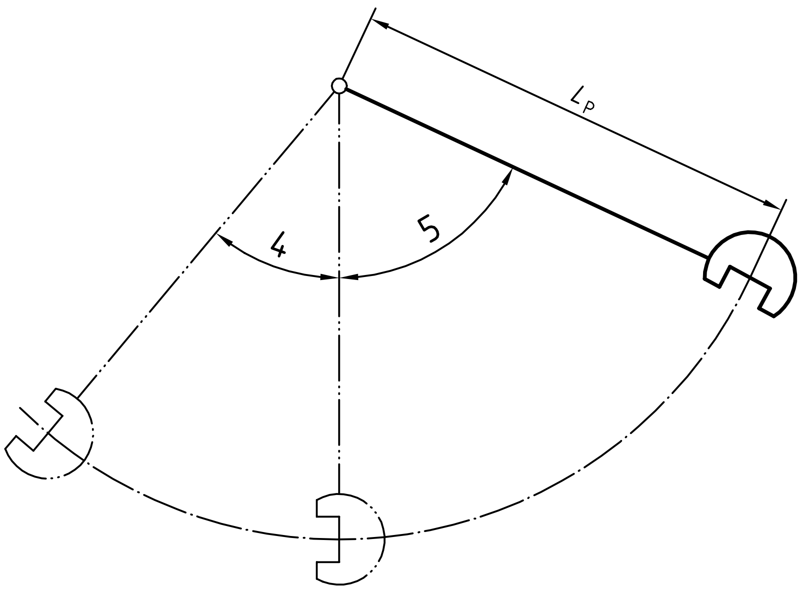
4 Measurement instruments

The verification methods described in this International Standard call for the use of straight edges, vernier calipers, set squares, levels and dynamometers, load cells or scales and timing devices to check if the geometrical and physical properties of the components of the test machine conform to the requirements given in this International Standard.

These measurement instruments shall be accurate enough to measure the parameters within the tolerance limits given in clause 5.



a) Quantities necessary to determine the horizontal moment



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

Key

1 Axis of rotation
2 Vertical force, F_H
3 Centre of percussion
4 Angle of rise, α_R
5 Starting angle, α_0

Figure 1 — Quantities necessary for energy verification

5 Verification of test machines

5.1 Components of test machines

The essential components are as follows:

5.1.1 Pendulum

5.1.1.1 Pendulum rod.

5.1.1.2 Striker, with striking edge for bending impact tests (see ISO 179 and ISO 180) or with striking surfaces or clamps for tensile impact testing (see ISO 8256:1990, test methods A and B respectively).

5.1.2 Frame

5.1.2.1 Test specimen supports, for Charpy impact testing (see ISO 179);

5.1.2.2 Vice, for Izod impact testing (see ISO 180);

5.1.2.3 Clamps or stops, for tensile impact testing (see ISO 8256, methods A and B);

5.1.2.4 Mechanism for holding and releasing the pendulum.

5.1.3 Energy indicating device

5.1.4 Crossheads for tensile impact testing

5.2 Pendulum

5.2.1 Pendulum length, L_P

Determine the pendulum length L_P from the period of oscillation T_P of the pendulum using the equation

$$L_P = \frac{g T_P^2}{4\pi^2} \quad (1)$$

where

g is the local acceleration due to gravity, in metres per second squared;

T_P is the period of oscillation of the pendulum, in seconds.

The value of T_P shall be determined to a precision of 0,2 %.

Determine the period of oscillation T_P as the mean value of four determinations, of total duration $n \cdot T_P$, of n consecutive oscillations to an accuracy of 0,1 s. Together with the precision demanded above of L_P, this results in a minimum number n of oscillation given by $n \geqslant 100/T_P$.

The use of a timing device accurate to better than 0,1 s allows the number of oscillations to be reduced accordingly (see Table 1).

Table 1 — Examples of minimum number of oscillations for determination of 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 L_I (3.8) shall be within 1 % of the pendulum length L_P, as determined from the period of oscillation T_P of the pendulum [see equation (1) and Figure 1a)].

5.2.3 Potential energy, E

The potential energy E shall not differ by more than ± 1 % from the nominal value given in the first column of Table 2.

Determine the potential energy by the following procedure, or by any other method capable of determining the initial potential energy of the pendulum to within the precision specified above.

a) Support the pendulum at an arbitrary length L_H from the axis of rotation, on a balance or dynamometer. Ensure that the line from the axis of rotation to the centre of gravity of the pendulum is horizontal [see Figure 1a)].

b) Measure the vertical force F_H, in newtons, at L_H and the length $L_{H,}$ in metres, to a precision of ± 0,2 %.

c) Calculate the horizontal moment M_H of the pendulum about the axis of rotation, in newton metres, using the equation:

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

d) Measure the starting angle α_0 [see Figure 1b)] to a precision $\Delta\alpha_0$ which corresponds to a relative precision of 1/400th of the potential energy E and, if applicable, the impact angle α_I to within 0,25°. Thus, for starting angles of 140°, 150° and 160°, $\Delta\alpha_0$ is 0,39°, 0,54° and 0,81°, respectively.

e) Calculate the potential energy E of the pendulum from the equation:

$$E = M_H(\cos\alpha_I - \cos\alpha_0) \quad (3)$$

where

E is the potential energy of the pendulum, in joules;

M_H is the horizontal moment of the pendulum [see equation (2)], in newton metres;

α_0 is the starting angle, in degrees;

α_I is the impact angle, in degrees.

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

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

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

Potential energy E J	Type of test	Impact velocity v_I m/s	Maximum permissible losses due to friction without test specimen % of E
0,5	Charpy	2,9 (± 10 %)	4
1,0	Charpy		2
2,0	Tensile		1
4,0	Tensile		0,5
5,0	Charpy		0,5
7,5	Tensile	3,8 (± 10 %)	0,5
15	Tensile		
25	Tensile		
50	Tensile		
1,0	Izod	3,5 (± 10 %)	2
2,75	Izod		1
5,5	Izod		0,5
11	Izod		0,5
22	Izod		0,5

5.2.4 Impact velocity, v_I

5.2.4.1 Value

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

5.2.4.2 Determination

Determine the impact velocity using the equation:

$$v_I = \sqrt{2gL_I(\cos\alpha_I - \cos\alpha_0)} \quad (4)$$

where

v_I is the impact velocity, in metres per second;

g is the local acceleration due to gravity, in metres per second squared;

L_I is the impact length (see 5.2.2), in metres;

α_0 is the starting angle, in degrees;

α_I is the impact angle, in degrees (see note 1 to 5.2.3).

5.2.5 Types of pendulum impact-testing machine

Three different types of test machine are covered by this International Standard.

Figure 2 shows a typical example of a Charpy test machine. Important values to be verified are listed in Table 3.

Figure 3 shows a typical example of an Izod test machine. Important values to be verified are listed in Table 4.

Figures 4 and 5 show typical examples of tensile impact-testing machines. Important values to be verified are listed in Table 5.

There are several pendulum designs available, and they are acceptable if they meet the requirements of this International Standard.

Table 3 — Properties of Charpy machines

Parameter	Symbol used in Figure 2	Unit	Value
Pendulum			
Angle of striker tip	θ_1	degrees	30 ± 1
Radius of striking edge	R_1	mm	2 ± 0,5
Frame/pendulum position			
Parallelism between long axis of test specimen and reference plane (if present)	p_1	—	± 4/1 000
Distance between striking edge and centre of gravity of striker			
Position of midplane between supports, relative to striking edge	D_1	mm	± 0,5
	D_2	mm	± 0,5
Test specimen supports			
Radius of curvature of supports	R_2	mm	1 ± 0,1
Angle of taper of supports	θ_2	degrees	10 ± 1
Angle of slope of supports	θ_3	degrees	5 ± 1
Angle of supports	θ_4	degrees	90 ± 0,1

Table 4 — Properties of Izod machines

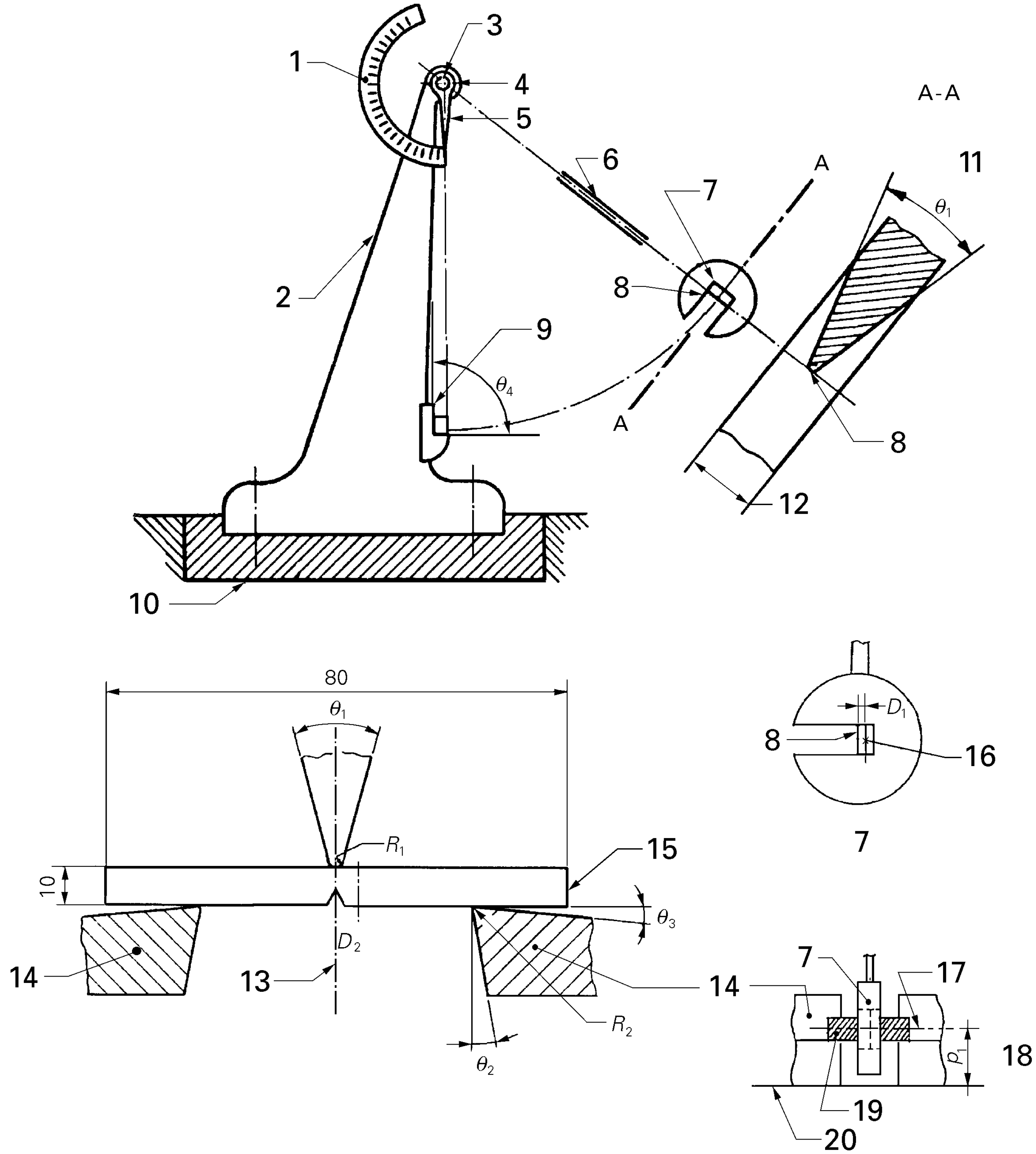
Parameter	Symbol used in Figure 3	Unit	Value
Striking edge			
Radius	R_1	mm	0,8 ± 0,2
Angle relative to long axis of test specimen	θ_1	degrees	90 ± 2
Parallelism with face of test specimen (over full width)	p_1	mm	± 0,025
Frame/pendulum position			
Horizontality of top surface of vice	p_2	—	± 3/1 000
Angle between locating groove and top surface of vice	θ_2	degrees	90 ± 0,5
Location of striking edge above top surface of support	D_1	mm	22 ± 0,2
Vice faces			
Parallelism in horizontal and vertical direction	p_3	mm	± 0,025
Radius of top edge of support about which bending takes place	R_2	mm	0,2 ± 0,1

Table 5 — Properties of tensile impact machines

Parameter	Symbol used in Figures 4 and 5	Unit	Value
Pendulum			
Parallelism of striker/anvil faces with crosshead face	p_1	—	± 4/1 000
Angle between striker/anvil faces and plane of swing	p_2	degrees	90 ± 1
Symmetry of striker/anvil faces with respect to plane of swing	S_1	mm	± 0,5
Test specimen position			
Symmetry with respect to plane of swing	S_2	mm	± 0,5
Angle relative to plane of swing	p_3	degrees	± 0,2
Crossheads			
For mass of crosshead, see ISO 8256:1990, Table 1			

NOTE The properties of pendulum impact-testing machines which depend on the test specimen position can only be measured using metallic gauge specimens which are exactly rectangular. Injection-moulded specimens are not suitable due to their draft angles.

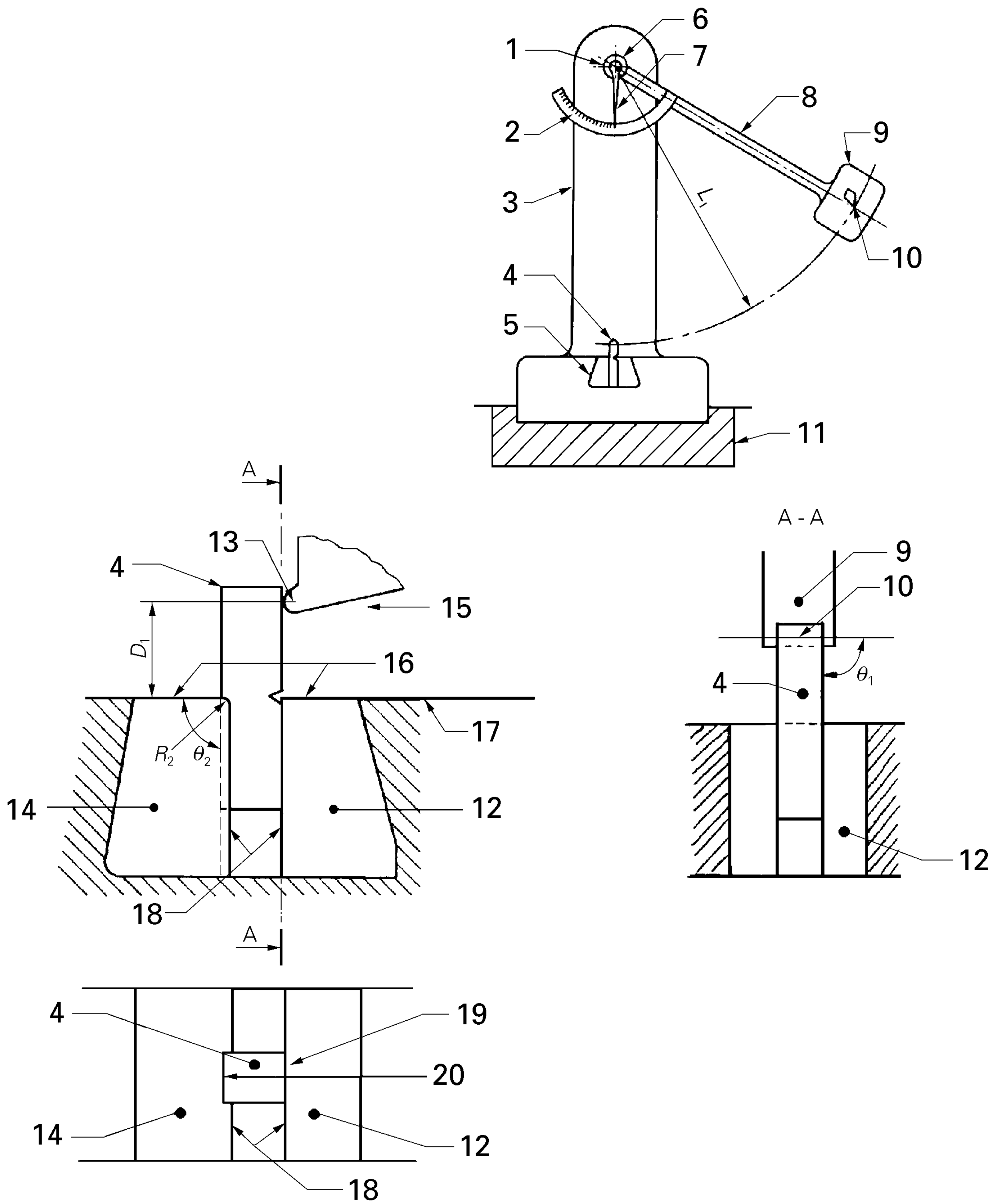
Dimensions in millimetres



Key

1 Scale
2 Machine frame
3 Axis of rotation
4 Pendulum bearings
5 Friction pointer
6 Pendulum rod
7 Striker
8 Striking edge
9 Test specimen supports
10 Foundation
11 Included angle of striker, θ_1
12 Width of striker
13 Plane of symmetry of supports
14 Support
15 Standard test specimen
16 Centre of gravity of striker
17 Axis of test specimen
18 Parallelism, p_1
19 Test specimen
20 Reference plane

Figure 2 — Details of Charpy test machine (for dimensions, see Table 3)

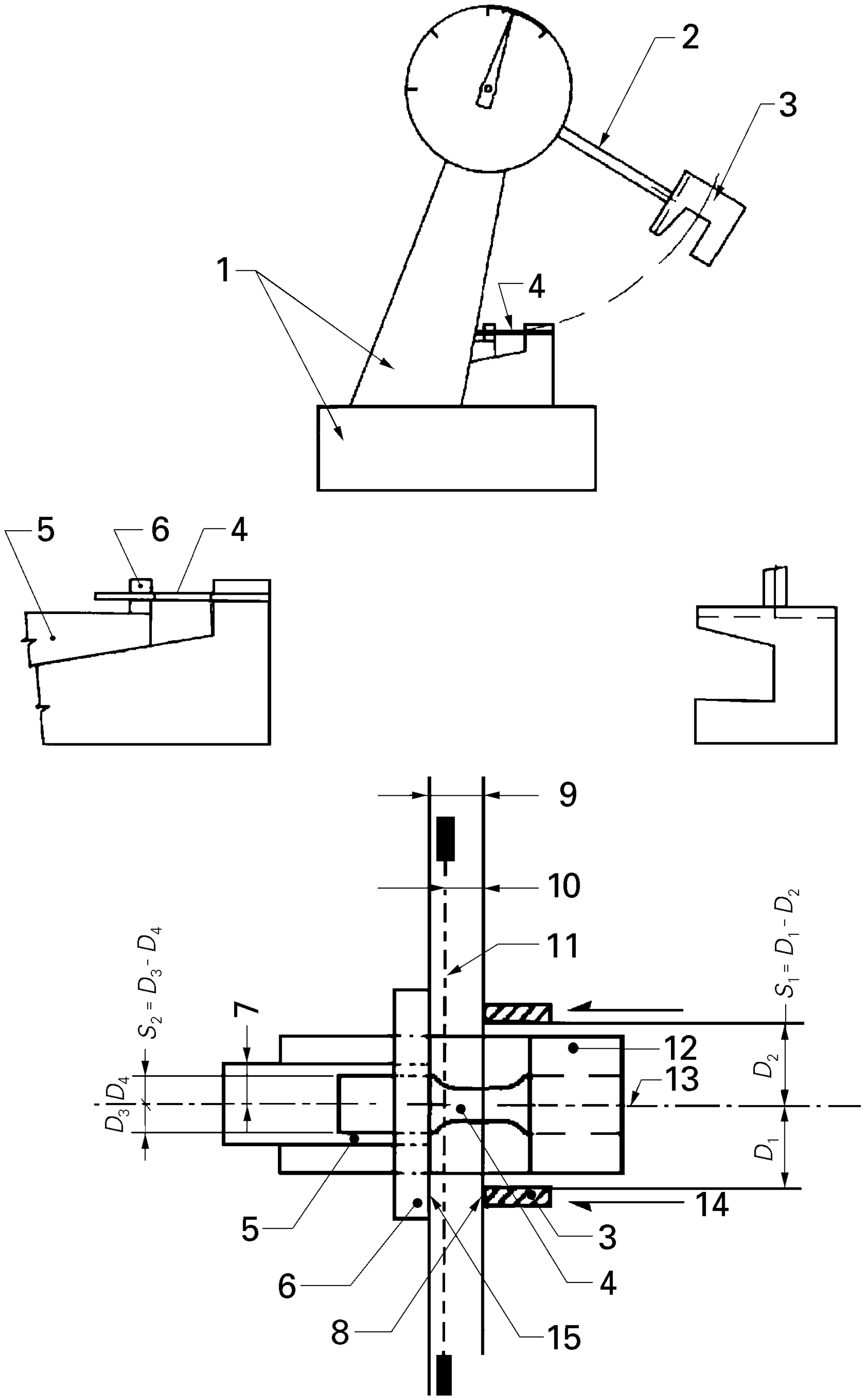


Key

1 Pendulum bearings
2 Scale
3 Frame
4 Test specimen
5 Test specimen supports
6 Axis of rotation
7 Friction pointer
8 Pendulum arm
9 Striker
10 Striking edge
11 Foundation
12 Clamping block
13 Radius of curvature of striking edge
14 Support block
15 Direction of impact
16 Top surface of vice
17 Horizontality, p_2
18 Parallelism, p_3
19 Parallelism, p_1
20 Locating groove

NOTE The support and clamping block together form a vice.

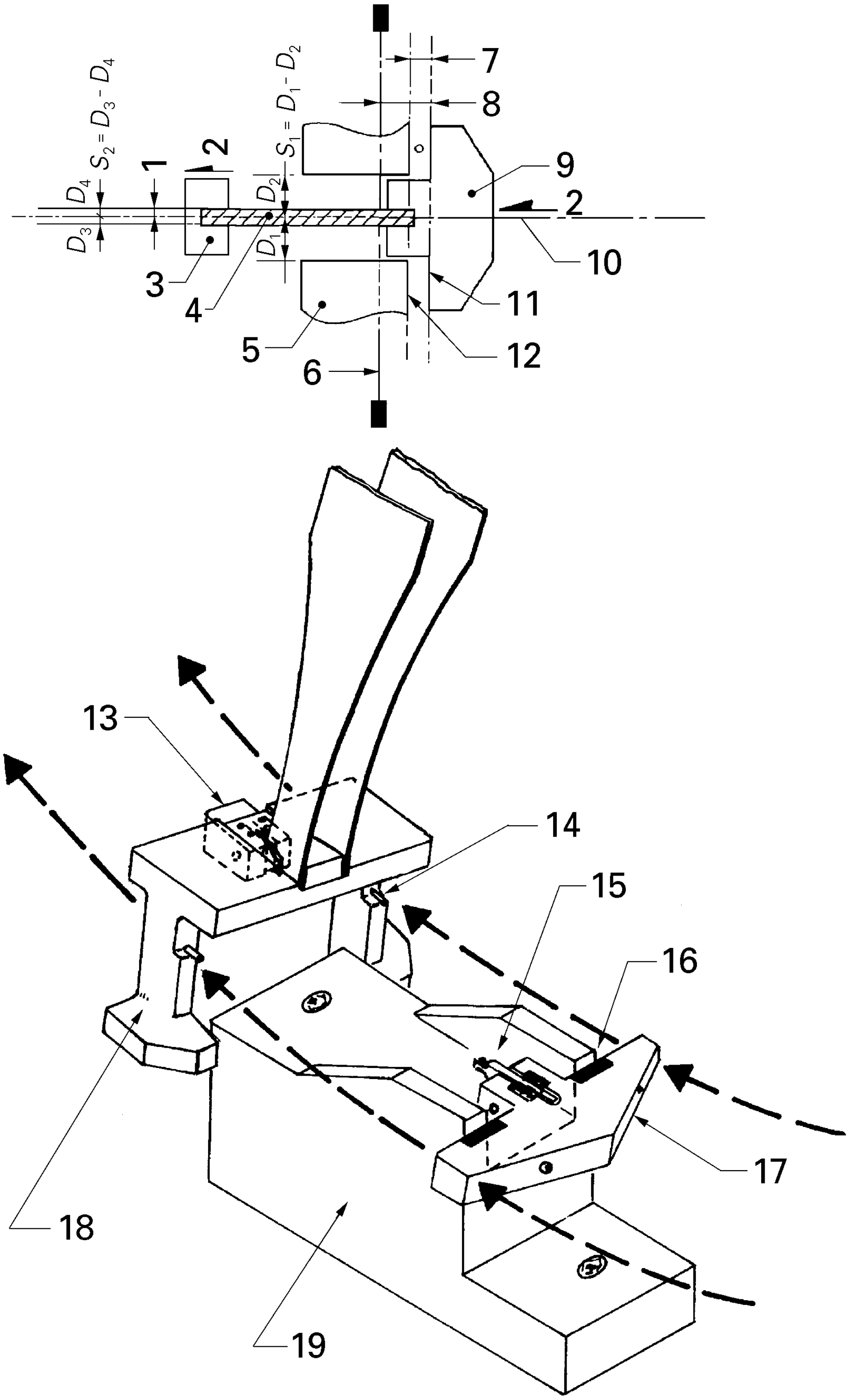
Figure 3 — Details of the Izod-test device (for dimensions, see Table 4)



Key

1 Frame
2 Pendulum rod
3 Striker
4 Test specimen
5 Support for crosshead
6 Crosshead
7 Coplanarity, p_3
8 Striker face
9 Parallelism, p_1
10 Parallelism, p_2
11 Axis of rotation
12 Vice jaw
13 Plane of swing
14 Direction of blow
15 Crosshead face

Figure 4 — Diagrams showing relationship of pendulum to test specimen clamps in tensile impact test machines for use in method A of ISO 8256:1990 (for dimensions, see Table 5)



Key

1 Coplanarity, p_3
2 Direction of blow
3 Pendulum head
4 Test specimen
5 Anvil
6 Axis of rotation
7 Parallelism, p_1
8 Parallelism, p_2
9 Crosshead clamp
10 Plane of swing
11 Crosshead face
12 Anvil face
13 Unsecured specimen clamp
14 Pin for other devices for holding unsecured crosshead during downward travel
15 Broken specimen
16 Hardened striker pad (if necessary to prevent permanent deformation)
17 Unsecured crosshead/specimen clamp
18 Pendulum head
19 Base

Figure 5 — Diagrams showing relationship of pendulum to test specimen clamps after test specimen rupture, for tensile impact test machines for use in method B of ISO 8256:1990 (for dimensions, see Table 5)

5.3 Basic properties of the frame

5.3.1 Construction

The frame shall be of rigid construction (see Table 6). Pendulum impact machines designed for use with this International Standard shall have the rotation shaft (upper part) free of obstructions to allow a direct level check using a proper level on the reference plane (see 5.3.2). The centre of gravity of the frame shall be at the same height as the centre of percussion of the pendulum at impact and in the plane of swing of the pendulum.

Table 6 — General characteristics of frame

Parameter	Unit	Value
Horizontality of axis of rotation of pendulum		
a) Machine with reference plane[1)]	—	± 2/1 000 relative to the reference plane
b) Machine without reference plane	—	± 4/1 000
Longitudinal play of bearings	mm	0,25
Radial play of bearings	mm	0,05
1) To be certified by the manufacturer.		

5.3.2 Levelling the frame

The frame shall be installed so that the reference plane is horizontal to within 2/1 000 and so that the axis of rotation is either horizontal to within 4/1 000 or parallel to the reference plane to within 2/1 000. In order to maintain the frame in position and the stiffness of the mounting (see 5.3.3), the adjustment screws shall be fixed after levelling.

5.3.3 Mass of frame and pendulum and stiffness of mounting

After an impact on a test specimen for which the work to break is greater than the potential energy of the pendulum, there shall be no visible displacement of the frame on the test bench.

Unless the ratio $m_F/m_{P,max}$ of the mass of the frame to the mass of the heaviest pendulum used is at least 40, the frame shall be fixed to a rigid test bench.

The minimum value of the ratio $m_F/m_{P,max}$ of the mass of the frame to the mass of the heaviest pendulum used depends on the maximum relative impact energy W_{max}/E_{max} measured (see Table 7 and annex B).

Table 7 — Minimum ratio of mass of frame to mass of pendulum as a function of maximum relative impact energy W_{max}/E_{max} measured, allowing a relative-energy error $\Delta W/E_{max}$ of, at the most, 0,5 %

W_{max}/E_{max}, in percent	40	50	60	70	80
$m_F/m_{P,max}$	10	18	28	42	62

NOTE 1 It is recommended that a mass ratio $m_F/m_{P,max}$ of 40 is used, which is suitable for the measurement of impact energies which are up to 70 % of the potential energy of the heaviest pendulum, e.g. $W_{max} \leqslant 35$ J for $E_{max} = 50$ J.

In order to avoid resonant transmission of energy from the pendulum to the frame during a single swing without a test specimen, the period of oscillation of the frame T_F shall satisfy the following inequality (see also annex D):

$$T_F \leqslant T_P/7 \tag{5}$$

where

T_F is the period of oscillation of the frame, in seconds;

T_P is the period of oscillation of the pendulum, in seconds.

NOTE 2 Commonly used pendulums have periods of oscillation T_P between 0,9 s and 1,3 s. Their frames, therefore, have to have a sufficiently stiff mounting for their period of oscillation T_F to be less than 0,13 s and 0,19 s, respectively.

The stiffness of the mounting S_F shall satisfy the following inequality:

$$S_F \geqslant \frac{4\pi^2 m_F}{T_F^2} \qquad (6)$$

Using the recommended mass ratio $m_F / m_{P,max}$ of 40 and combining inequality (5) with inequality (6) gives

$$S_F \geqslant \frac{7{,}7 \times 10^4 \times m_{P,max}}{T_P^2} \qquad (7)$$

where

S_F is the stiffness of the mounting, in newtons per metre;

$m_{P,max}$ is the mass of the heaviest pendulum, in kilograms;

T_P is the period of oscillation of the pendulum, in seconds.

NOTE 3 The stiffness of the mounting S_F may be determined, for instance, from the displacement s caused by a known horizontal force F_F ($S_F = F_F / s$) acting on the frame in the direction of impact (see Figure D.3). Alternatively, the period of oscillation of the frame T_F may be deduced from the resonant vibration excited by an impulse acting in the direction of impact and monitored by a suitable recording device.

5.4 Bearing

The end play in the axial direction in the bearings (see Table 6) of the pendulum spindle shall not exceed 0,25 mm, and the total play in the radial direction shall not exceed 0,05 mm.

The radial play can be measured, for example, by a dial gauge mounted on the frame close to the bearing housing in order to indicate movement in the bearings at the end of the spindle when a force is applied to the pendulum perpendicularly to the plane of swing. It is recommended that this perpendicular force is of the same order of magnitude as the weight of the heaviest pendulum used.

5.5 Energy indicator

5.5.1 Types of scale

The machine may be graduated either in angle of rise α_R [see Figure 1b)] or in impact energy W absorbed, the two being related by the equation

$$W = M_H(\cos\alpha_R - \cos\alpha_0) \qquad (8)$$

where

W is the impact energy, in joules;

M_H is the horizontal moment of the pendulum, as given by equation (2), in newton metres;

α_0 is the starting angle, expressed in degrees;

α_R is the angle of rise, in degrees.

NOTE It may be useful to have the scale graduated both in joules of absorbed energy and in degrees. Also, for the installation and calibration of the machine and the measurement of friction losses, it is useful to be able to change the starting angle.

5.5.2 Scale resolution

The resolution ΔW of the scale for the impact energy W, which may be analogue or digital, shall be at least 1/400th of the potential energy E, corresponding to the resolution $\Delta\alpha_R$ of the angle of rise α_R, as given, in degrees, by the equation

$$\Delta\alpha_R = \frac{180(1-\cos\alpha_0)}{\pi(400\sin\alpha_R)} \tag{9}$$

NOTE For a starting angle α_0 of e.g. 145°, $\Delta\alpha_R$ = 0,26° at the most critical range near α_R = 90°. The values of the resolutions ΔW and $\Delta\alpha_R$ indicated above include uncertainties influencing the readings like parallax and/or thickness of the pointer and fluctuations of digital scales.

5.5.3 Calibration of energy/angle of rise scale

The graduation marks on the scale, corresponding to approximately 10 %, 20 %, 30 %, 50 % and 70 % of the range of the scale shall be checked as follows, measuring angle of rise to the precision specified in 5.5.2:

a) Operate the machine normally, but without a test specimen in position, and obtain a zero reading ($W_{S,1}$) as indicated by the pointer. Record this reading, which shall not exceed ± 2,5 % of the potential energy E.

b) Support the pendulum so that the zero reading ($W_{S,1}$) is indicated by the pointer and measure the corresponding angle of rise $\alpha_{R,1}$.

c) Support the pendulum so that the mark for each of the above calibration positions is indicated by the pointer, and measure the corresponding angle of rise $\alpha_{R,I}$ for each position.

d) Calculate the absorbed energy W_I using the following equation:

$$W_I = M_H(\cos\alpha_{R,I} - \cos\alpha_{R,1}) \tag{10}$$

NOTE The precision specified for L_I and F_H (see 5.2.3) and for $\alpha_{R,1}$ and $\alpha_{R,I}$ enables W_I to be determined to a precision of approximately 0,3 % of full-scale deflection.

e) Repeat steps a) to d) twice.

f) Calculate the mean of the three determinations. The difference between the individual values and their mean shall not exceed 1 % of the energy corresponding to the indicated value or 1 % of the full-scale value, whichever is the greater.

5.6 Losses due to friction

5.6.1 Types of loss

Energy is absorbed by friction, including in the pointer (if the machine has one) or in electronic angular-displacement transducers, air resistance and friction in the pendulum bearings.

5.6.2 Determination of the loss due to friction in the pointer

If the machine has a pointer, determine the loss due to friction in the pointer $W_{f,P}$ using the following procedure:

a) Operate the machine normally, but without a test specimen, to obtain a first reading $W_{f,1}$.

b) Without resetting the pointer, again release the pendulum from the initial position and obtain a second reading $W_{f,2}$.

c) Repeat steps a) and b) twice.

d) Calculate the means of the three determination of $W_{f,1}$ and $W_{f,2}$.

e) Calculate the loss due to friction in the pointer $W_{f,P}$ for one swing by subtracting the mean of the second readings $W_{f,2}$ from the mean of the first readings $W_{f,1}$, i.e.

$$W_{f,P} = W_{f,1} - W_{f,2} \tag{11}$$

5.6.3 Determination of losses due to air resistance and friction in the pendulum bearings

Determine the losses due to air resistance and friction in the pendulum bearings using the following procedure:

a) If the machine has a pointer, operate the machine as described in 5.6.2 to obtain a reading $W_{f,2}$. Allow the pendulum to continue to swing freely. At the beginning of the tenth forward swing after measuring $W_{f,2}$, reposition the pointer so that, on completion of this swing, it is driven only a few divisions along the scale. Record the reading $W_{f,3}$.

b) Repeat step a) twice.

c) Calculate the means of the three determinations of $W_{f,2}$ and $W_{f,3}$.

d) Calculate the energy lost due to air resistance and pendulum bearing friction $W_{f,AB}$ for one swing using the equation

$$W_{f,AB} = \frac{W_{f,3} - W_{f,2}}{20} \tag{12}$$

NOTE Electronic angular-displacement transducers are frequently used to measure pendulum motion. These devices are either frictionless optoelectronic devices or their frictional losses are included in $W_{f,AB}$.

5.6.4 Calculation of the total energy lost due to friction

Calculate the total energy lost due to friction W_f using the equation:

$$W_f = \frac{1}{2}\left[W_{f,AB} + \frac{\alpha_R}{\alpha_0}\left(W_{f,AB} + 2W_{f,P}\right)\right] \tag{13}$$

5.6.5 Maximum permissible losses due to friction

The total losses due to friction for one swing shall not exceed the applicable value(s) given in Table 2.

The total energy lost W_f calculated from equation (13), shall be subtracted from the impact energy measured with a test specimen, but only in cases when W_f exceeds 0,5 % of the potential energy E, i.e. only for pendulums with a potential energy less than 4 J (see Table 2).

5.7 Test specimen supports, clamps and crossheads

5.7.1 Supports in Charpy test machines

The test specimen supports in Charpy machines (see Figure 2) shall conform to all of the following requirements:

5.7.1.1 Arrangement of supports

The test specimen supports shall be located one on each side of the plane of swing of the pendulum and shall each consist of two mutually perpendicular surfaces normal to the plane of swing of the pendulum. Essentially, one of these two surfaces supports the specimen and the other takes the reaction from the impact on the specimen. The corresponding surfaces on each of the two supports shall be coplanar.

A recess shall be provided at the junction between the two surfaces, to accommodate flash along one edge of the specimen, for instance.

5.7.1.2 Orientation of supports

When a specimen measuring (80 mm ± 0,2 mm) × (10 mm ± 0,2 mm) × (4 mm ± 0,2 mm) is used, the supports shall conform to the following requirements:

a) the long axis shall be parallel, to within 4/1 000, to the reference plane of the machine;

b) the surfaces shall be parallel, to within 4/1 000, to the corresponding faces of the specimen;

c) when the striking edge of the pendulum is in contact with the specimen, the striking edge and the face of the specimen shall be coincident to within 0,025 mm over the full length of the striking edge, and the line of contact shall be perpendicular, to within 2°, to the longitudinal axis of the specimen.

   NOTE One method of verifying this is as follows: A specimen is tightly wrapped in thin paper (e.g. using adhesive tape) and placed in the supports. Similarly, the striker edge is tightly wrapped in carbon paper with the carbon outside (i.e. not facing the striker). From its position of equilibrium, the pendulum is raised a few degrees, released so that it contacts the specimen, but prevented from contacting the specimen a second time. The mark made by the carbon paper on the covering round the specimen should extend across the whole width of the specimen. This test may be performed concurrently with that to check the angle of contact between the striker and the specimen (see 5.8.1).

5.7.1.3 Angle between support surfaces

When checked by a gauge, the angle between the two surfaces of each support shall be 90° ± 0,1°.

5.7.1.4 Distance between supports

This may vary (see ISO 179-1).

5.7.1.5 Slope of supports

The slope (see Figure 2) of the supports, as checked by a gauge, shall be 5° ± 1°.

5.7.1.6 Taper of supports

The taper (see Figure 2) of the supports, as checked by a gauge, shall be 10° ± 1°.

5.7.1.7 Radius of curvature of supports

The radius of curvature of the supports, as checked by a gauge, shall be 1 mm ± 0,1 mm.

5.7.1.8 Location of notch

If means is provided for locating the test specimen, this shall ensure that the plane of symmetry of the notch lies within ± 0,5 mm of the centre of the gap between the specimen supports.

NOTE A gauge that can be used to check the distance between the supports and their alignment relative to the striking edge is shown in annex E.

5.7.2 Vices for Izod test machines

Vices designed to hold the test specimen in Izod machines (see Figure 3) shall conform to all of the following requirements:

5.7.2.1 Locating groove for specimen

The specimen-locating groove in the support blocks (if fitted) shall be checked with a gauge and shall conform to the dimensional requirements specified in Table 4.

The locating groove shall enable the specimen to be fully supported at the face about which bending takes place.

The top edge of the support about which bending takes place shall be rounded to a radius of 0,2 mm ± 0,1 mm.

5.7.2.2 Location of specimen and striker

When a specimen having the dimensions given in 5.7.1.2 is located in the vice and clamped so that it is attached rigidly to the frame, the following requirements shall be conformed to:

a) the top surface of the support block shall be parallel, to within 3/1 000, to the reference plane of the machine;

b) the longitudinal axis of the specimen shall be perpendicular, to within ± 0,5°, to the top surface of the support block;

c) the notch, which shall face the striker, shall be perpendicular to the plane of swing of the pendulum, and the plane of symmetry of the notch shall coincide with the top surface of the support block, both within ± 0,1 mm;

d) when it contacts the specimen, the striking edge, which shall be sufficiently wide to extend beyond both sides of the specimen, shall be perpendicular, to within ± 2°, to the longitudinal axis of the specimen and parallel, to within 0,025 mm (= 0,36°), to the face of the specimen, over the full width of the specimen.

5.7.2.3 Vice faces

With a specimen clamped in place, the vice faces shall be parallel, to within 4/1 000, in both the horizontal and the vertical direction.

5.7.3 Clamps for tensile impact testing

5.7.3.1 General

For specimen types 1, 2, 3 and 4 (see ISO 8256:1990, Table 2 and Figure 3), the surfaces between which the specimen is clamped shall be such that there is no slippage when the blow is struck. This applies to the jaw faces of the clamps attached to the frame or striker, as well as to the crossheads. The clamps shall be of such a design that they do not contribute to the failure of the specimen.

Jaws may have file-like serrations, and the size of the serrations shall be selected, according to experience, to suit the hardness and toughness of the specimen material and its thickness. The edges of the serrated jaws in close proximity to the test region shall have a radius such that they cut across the edges of the first serrations.

5.7.3.2 Special clamps (jaws)

For type 5 specimens (see ISO 8256:1990, Table 2 and Figure 3), held only by embedding, a pair of notched jaws of different heights is necessary. The pair of jaws chosen for the test shall have a height which is greater than the thickness of the specimen but less than 120 % of its thickness.

5.7.3.3 Alignment

When clamped in place, the specimen shall lie the plane of swing of the pendulum to within ± 0,5 mm.

5.7.4 Crossheads for tensile impact testing

5.7.4.1 Mass of crosshead

Depending on the energy of the pendulum used, crossheads of different masses have to be used. Ensure, by weighing, that the crosshead mass conforms to the limits given in Table 1 of ISO 8256:1990.

NOTE In order to reduce bouncing due to the impact of the metal striker on metal crossheads, it is recommended that a material is used for the crosshead which gives an essentially inelastic impact. Ductile aluminium has been found satisfactory.

5.7.4.2 Alignment of crossheads

Means shall be provided to ensure conformity to the following requirements after clamping the specimen in place:

a) the impacted faces of the crosshead shall be coplanar and parallel, to within 2/100, to the axis of rotation of the pendulum;

b) the centres of the impacted faces shall be symmetrical, to within ± 0,5 mm, to the plane of swing of the pendulum.

5.8 Striker

5.8.1 Striker for Charpy test machines

The striking edge of the pendulum shall be hardened steel tapered to an included angle of 30° ± 1° and shall be rounded to the radius R_1 of 2 mm ± 0,5 mm. These dimensions can be checked with gauges (see annex E). The striking edge shall pass midway, to within ± 0,2 mm, between the specimen supports, and shall be aligned so that it makes contact across the full width or thickness of rectangular specimens. The line of contact shall be within ± 2° of perpendicular to the longitudinal axis of the specimen [see Figure 2 and the note to 5.7.1.2 c)].

The clearance between the supports and the striker, or any adjacent part of the pendulum which passes between the supports, shall be sufficient to ensure that the broken specimen is free to leave the machine with the minimum of interference, thus preventing the possibility of the specimen rebounding into the pendulum.

Any end stop used for locating the test specimen in the supports shall not impede the movement of the specimen during the test.

5.8.2 Striker for Izod test machines

The striking edge of the pendulum shall be hardened steel and have a cylindrical surface with a radius of curvature R_1 of 0,8 mm ± 0,2 mm, with its axis horizontal and perpendicular to the plane of motion of the pendulum. It shall be aligned so that it makes contact across the full width or thickness of rectangular specimens. The line of contact shall be within ± 2° of the perpendicular to the longitudinal axis of the specimen, and shall be 22 mm ± 0,2 mm above the top surface of the vice (see Figure 3).

5.8.3 Striker for tensile impact test machines

See ISO 8256:1990.

5.8.3.1 Striker for method A

The striker for method A shall be made of steel. It shall have two surfaces coplanar to within 4/1 000 and parallel, to within 5/1 000, to the axis of rotation of the pendulum.

When using a specimen measuring (80 mm ± 2 mm) × (10 mm ± 0,2 mm) × (4 mm ± 0,2 mm), the centres of the contact areas on the crossheads (see 5.7.4.2) and on the striker shall lie in a plane which is horizontal to within 2° and within ± 0,5 mm of the plane of swing of the pendulum.

5.8.3.2 Striker for method B

The striker for method B shall be made of steel. It shall be designed so that specimens can be securely clamped in it (see 5.7.3.1).

When clamped in place, the specimen shall lie in the plane of swing of the pendulum to within ± 0,5 mm.

The contact surfaces on the crosshead, mounted on a rectangular reference specimen, shall be coplanar and parallel, to within 5/1 000, to the axis of rotation of the pendulum.

For this purpose, the reference test specimen (made e.g. from stainless steel) shall be clamped in the striker in such a way that its longitudinal axis is parallel, to within 4/1 000, to the plane of swing of the pendulum.

6 Time interval between verifications

All impact-testing machines shall be reverified at suitable intervals, depending on their design and the nature and extent of their use.

NOTE 1 An interval of 2 years is recommended for a machine which is in good order and is used under favourable conditions of service.

NOTE 2 During the period between successive verifications, partial verifications are recommended at intervals of 1 year for a machine which is in good order and is used under favourable conditions of service.

A machine shall be reverified if it is moved to a new location, or is subject to major repairs or adjustments, or if there is any reason to doubt the accuracy of the results it gives. The decision as to whether a complete or partial verification is to be carried out shall rest with the verifying authority.

For a partial verification, compliance with clauses 5.2, 5.4, 5.6 and 5.8. is required.

7 Verification report

On completion of a complete verification, a report shall be issued. The report shall include the following information:

a) the name and address of the verifying authority;

b) the name and address of the client;

c) a description of the machine, including, where relevant

   1) the maker,

   2) the type or model,

   3) the serial number,

   4) the type or types of test,

   5) the nominal potential energy of each pendulum;

d) the location of the machine;

e) the date of verification

f) a reference to this International Standard;

g) details of any repairs and adjustments made;

h) the mean values of $W_{f,1}$, $W_{f,2}$ and $W_{f,3}$ (see 5.6);

i) a statement of conformity or otherwise to the requirements of clause 5;

j) the date of the report.

In addition, a report number and the recommended date for the next verification, complete or partial, shall be included in the report.

Annex A
(informative)

Relationship between the various pendulum lengths

Three pendulum lengths are defined in 3.5 to 3.7. They are the distance from the axis of rotation to:

the centre of gravity of the pendulum (L_M);

the centre of percussion (L_P);

the centre of inertia (L_G).

The pendulum length L_P can be determined by measuring the period of oscillation of the pendulum T_P [see equation (1)].

The gyration length L_G cannot be measured directly. It is given, in metres, mathematically by the equation

$$L_G = \sqrt{J/m_P} \tag{A.1}$$

where

m_P is the pendulum mass, in kilograms (determined by weighing),

J is the moment of inertia, in kilograms metre squared, of the pendulum, given by

$$J = \int_0^{m_P} r^2 \, dm \tag{A.2}$$

r being the distance, in metres, from the axis of rotation.

The distance from the axis of rotation to the centre of gravity L_M can be determined by measuring the horizontal moment M_H, in newton metres, required to support the pendulum in a horizontal position. This is given by

$$M_H = g \cdot \int_0^{m_P} r \, dm \tag{A.3}$$

where g is the local acceleration due to gravity, in metres per second squared.

Since the gravity length L_M is given by

$$L_M = \frac{1}{m_P} \int_0^{m_P} r \, dm \tag{A.4}$$

it follows from equation (A.3) that

$$L_M = \frac{M_H}{g m_P} \tag{A.5}$$

As an alternative to equation (1), the pendulum length L_P can be described by the equation

$$L_P = \frac{J}{m_P L_M} \quad \text{(A.6)}$$

From equations (A.1) and (A.6), it follows that the gyration length represents the geometric mean of the gravity length and the pendulum length

$$L_G = \sqrt{L_P L_M}$$

$$L_P = \frac{L_G^2}{L_M} \quad \text{(A.7)}$$

It can also be shown that

$$L_M \leqslant L_G \leqslant L_P \quad \text{(A.8)}$$

where the identities are for the case of a mathematical pendulum. Since the height of fall $H_M = L_M (1 - \cos \alpha_0)$ where α_0 is the starting angle [see (Figure 1b)], the potential energy $E = H_M \cdot m_P \cdot g$ can be calculated in terms of L_M and α_0. Inserting equation (A.5) gives equation (3).

Annex B
(informative)

Ratio of frame mass to pendulum mass

The maximum value of the energy W_F transferred to the frame during impact can be estimated assuming that during the impact the elastically mounted frame can move freely. The period of impact is short compared with the period of oscillation T_F of the frame.

Neglecting the momentum of the broken specimen, the principle of conservation of momentum gives

$$m_F v_F = m_P \left(v_I - v_A\right) \qquad \text{(B.1)}$$

where

m_F is the mass of the frame, in kilograms;

m_P is the mass of the pendulum, in kilograms;

v_F is the maximum velocity of the frame just after impact, in metres per second;

v_I is the impact velocity, in metres per second;

v_A is the velocity of the pendulum just after impact, in metres per second.

Squaring equation (B.1) and inserting the potential energy:

$$E = \frac{m_P {v_I}^2}{2}$$

and the energy uptake by the frame:

$$W_F = \frac{m_F {v_F}^2}{2}$$

gives

$$\frac{m_F}{m_P} = \frac{\left(1 - \frac{v_A}{v_I}\right)^2 E}{W_F} \qquad \text{(B.2)}$$

The principle of conservation of energy gives

$$E = \frac{m_P v_A^2}{2} + W + W_F \qquad \text{(B.3)}$$

which, on rearrangement, gives

$$\frac{v_A}{v_I} = \sqrt{\frac{1 - \left(W + W_F\right)}{E}} \qquad \text{(B.4)}$$

where W is the impact energy.

Inserting equation (B.4) into (B.2) gives the ratio of the frame mass to the pendulum mass expressed in terms of the relative impact energy of the specimen and the relative energy uptake of the frame:

$$\frac{m_F}{m_P} = \left[1 - \sqrt{\frac{1-(W+W_F)}{E}}\right]^2 \times \frac{E}{W_F} \tag{B.5}$$

The energy absorbed by the frame shall not exceed 0,5 % of E. The mass ratio m_F/m_P is shown in Figure B.1 for W_F/E = 0,005 and 0,01, i.e. for an energy uptake by the frame of 0,5 % and 1 % of E (see also Table 7).

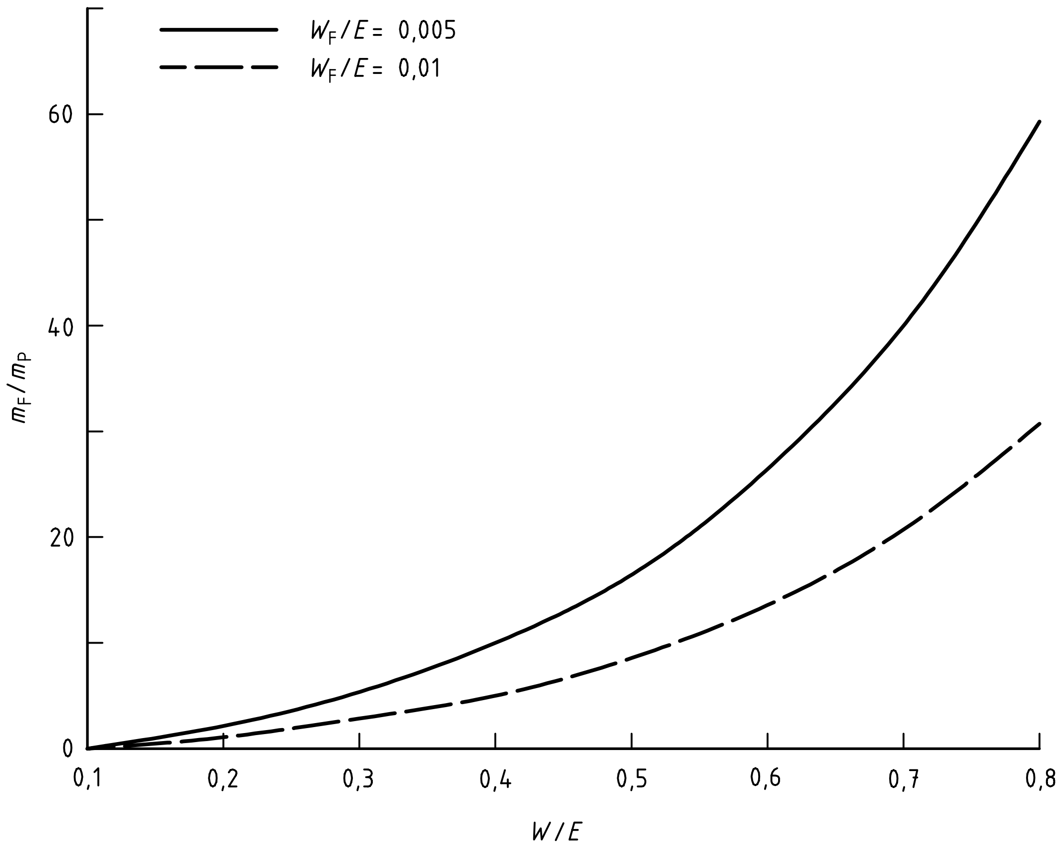


Figure B.1 — Ratio of mass of frame to mass of pendulum plotted against the relative energy uptake by the specimen W/E for two values of the relative energy uptake by the frame W_F/E

Annex C
(informative)

Deceleration of pendulum during impact

The tangential velocity v_A, in metres per second, of the pendulum, at the impact length, just after impact can be written as in equation (B.4) but without W_F:

$$v_A = v_I \sqrt{1 - \frac{W}{E}} \tag{C.1}$$

where

v_I is the impact velocity, in metres per second;

W is the impact energy, in joules;

E is the potential energy of the pendulum, in joules.

Figure C.1 shows v_A plotted as function of impact energy, impact strength and notched impact strength (Charpy impact test ISO 179-1/1eU and ISO 179-1/1eA) for the different pendulums used.

The velocities after impact are given for 10 % to 80 % of the potential energy E that may be absorbed for a particular pendulum (20 % to 80 % for tensile impact tests — see ISO 8256).

In addition, within the energy range given above, the pendulum with the highest possible potential energy shall always be used.

This requirement is indicated by the bold line in Figure C.1. As a consequence of this requirement, the range of velocities occurring in Charpy impact testing is considerably reduced. The deceleration due to the work spent in impacting the specimen is effectively restricted to 5 % to 10 % of the impact velocity.

This requirement ensures that impact tests employing pendulums of different potential energy are performed at approximately the same velocity.

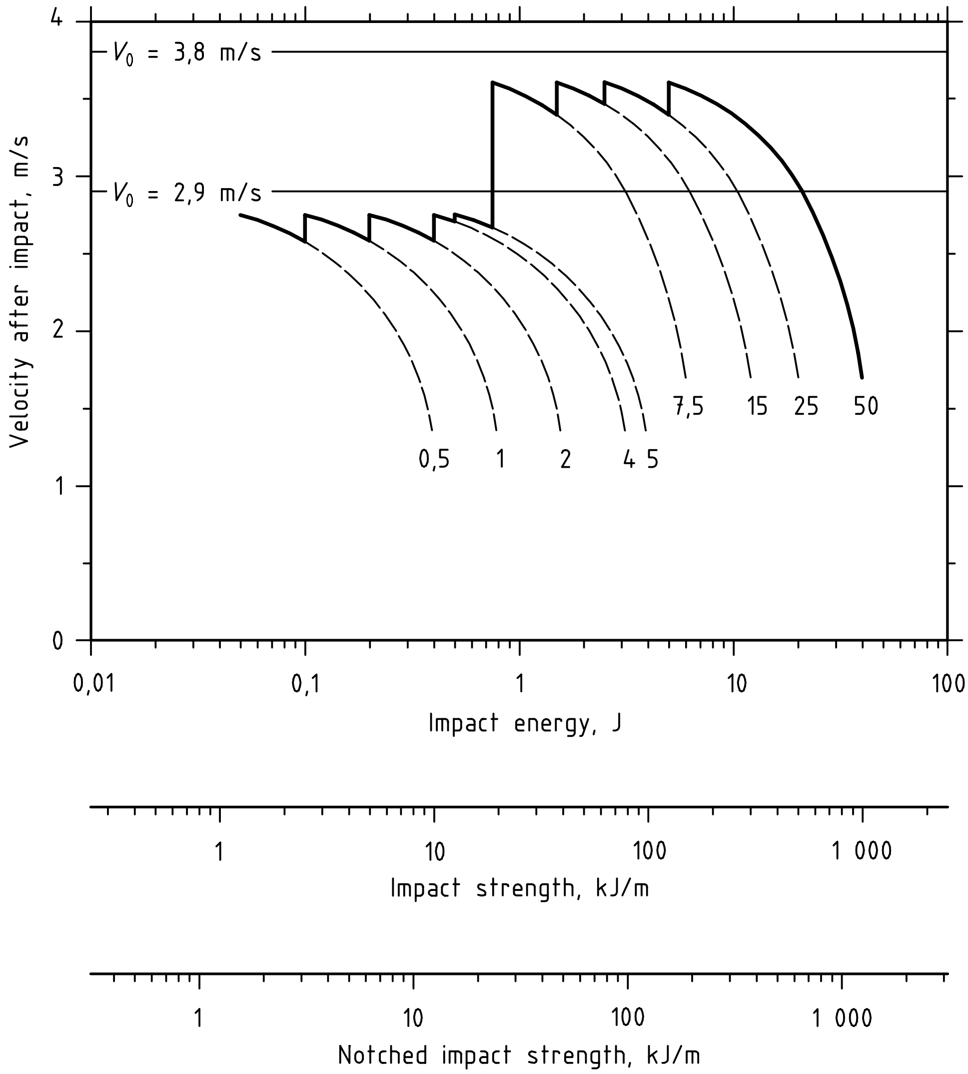


Figure C.1 — Pendulum velocity after impact as a function of impact energy, impact strength and notched impact strength for Charpy impact testing

Annex D
(informative)

Interrelationship between the movement of the pendulum and that of the frame

D.1 General

As it moves, the pendulum exerts forces on the frame. The frame, which has a finite mass and a mounting of finite stiffness, reacts to these forces in the form of forced oscillations involving both potential and kinetic energy. The loss of energy of the pendulum cannot therefore be attributed solely to the impact test and attendant frictional losses but includes as an additional error the energy transferred to the frame. Depending on the mass of the frame and that of the pendulum, and on the stiffness of the mounting, resonant effects may occur which lead to a large increase in the energy absorbed by the frame. The design of the pendulum impact machine must ensure that the errors mentioned above remain below an acceptable limit throughout the working range of the machine. This annex makes recommendations for the design of the machine, derived from numerical analysis of the movement of the frame and the pendulum.

Figure D.1 shows the model of machine used. It will be assumed that the frame can move horizontally only. Thus, only its stiffness S_F in the horizontal direction has to be considered.

Figure D.2 shows curves of the normalized horizontal force f_h (= F_h/G_P) (solid lines) and angle of the pendulum (dashed lines) versus normalized time t/T_P, T_P being the period of oscillation of the pendulum and G_P being the effective weight of the pendulum. Since t/T_P tends to infinity at α = 180°, the time scale is centred on α = 0°.

The dot and dashed line is the locus of the points representing one-quarter of the period of oscillation for each different starting angle α_0. It shows that the period of oscillation increases with increasing starting angle. Only near α = 0° is the period of oscillation independent of the starting angle and tends towards the limit $T_P/4$.

One important fact is that the horizontal force f_h forms a double pulse, the peaks of which have a relative normalized time interval of $\Delta t/T_P$ = 0,16 for α_0 = 180°. This is about one-third of the corresponding time interval ($\Delta t/T_P$ = 0,5) for the small amplitude limit. It can be seen from Figure D.2 that the positions of the peaks in the horizontal force are almost constant from α_0 = 180° down to α_0 = 90°.

Hence, regardless of the type of the machine, it can be expected that the frame will vibrate strongly if its period of oscillation is about one-third of that of the pendulum at small amplitudes.

For the complete pendulum, the above condition can be checked by using the ratio of the period of oscillation of the frame to that of the pendulum. The ratio of these two periods of oscillation is given by

$$\frac{T_P}{T_F} = \frac{v_I^2}{2g}\sqrt{\frac{S_F}{\mu E(1-\cos\alpha_0)}} \tag{D.1}$$

where

T_P is the period of oscillation of the pendulum, in seconds;

T_F is the period of oscillation of the frame, in seconds;

v_I is the impact velocity, in metres per second;

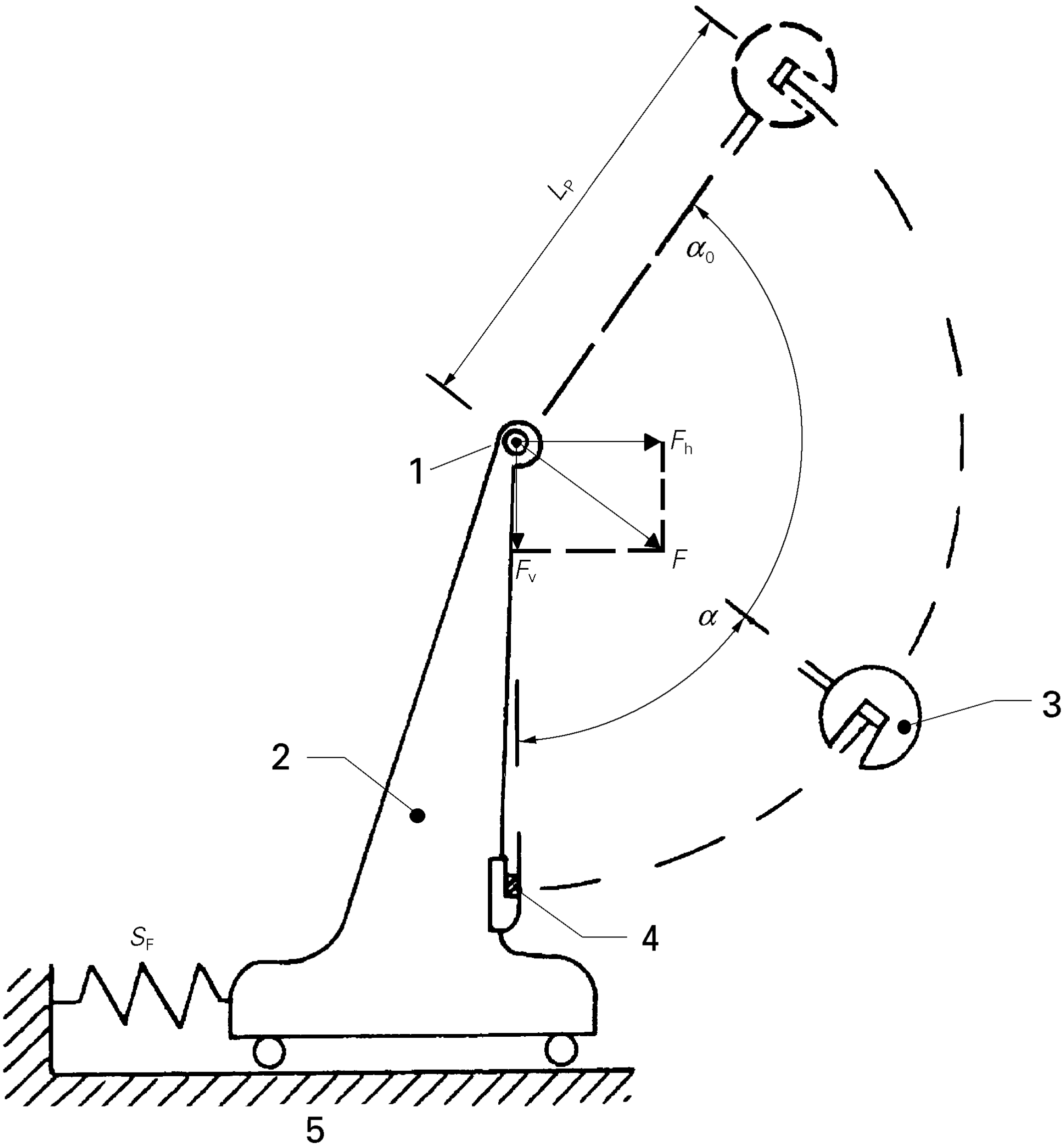
μ (= m_F/m_P) is the ratio of the mass of the frame to that of the pendulum;

S_F is the horizontal stiffness between the frame and the foundation, in newtons per metre (see Figure D.1);

E is the potential energy of the pendulum, in joules;

α_0 is the starting angle, in degrees;

g is the local acceleration due to gravity, in metres per square second.



Key

1 Axis of rotation
2 Frame
3 Pendulum
4 Test specimen
5 Foundation

Figure D.1 — Model for calculating the movement of the frame

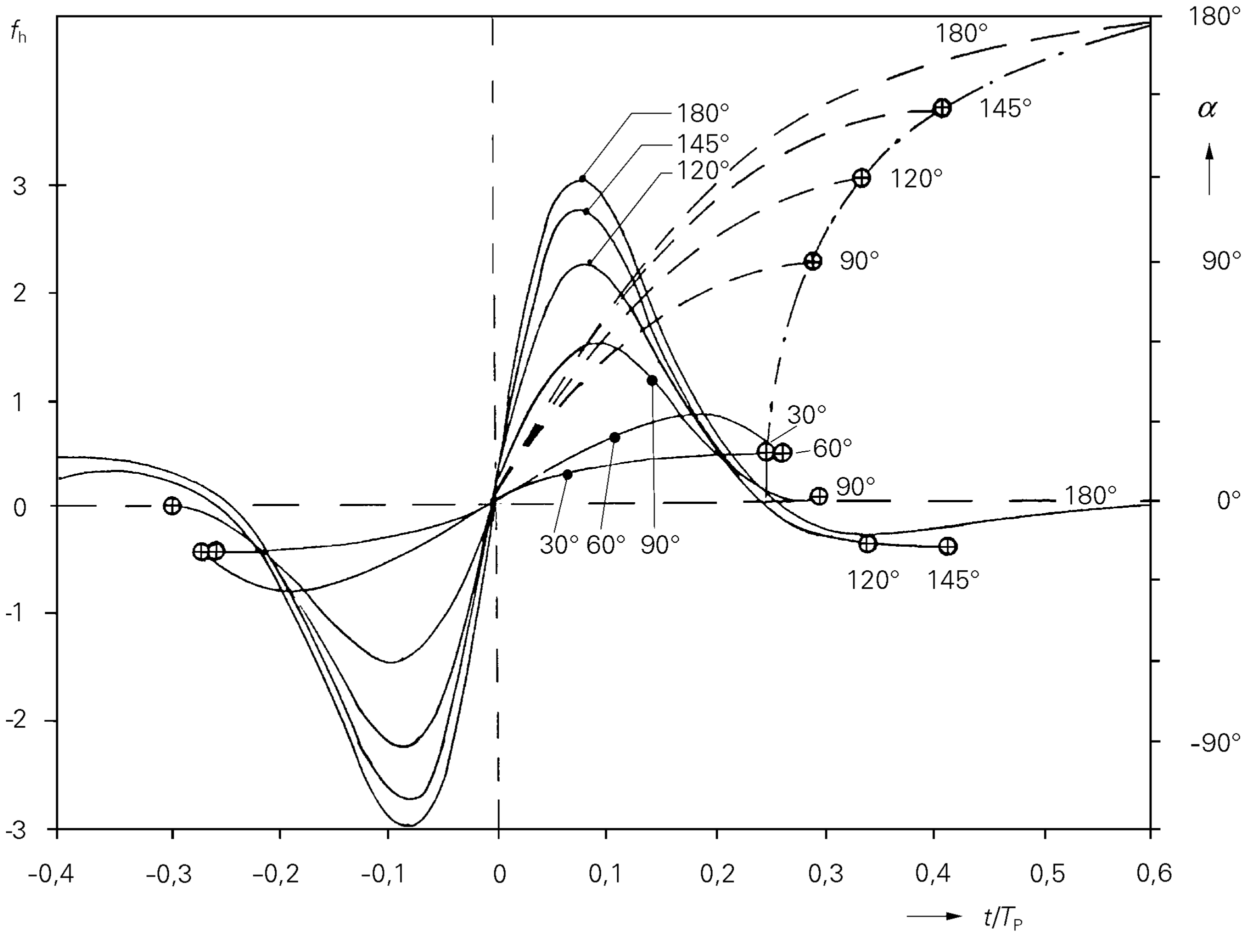


Figure D.2 — Normalized horizontal force f_h (= F_h/G_P) (solid lines) and angle α (dashed lines) of a pendulum versus normalized time t/T_P for different values of the starting angle α_0

An example of the experimental determination of S_F is shown in Figure D.3.

For T_P/T_F = 3, the horizontal oscillation of the frame is in resonance with the pendulum oscillation. The elimination of this resonance is necessary, but does not suffice. Two limiting cases of machine set-up may occur.

These are

a frictionless, horizontally freely movable frame, i.e. a frame with a very low stiffness, for which T_F is therefore $\gg T_P$;

an elastically mounted frame with a very high stiffness, for which $T_F \ll T_P$.

D.2 Case 1: freely movable frame

Figure D.4 shows as an example the relative positions of a frame and pendulum with a mass ratio μ of 4 during a half-swing. The amplitude of oscillation of the frame is given by $s = \pm L_M/4$.

Due to the movement of the frame, the impact velocity is not constant, but varies according to the equation

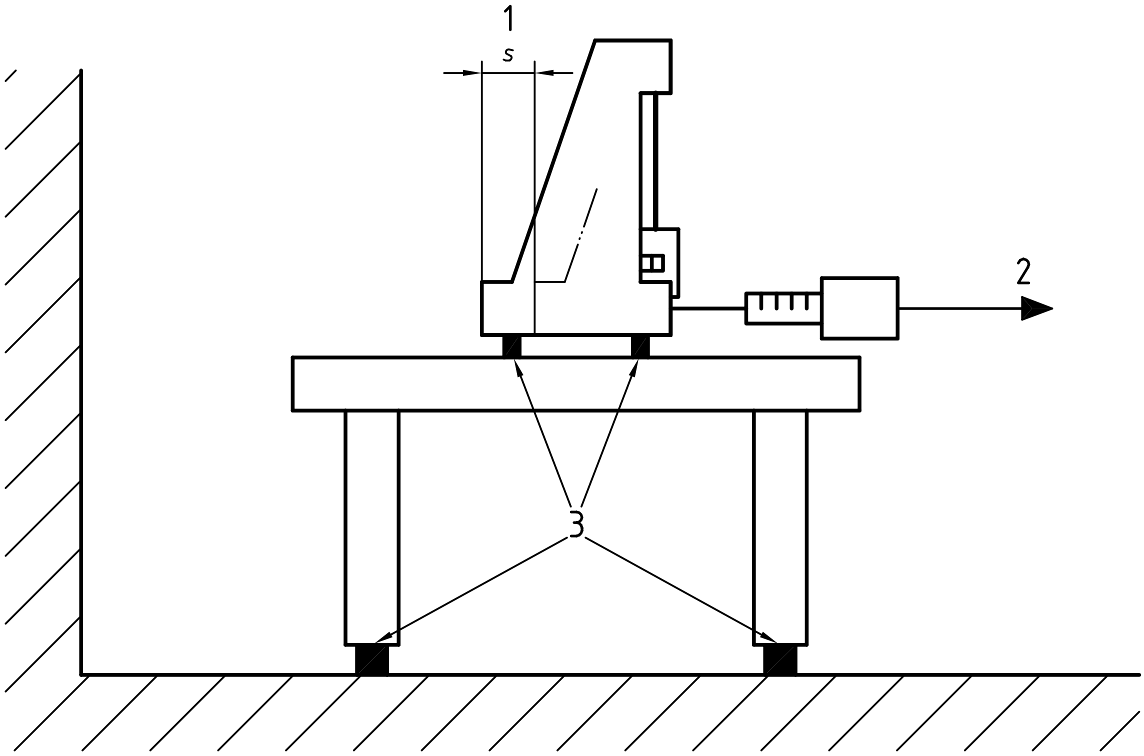
$$v_{I,1} = v_I \sqrt{1 + \frac{1}{\mu}} \qquad \text{(D.2)}$$

where

$v_{I,1}$ is the impact velocity for a case 1 foundation, expressed in metres per second;

v_I is the impact velocity for a completely rigid foundation, expressed in metres per second;

μ (= m_F/m_P) is the ratio of the mass of the frame to that of the pendulum.



Key

1 Displacement of foundation, s, due to force F_F
2 Applied force, F
3 Levelling screws, rubber feet

Stiffness is given by $S_F = \frac{F_F}{s}$

Figure D.3 — Example of experimental determination of the stiffness S_F (levelling screws, rubber feet) of the foundation

With a tolerance for v_I of ± 10 % at the most, equation (D.2) yields a minimum mass ratio of $\mu \geqslant 10$, which however is already fulfilled by the conditions specified in 5.3.3 (see also annex B).

D.3 Case 2: elastically mounted frame

An elastically mounted frame excited by an oscillating pendulum can be considered as coupled double oscillators, the pendulum oscillations being a non-linear one. The complicated resonance effects which are generated by the horizontal double pulse (see Figure D.2) acting on the elastically mounted frame are shown in Figure D.5. This figure shows, as a function of the period-of-oscillation ratio T_F/T_P, the mass ratio μ required to restrict the energy uptake W_F/E at the end of the first half-swing to 1 %.

The consequences for the set-up of the test machine are as follows:

The gently sloping right-hand sides of the curves in Figure D.5 represent the lower limit of the application range of the freely movable frame for $T_F \gg T_P$. For a mass ratio μ of 10 and a starting angle α_0 of 120°, the period of oscillation of the frame T_F must be at least 3,3 times that of the pendulum T_P in order for W_F/E to stay below 1 % of E.

The steeply sloping left-hand sides of the curves in Figure D.5 represent the upper limit of the application range of the elastically mounted frame for $T_F \ll T_P$. For the final set-up of the machine, a reasonable upper limit is that defined by

$$\frac{T_F}{T_P} \leqslant 0{,}15 \quad \text{(D.3)}$$

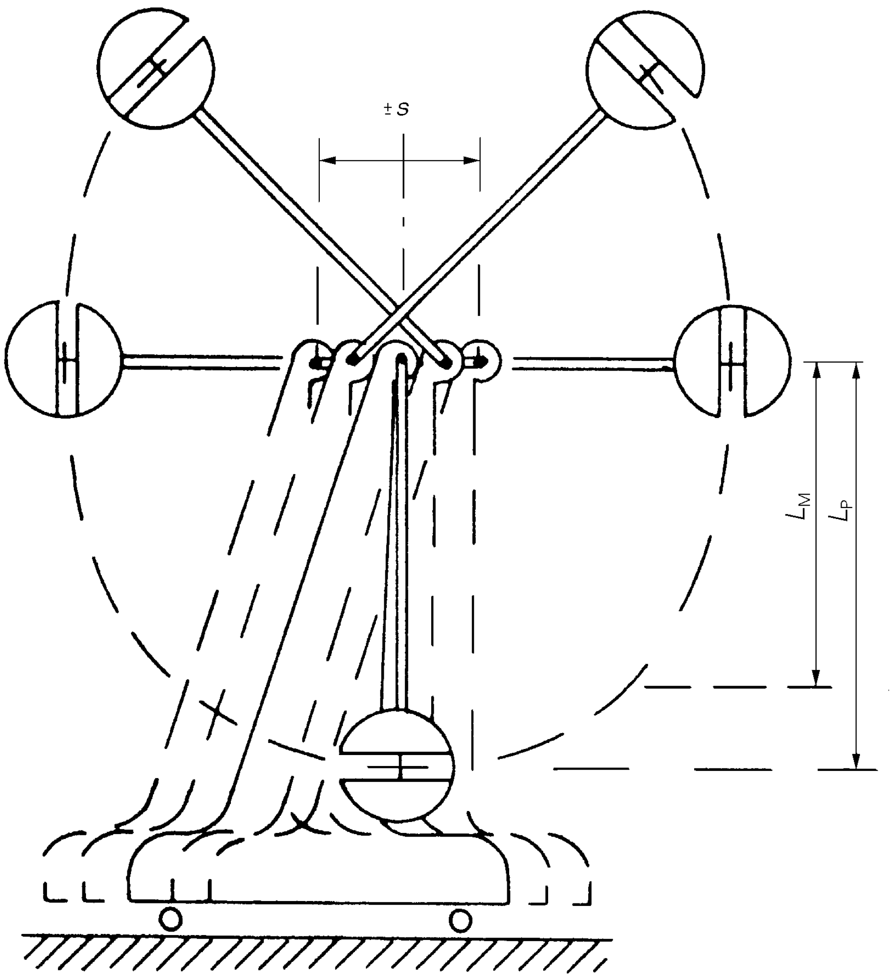


Figure D.4 — Movements of a pendulum and a freely movable frame for a mass ratio μ (= m_F/m_P) of 4

It follows that, for the final set-up of an elastically mounted pendulum impact machine, two concurrent effects have to be considered:

a) the period of oscillation should conform to equation (D.3);

b) the mass ratio μ should be $\geqslant$ 40 (see annex B).

Increasing the mass ratio, however, will generally decrease T_F/T_P provided the stiffness of the foundation remains unchanged.

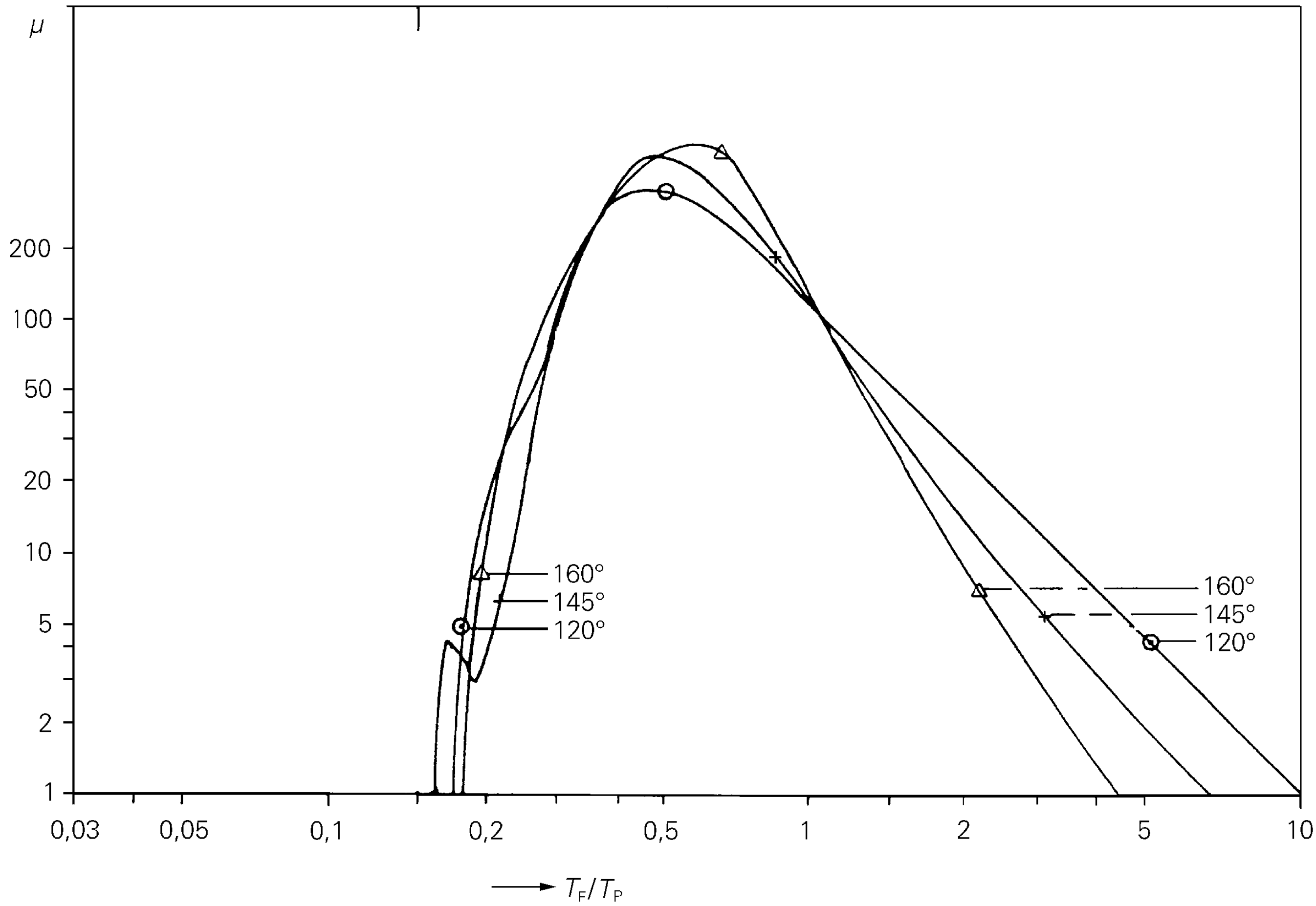


Figure D.5 — Plots of the frame/pendulum mass ratio μ for a relative energy uptake by the frame W_F/E of 1 % at the end of the first half-swing versus the frame/pendulum period-of-oscillation ratio for different starting angles

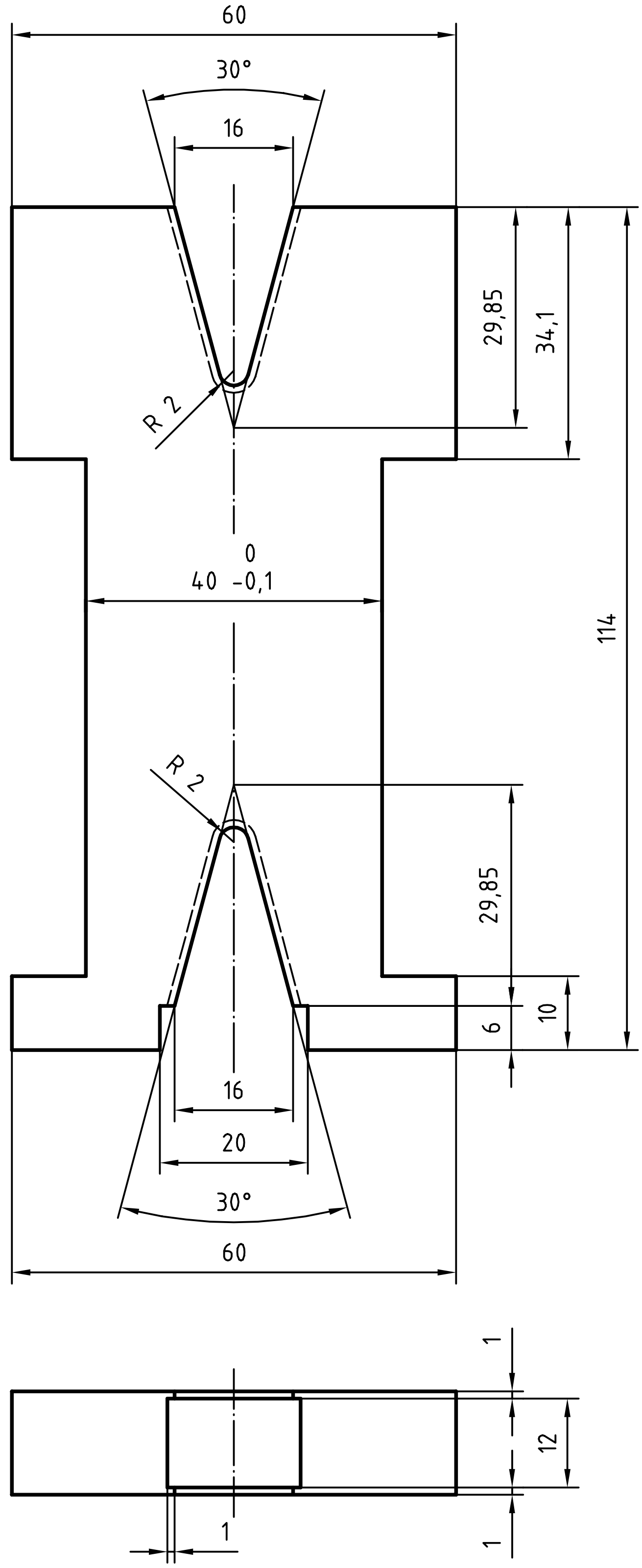
Annex E
(informative)

Gauge plate for verification of Charpy impact pendulums

Figures E.1 to E.3 illustrate the design and use of a gauge plate for verification of Charpy impact pendulums.

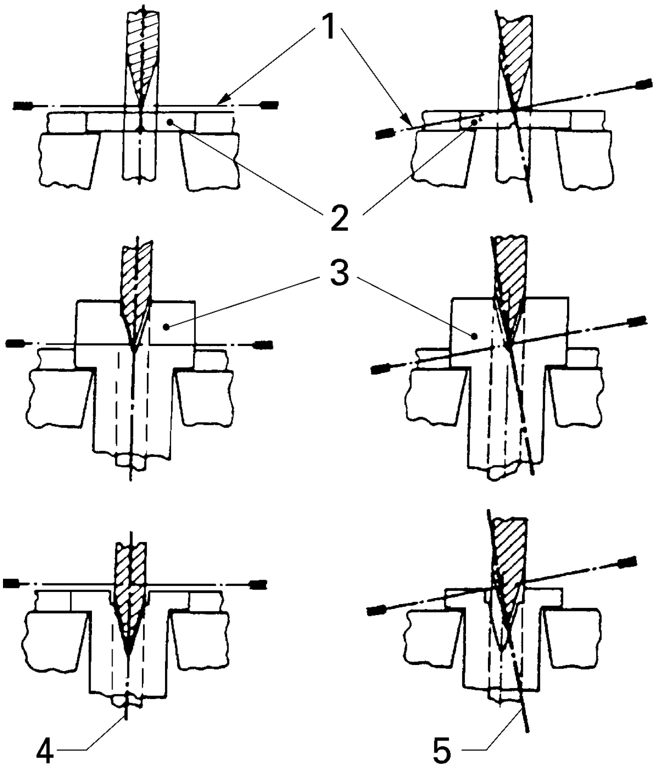
Material: Corrosion-resistant or stainless steel, e.g. X 46 Cr 13, 100 Cr 6.

Dimensions in millimetres

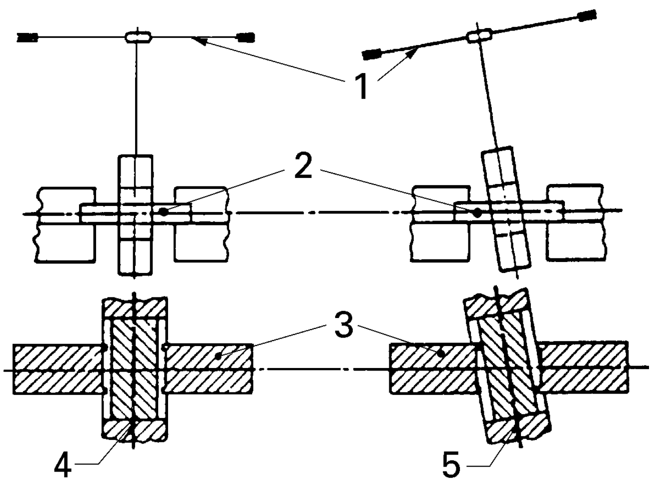


$\sqrt{R_Z 25}$ on all sides

Figure E.1 — Shape and dimensions of the gauge plate



a) The error is detected by "overturning" of the gauge plate

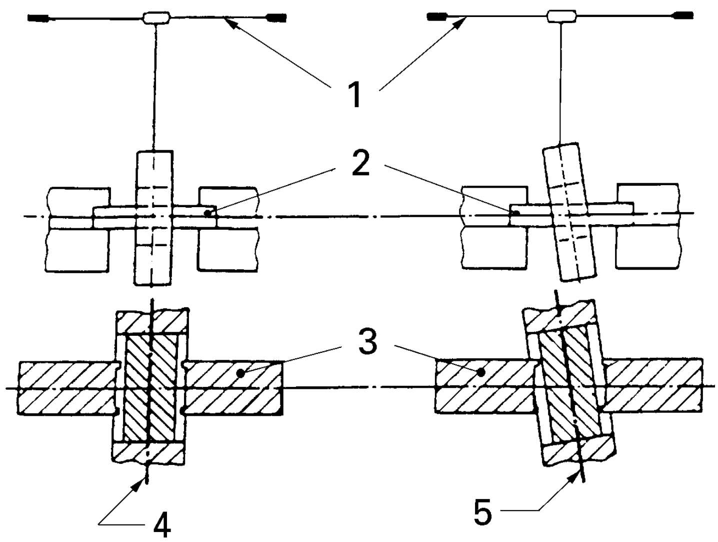


b) The error may be recognized as a result of the striker edge containing the gauge plate edges

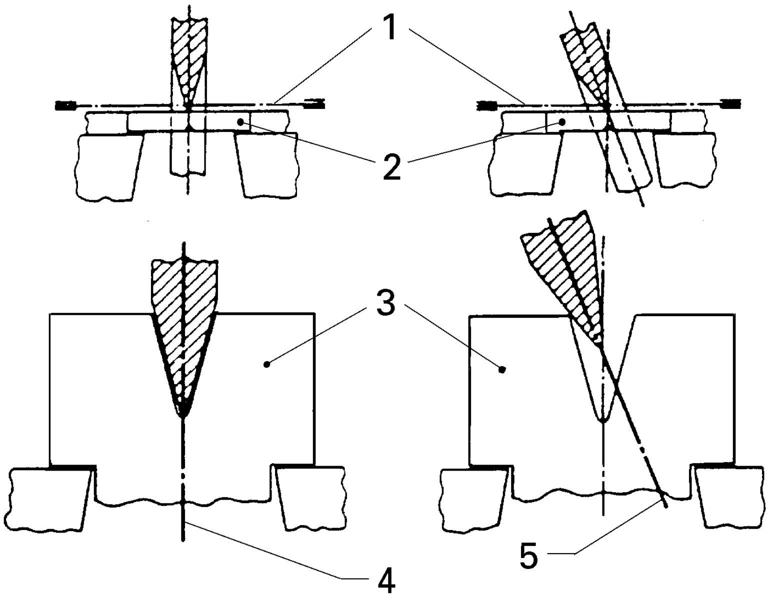
Key

1 Axis of rotation of pendulum
2 Test specimen
3 Gauge plate
4 Plane of swing of pendulum perpendicular to longitudinal axis of test specimen
5 Plane of swing of pendulum not perpendicular to longitudinal axis of test specimen

Figure E.2 — Example of the use of the gauge plate illustrated in Figure E.1 if the plane of swing of the pendulum is not perpendicular to the longitudinal axis of the test specimen (right-hand side of figure)



a) The error may be recognized as a result of the striker edge contacting the gauge plate edges



b) The error may be recognized as a result of the striker edge not reaching the bottom of the recess in the gauge plate

Key

1 Axis of rotation of pendulum
2 Test specimen
3 Gauge plate
4 Plane of symmetry of striker edge in plane of swing of pendulum
5 Plane of symmetry of striker edge not in plane of swing of pendulum

Figure E.3 — Further example of the use of the gauge plate illustrated in Figure E.1 if the plane of symmetry of the striker edge is not in the plane of swing of the pendulum (right-hand side of figure)

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