
**Mechanical testing of metals — Symbols
used with their definitions —**

Part 1:

Symbols and definitions in published standards

*Essais mécaniques des métaux — Symboles utilisés et leurs définitions —
Partie 1: Symboles et définitions figurant dans les normes publiées*



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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 12735-1, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*.

ISO/TR 12735 consists of the following parts, under the general title *Mechanical testing of metals — Symbols used with their definitions*:

- *Part 1: Symbols and definitions in published standards*

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- *Part 2: Recommendations for the development of symbols and definitions*

Annex A of this part of ISO/TR 12735 is for information only.

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Introduction

This part of ISO/TR 12735 has been prepared to provide the appropriate means of avoiding contradictions and misunderstandings and to standardize various kinds of symbols and their definitions generally used in this field. Wherever possible the same symbol has been used to denote the same type of parameter in the different tests but the differing types of test piece, product form and test have to be taken into account. This has not been universally possible and symbols should always be considered in the context of the specific method of test being used.

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Mechanical testing of metals — Symbols used with their definitions —

Part 1:

Symbols and definitions in published standards

1 Scope

This part of ISO/TR 12735 is entirely informative. In it are enumerated the symbols and definitions used in ISO international standards for specific methods of mechanical testing of metallic materials which are the responsibility of ISO Technical Committee 164. The data are indexed alphabetically and via a coding system. Annex A provides an additional cross-reference between the coding system and relevant ISO standard numbers.

2 Designation system

To assist in indexing and cross-referencing symbols and definitions, a code number is used to identify test methods. The first digit of the code identifies the sub-committee of ISO/TC 164 that is responsible for preparing and reviewing International Standards for that test method. Subsequent digits are in ascending order of the ISO number for each international standard or draft international standard.

International standards that relate to a common test method and which all share the same set of symbols and definitions are given a single code number.

If, at the time of publication of this part of ISO/TR 12735, there existed both a valid International Standard and a document designed to replace it that had reached DIS stage, then both the international standard and the draft international standard will have been assigned to the same code number.

Each test method for metallic materials is identified and designated as shown in table 1. Annex A provides a rapid cross-reference to the coding system.

Table 1. Identity and code of mechanical test		
TEST IDENTITY	CODE	ISO STANDARD
Creep test (Non-interrupted)	1.01	204:-
Calibration of force proving devices	1.02	376:1987
Elevated temperature tensile test	1.03	783:1989
Tensile test	1.04	6892:-
Verification of the tensile testing machine	1.05	7500-1:1986
Verification of the uniaxial tensile creep testing machine	1.06	7500-2:-
Verification of extensometers	1.07	9513:-
Bend test	2.01	7438:1985
Reverse bend test on sheets and strips	2.02	7799:1985
Torsion testing on wire	2.03	7800:1984
Reverse bend testing of wire	2.04	7801:1984
Wire wrapping test	2.05	7802:1983
Modified Erichsen cupping test	2.06	8490:1986
Bend testing of tube	2.07	8491:1986
Flattening test on tubes	2.08	8492:1986
Drift expanding test on tubes	2.09	8493:1986

Table 1. Identity and code of mechanical test		
TEST IDENTITY	CODE	ISO STANDARD
Flanging test on tubes	2.10	8494:1986
Ring expansion test on tubes	2.11	8495:1986
Ring tensile test on tube	2.12	8496:1986
Reverse torsion testing of wire	2.13	9649:1990
r value test	2.14	10113:1991
n value test	2.15	10275:1993
Earing test	2.16	11531:1994
Brinell hardness test	3.01	6506:1981
Tables of Brinell hardness values	3.01	410:1982
Verification of Brinell testing machine	3.01	156:1982
Calibration of Brinell standardized blocks	3.01	726:1982
Vickers hardness test, HV 5 - HV 100	3.02	6507-1:-
Vickers hardness test, HV 0.2 - HV 5	3.02	6507-2:-
Vickers microhardness test, <HV 0.2	3.02	6507-3:-
Tables of Vickers hardness values, HV 5 - HV 100	3.02	6507-1:-
Tables of Vickers hardness values, HV 0,2 - HV 5	3.02	6507-1:-
Tables of Vickers hardness values, less than HV 0,2	3.02	6507-1:-
Verification of Vickers testing machine: HV 0,2 - HV 100	3.02	6507-2:-
Verification of Vickers testing machine: less than HV 0,2	3.02	6507-2:-
Calibration of Vickers standardized blocks: HV 0,2 - HV 100	3.02	6507-3:-
Calibration of Vickers standardized blocks : less than HV 0,2	3.02	6507-3:-
Rockwell hardness test	3.03	6508:1986
Verification of Rockwell testing machine	3.03	716:1986
Calibration of Rockwell standardized blocks	3.03	674:1988
Rockwell superficial hardness test	3.04	1024:1989

Table 1. Identity and code of mechanical test		
TEST IDENTITY	CODE	ISO STANDARD
Verification of superficial Rockwell testing machines	3.04	1079:1989
Calibration of superficial Rockwell standardized blocks	3.04	1355:1989
Knoop hardness test	3.05	4545:1993
Verification of Knoop hardness testing machines	3.05	4546:1993
Calibration of Knoop standardized blocks	3.05	4547:1993
Tables of Knoop hardness values	3.05	10250:1994
Macro Rockwell hardness test	3.06	11700-1:-
Verification of Macro Rockwell hardness testing machines	3.06	11700-2:-
Calibration of Macro Rockwell standardized blocks	3.06	11700-3:-
Impact test - Steel, Charpy U-notch	4.01	83:1976
Impact test - Steel, Charpy V-notch	4.02	148:1983
Verification of impact testing machines	4.03	148-2:- and 148-3:-
Steel - designation of test piece axes	4.04	3785:-
Determination of the plane strain fracture toughness	4.05	12737:-
Axial fatigue test	5.01	1099:1975
Rotating bend fatigue test	5.02	1143:1975
Torsional fatigue test	5.03	1352:1977
Dynamic calibration (axial load)	5.04	4965:1979

3. DEFINITIONS AND SYMBOLS

Definitions and symbols employed in all of the international standards and draft international standards prepared by ISO TC 164 are here classified under the codes listed in Table 1. If a standard has separate clauses for definitions and symbols, the definitions are listed first, followed by a table of symbols. Each table of symbols is re-arranged into a consistent alphabetical order. For clarity, Notes, alternative definitions and conditions

embodied within definitions which are particular to the individual standard are excluded.

3.1 Code 1.01 – *Uninterrupted uniaxial creep testing in tension*

3.1.1 *Definitions.*

Reference length (L_r). Base length used for the calculation of elongation.

Original reference length (L_{r0}). Reference length determined at ambient temperature before the test.

Final reference length (L_{ru}). Reference length determined at ambient temperature after rupture, the two straight pieces having been carefully fitted back together so that their axes lie in a straight line.

Original gauge length (L_0). Length between gauge marks on the testpiece measured at ambient temperature before the test.

Final gauge length after rupture (L_u). Length between gauge marks on the testpiece measured after rupture, at ambient temperature, the two pieces having been carefully fitted back together so that their axes lie in a straight line.

Parallel length (L_c). Length of the parallel reduced section of the test piece.

Extensometer gauge length (L_e). Distance between the measuring points of the extensometer. The extensometer gauge length shall be as near as possible to the reference length.

Original cross-sectional area (S_0). Cross-sectional area of the parallel length determined at ambient temperature prior to testing.

Minimum cross-sectional area after rupture (S_u). Minimum cross-sectional area of the parallel length determined at ambient temperature after rupture, the two pieces having been carefully fitted back together so that their axes lie in a straight line.

Initial stress (σ_0). Applied force divided by the original cross-sectional area (S_0) of the test piece.

Elongation. Increase of the reference length at any moment during the test.

Percentage creep elongation (A_f). At any given moment t during the test, the increase in the reference length between this moment t and the zero moment (ΔL_{rt}) at the specified temperature expressed as a percentage of the original gauge length.

Percentage elongation after creep rupture (A_{fu}). Permanent elongation of the reference length after rupture ($L_{ru} - L_{r0}$) expressed as a percentage of the original reference length.

Percentage reduction of area after creep rupture (Z_f). Maximum change in cross-sectional area occurring during the test ($S_0 - S_u$) expressed as a percentage of the original cross-sectional area (S_0).

Creep rupture time (t_u). Time required for the test piece, maintained at the specified temperature (T) and strained by the specified tensile force, to rupture.

Table 2. Symbols designated in the international standard, Code 1.01

Symbol	Units	Definition
ΔL_{rt}	mm	Increase in the reference length between a moment t and the zero moment
σ_o	MPa	Initial stress
A_f	%	Percentage creep elongation
A_{fu}	%	Percentage elongation after stress rupture
b	mm	Width of the cross-section of the parallel length of a test piece of square or rectangular cross-section
d	mm	Diameter of the cross-section of the parallel length of a cylindrical testpiece
L_c	mm	Parallel length
L_e	mm	Extensometer gauge length
L_o	mm	Original gauge length
L_r	mm	Reference length
L_{ro}	mm	Original reference length
L_{ru}	mm	Final reference length
L_u	mm	Final gauge length after rupture
r	mm	Transition radius
S_o	mm ²	Original cross-sectional area of the parallel length
S_u	mm ²	Minimum cross-sectional area after rupture
T	°C	Specified temperature
T_1	°C	Indicated temperature
t_u	h	Creep rupture time
Z_f	%	Percentage reduction in area after creep rupture

3.2 Code 1.02 - Calibration of force proving devices used for the verification of uniaxial testing machines.

Table 3. Symbols designated in the international standard, Code 1.02		
Symbol	Unit	Definition
b	%	Relative repeatability error of the force proving instrument
f_c	%	Relative interpolation error
F_f	N	Maximum capacity of the transducer
F_N	N	Maximum capacity of the measuring range
f_o	%	Relative zero error
r	-	Resolution of the indicator
u	%	Relative reversibility error of the force proving instrument
X	-	Reading on the indicator with increasing test force
X'	-	Reading on the indicator with decreasing test force
\bar{X}	-	Average value of the readings on the indicator
X_a	-	Computed value of deflection
X_{if}	-	Reading on the indicator after removal of force
X_{io}	-	Reading on the indicator before application of force
X_{max}	-	Maximum reading on the indicator
X_{min}	-	Minimum reading on the indicator
X_N	-	Reading on the indicator, corresponding to the maximum capacity

3.3 Code 1.03 - Metallic materials - Tensile testing at elevated temperature

3.3.1 Definitions.

Gauge length. Length of the parallel-sided portion of the test piece on which elongation is measured at any moment during the test.

Original gauge length, L_o : Gauge length at ambient temperature before heating of the test piece and before application of force.

Final gauge length, L_u : Gauge length after rupture, the two pieces having been carefully fitted back together so that their axes lie in a straight line. This length is measured at ambient temperature.

Extensometer gauge length, L_e : Length of the parallel portion of the test piece used for the measurement of elongation by means of an extensometer.

Elongation: Increase in the original gauge length, L_o , under the action of the tensile force, at any moment during the test.

Percentage elongation: Elongation expressed as a percentage of the original gauge length, L_o .

Percentage permanent elongation: Increase in the original gauge length of a test piece after removal of a specified stress, expressed as a percentage of the original gauge length, L_o .

Percentage elongation after fracture, A : Difference between final gauge length and original gauge length, $L_u - L_o$, expressed as a percentage of the original gauge length, L_o .

Percentage total elongation at fracture, A_t : Increase in the original gauge length of test piece at the moment of fracture, expressed as a percentage of the original gauge length, L_o .

Percentage reduction of area, Z : Maximum change in cross-sectional area which has occurred during the test, $S_o - S_u$, expressed as a percentage of the original cross-sectional area, S_o .

Maximum force (F_m): The maximum force which the testpiece withstands during the test.

Stress: Force at any moment during the test divided by the original cross-sectional area, S_o , of the test piece.

Tensile strength, R_m : Stress corresponding to the maximum force, F_m .

Yield stress: When the metallic material exhibits a yield phenomenon, a point is reached during the test at which plastic deformation occurs without any increase in the force.

Upper yield stress, R_{eH} : Value of stress at the moment when the first decrease in force is observed.

Lower yield stress, R_{eL} : Lowest value of stress during plastic yielding, ignoring any transient effects.

Proof stress of non-proportional elongation, R_p : Stress at which a non-proportional elongation is equal to a specified percentage of the original gauge length, L_o .

Table 4. Symbols designated in the international standard, Code 1.03		
Symbol	Unit	Definition
θ_i	°C	Indicated temperature
a	mm	Thickness of a flat testpiece or wall thickness of a tube
A	%	Percentage elongation after fracture: $\frac{L_u - L_o}{L_o} \times 100$
A_t	%	Percentage total elongation at fracture
b	mm	Width of the parallel-sided portion of a flat test piece or average width of the longitudinal strip taken from a tube or width of flat wire
d	mm	Diameter of the parallel-sided portion of a circular test piece, or diameter of round wire or internal diameter of a tube
D	mm	External diameter of a tube
F_m	N	Maximum force
L_c	mm	Parallel length
L_e	mm	Extensometer gauge length
L_o	mm	Original gauge length
L_t	mm	Total length of test piece
L_u	mm	Final gauge length after fracture
R_{eH}	N/mm ²	Upper yield stress
R_{eL}	N/mm ²	Lower yield stress
R_m	N/mm ²	Tensile strength
R_p	N/mm ²	Proof stress (non-proportional elongation)
S_o	mm ²	Original cross-sectional area of the parallel sided portion
S_u	mm ²	Minimum cross-sectional area after fracture
Z	%	Percentage reduction of area: $\frac{S_o - S_u}{S_o} \times 100$

3.4 Code 1.04 - *Metallic materials - Tensile testing*

3.4.1 *Definitions.*

Gauge length: Length of the cylindrical or prismatic portion of the test piece on which elongation is measured at any moment during the test.

Original gauge length (L_0): Gauge length before application of force.

Final gauge length (L_u): Gauge length after rupture, the two pieces having been carefully fitted back together so that their axes lie in a straight line.

Extensometer gauge length (L_e): Length of the parallel portion of the test piece used for the measurement of elongation by means of an extensometer.

Elongation: Increase in the original gauge length (L_0) at any moment during the test.

Percentage elongation: Elongation expressed as a percentage of the original gauge length (L_0).

Percentage permanent elongation: Increase in the original gauge length of a test piece after removal of a specified stress, expressed as a percentage of the original gauge length (L_0).

Percentage elongation after fracture (A): Permanent elongation of the gauge length after fracture ($L_u - L_0$), expressed as a percentage of the original gauge length (L_0).

Percentage total elongation at fracture (A_t): Increase in the original gauge length of test piece at the moment of fracture, expressed as a percentage of the original gauge length (L_0).

Percentage elongation at maximum force: Increase in the gauge length of the test piece at maximum force, expressed as a percentage of the original gauge length (L_0).

Percentage yield point elongation: Elongation between the start of yielding and the start of work-hardening ... expressed as a percentage of the original gauge length (L_0).

Percentage reduction of area (Z): Maximum change in cross-sectional area which has occurred during the test ($S_0 - S_u$) expressed as a percentage of the original cross-sectional area (S_0).

Maximum force (F_m): The greatest force which the testpiece withstands during the test.

Stress: Force at any moment during the test divided by the original cross-sectional area (S_0) of the test piece.

Tensile strength (R_m): Stress corresponding to the maximum force (F_m).

Yield stress: When the metallic material exhibits a yield phenomenon, a point is reached during the test at which plastic deformation occurs without any increase in the force.

Upper yield stress (R_{eH}): Value of stress at the moment when the first decrease in force is observed.

Lower yield stress (R_{eL}): Lowest value of stress during plastic yielding, ignoring any transient effects.

Proof stress of non-proportional elongation (R_p): Stress at which a non-proportional elongation is equal to a specified percentage of the original gauge length (L_0).

Proof stress, total elongation (R_t): Stress at which total elongation (elastic elongation plus plastic elongation) is equal to a specified percentage of the original gauge length (L_0).

Permanent set stress (R_r): Stress at which, after removal of force, a specified permanent elongation, expressed as a percentage of original gauge length (L_0), occurs.

Table 5. Symbols designated in the international standard, Code 1.04		
Symbol	Unit	Definition
a	mm	Thickness of a flat test piece or wall thickness of a tube
A	%	Percentage elongation after fracture = $\frac{L_u - L_0}{L_0} \times 100$
A_g	%	Percentage non proportional elongation at maximum force F_m
A_{gt}	%	Percentage total elongation at maximum force F_m
A_t	%	Percentage total elongation at fracture
b	mm	Width of the parallel length of a flat test piece or average width of the longitudinal strip taken from a tube or the width of a flat wire
d	mm	Diameter of the parallel length of a circular test piece, or diameter of round wire or internal diameter of a tube
D	mm	External diameter of a tube
E	N/mm ²	Modulus of elasticity
F_m	N	Maximum force
L_c	mm	Parallel length
L_e	mm	Extensometer gauge length
L_0	mm	Original gauge length
L_t	mm	Total length of testpiece
L_u	mm	Final gauge length after fracture
R_{eH}	N/mm ²	Upper yield stress
R_{eL}	N/mm ²	Lower yield stress
R_m	N/mm ²	Tensile strength

Table 5. Symbols designated in the international standard, Code 1.04

Symbol	Unit	Definition
R_p	N/mm ²	Proof stress (non proportional elongation)
R_r	N/mm ²	Permanent set stress
R_t	N/mm ²	Proof stress, total elongation
S_o	mm ²	Original cross sectional area of the parallel length
S_u	mm ²	Minimum cross sectional area, after fracture
Z	%	Percentage reduction of area = $\frac{S_o - S_u}{S_o} \times 100$

3.5 Code 1.05 - Verification of static uniaxial tensile testing machines**Table 6. Symbols designated in the international standard, Code 1.05**

Symbol	Unit	Definition
a	%	Relative resolution of the force indicator of the testing machine
b	%	Relative repeatability error of the force-measuring system of the testing machine
F	N	True force indicated by the force-proving instrument with increasing test force
F'	N	True force indicated by the force-proving instrument with decreasing test force
F_c	N	True force indicated by the force-proving instrument with increasing test force, for the complementary series of measurements for the smallest range which is used
F_i	N	Force reading on the force indicator of the testing machine to be verified, with increasing test force
$F_{i \max}$ $F_{i \min}$ F_{\max} F_{\min}	N	Highest or lowest value of F_i and F for the same discrete force
F_i'	N	Force reading on the force indicator of the testing machine to be verified, with decreasing force
\bar{F}_i, \bar{F}	N	Arithmetic mean of several measurements of F_i and F for the same discrete force

Symbol	Unit	Definition
F_{i0}	N	Residual indication on the force indicator of the testing machine to be verified after removal of force
F_{ic}	N	Force reading on the force indicator of the testing machine to be verified, with increasing test force, for the complementary series of measurements for the smallest range which is used
F_N	N	Maximum capacity of the measuring range of the force indicator of the testing machine
f_o	%	Relative zero error
q	%	Relative accuracy error of the force-measuring system of the testing machine
u	%	Relative error in reversibility

3.6 Code 1.06 - Verification of the uniaxial tensile creep testing machine

Symbol	Unit	Definition
a	%	Relative discrimination threshold
b	%	Relative repeatability error of the testing machine
d	N	Discrimination threshold
d_1	N	Discrimination threshold corresponding to 20% of the force range
g	ms^{-2}	local acceleration due to gravity
q	%	Relative accuracy error of the testing machine
F	N	True force indicated by the force proving instrument
\bar{F}	N	Arithmetic mean of several measurements of F for the same discrete force
F_1	N	Force applied by the testing machine to be verified - for deadweight machines: $F_1=Mg$ - for lever-type machines: $F_1=MgR$ - for jockey weight machines, the value of F_1 is indicated on the scale of the machine
F_M	N	Force applied by the masses on the scale pan of the machines

Symbol	Unit	Definition
F_{\max} F_{\min}	N	Highest or lowest value of F for the same discrete force
F_N	N	Maximum capacity of the force range of the testing machine
F_v	N	Lower limit of the verified force range
R	-	Lever ratio used for the verification

3.7 Code 1.07 - Verification of extensometers used in uniaxial testing

Symbol	Unit	Definition
E_{\max}	mm	Maximum limit of verification range
E_{\min}	mm	Minimum limit of verification range
l_i	μm	Displacement indicated by the extensometer
l_t	μm	True displacement given by the calibration apparatus
L_e	mm	Nominal value of gauge length of extensometer
L'_e	mm	Measured value of gauge length of extensometer
q	%	Relative bias error of the extensometer
q_{Le}	%	Relative gauge length error
r	μm	Resolution of the extensometer

3.8 Code 2.01 - *Metallic materials - Bend test*

Symbol	Unit	Definition
α	degree	Angle of bend
a	mm	Thickness or diameter of testpiece (or diameter of the inscribed circle for pieces of polygonal cross section)
b	mm	Width of the testpiece
D	mm	Diameter of mandrel
l	mm	Distance between supports
L	mm	Length of test piece
r	mm	Internal radius of bend portion of test piece after bending

3.9 Code 2.02 - *Sheet and strip 3mm thick or less - Reverse bend test*

Symbol	Unit	Definition
a	mm	Thickness of test piece
h	mm	Distance from top tangential plane of cylindrical supports to the bottom face of the guide
N_b	-	Number of reverse bends
r	mm	Radius of cylindrical supports
v	mm	Distance from a plane defined by the axis of cylindrical supports and the nearest point of contact with the test piece

3.10 Code 2.03 - *Metallic materials - Wire - Simple torsion test*

Symbol	Unit	Definition
d	mm	Diameter of round wire
D	mm	Characteristic dimension for non-circular wires
L	mm	Free length between grips
N_t	-	Number of turns

3.11 Code 2.04 - *Metallic materials - Wire - Reverse bend test*

Symbol	Unit	Definition
a	mm	Minimum thickness of wire of non-circular section capable of being held between parallel grips
d	mm	Diameter of round wire
d_g	mm	Diameter of guide hole
h	mm	Distance from top tangential plane of cylindrical supports to bottom face of guide
N_b	-	Number of reverse bends
r	mm	Radius of cylindrical supports
y	mm	Distance from the plane defined by the axes of the cylindrical supports to the nearest point of contact with the test piece

3.12 Code 2.05 - *Metallic materials - Wire - Wrapping test*

There are no symbols or definitions in the text of the standard.

3.13 Code 2.06 - *Sheet and strip - Modified Erichsen cupping test*

Table 13. Symbols designated in the international standard, Code 2.06		
Symbol	Unit	Definition
a	mm	Thickness of test piece
b	mm	Width of diameter of test piece
d_1	mm	Diameter of the spherical end of the punch
d_2	mm	Bore diameter of the die
d_3	mm	Bore diameter of the blank holder
d_4	mm	Outside diameter of the die
d_5	mm	Outside diameter of the blank holder
h_1	mm	Height of the inside rounded part of the die
h	mm	Depth of the cup during the test
IE	-	Erichsen cupping index
R_1	mm	Outside corner radius of the die, outside corner radius of the blank holder
R_2	mm	Inside corner radius of the die

3.14 Code 2.07 - *Tube (in full section) - Bend test*

Table 14. Symbols designated in the international standard, Code 2.07		
Symbol	Unit	Definition
α	degree	Angle of bend
a	mm	Wall thickness of tube
D	mm	Outside diameter of tube
L	mm	Length of testpiece before test
r	mm	Inside radius at the bottom of the groove

3.15 Code 2.08 - *Metallic materials - Tube - Flattening test*

Table 15. Symbols designated in the international standard, Code 2.08		
Symbol	Unit	Definition
<i>a</i>	mm	Wall thickness of tube
<i>b</i>	mm	Inside width of flattened test piece
<i>D</i>	mm	Outside diameter of tube
<i>H</i>	mm	Distance between platens measured under load
<i>L</i>	mm	Length of test piece

3.16 Code 2.09 - *Metallic materials - Tube - Drift expanding test*

Table 16. Symbols designated in the international standard, Code 2.09		
Symbol	Unit	Definition
β	degree	Angle of mandrel
<i>a</i>	mm	Wall thickness of tube
<i>D</i>	mm	Original outside diameter of tube
<i>D_u</i>	mm	Maximum outside diameter after testing
<i>L</i>	mm	Length of test piece before test

3.17 Code 2.10 - *Metallic materials - Tube - Flanging test*

Table 17. Symbols designated in the international standard, Code 2.10		
Symbol	Unit	Definition
β	degree	Angle of the first forming tool
<i>a</i>	mm	Wall thickness of tube
<i>D</i>	mm	Original outside diameter of tube
<i>D_u</i>	mm	Maximum outside diameter of flange
<i>L</i>	mm	Length of test piece before test
<i>R</i>	mm	Corner radius of second forming tool

3.18 Code 2.11 - Metallic materials - Tube - Ring expanding test

Table 18. Symbols designated in the international standard, Code 2.11		
Symbol	Unit	Definition
a	mm	Wall thickness of tube
D	mm	Original outside diameter of tube
$D_{m \max}$	mm	Maximum diameter of the mandrel
$D_{m \min}$	mm	Minimum diameter of the mandrel
D_u	mm	Maximum outside diameter of the expanded part of the test piece
L	mm	Length of test piece before test

3.19 Code 2.12 - Metallic materials - Tube - Ring tensile test

There are no symbols or definitions in the text of the standard.

3.20 Code 2.13 - Wire - reverse torsion test

Table 19. Symbols designated in the international standard, Code 2.13		
Symbol	Unit	Definition
d	mm	Diameter of a round wire
L	mm	Free length between grips
N_t	-	Number of turns in one direction

3.21 Code 2.14 - Sheet and strip - Determination of plastic strain ratio

3.21.1 Definition

Plastic strain ratio, r: The ratio of the true width strain and true thickness strain in a test piece that has been submitted to uniaxial tensile stress.

Symbol	Unit	Definition
Δr	-	Degree of planar anisotropy
e_a	-	True thickness strain
e_b	-	True width strain
b	mm	Gauge width of the test piece after straining to a specified elongation
b_o	mm	Original gauge width of the test piece
L	mm	Gauge length after straining to a specified elongation
L_o	mm	Original gauge length
r	-	Plastic strain ratio
r_m, \bar{r}	-	Weighted average of $r_{x/y}$ values
$r_{x/y}$	-	Plastic strain ratio in x-direction (in degrees) relative to the rolling direction at a strain level of y %

3.22 Code 2.15 - Sheet and strip - Determination of tensile strain hardening exponent.

3.22.1 Definition

Strain hardening exponent, n: The exponent of the true strain in the mathematical equation $\sigma = k.e^n$ relating the true stress to the true strain (during uniaxial application of a force).

Symbol	Unit	Definition
n	-	Gradient of line $\ln \sigma$ versus $\ln e$
ΔL	mm	Instantaneous extension of measurement base
e	-	True strain in test piece under action of force F $e = \ln (L/L_e)$

Symbol	Unit	Definition
σ	N/mm ²	True stress in test piece under action of force F $\sigma = F(L/L_e S_o)$
F	N	Instantaneous force applied to test piece
K	N/mm ²	Strength coefficient
L	mm	Instantaneous length of measurement base $L = L_e + \Delta L$
L_e	mm	Extensometer gauge length
n	-	Strain hardening exponent
N	-	Number of measurements made in determining tensile strain hardening exponent
S	mm ²	Cross-sectional area of parallel-sided section of testpiece under action of force F , $S = S_o(L_e/L)$
S_o	mm ²	Original cross-sectional area of parallel-sided section of test piece

3.23 Code 2.16 - Earing test

Symbol	Unit	Definition
a	mm	Thickness of the testpiece
d_1	mm	Diameter of the punch
d_2	mm	Inside diameter of the die
d_b	mm	Diameter of the circular blank
h_e	mm	Height of ear
$h_{e_{max}}$	mm	Maximum height of ear
\bar{h}_t	mm	Mean value of h_t
$h_{t_{max}}$	mm	Maximum value of h_t
h_t	mm	Distance between outside bottom of cup to any ear peak
\bar{h}_v	mm	Mean value of h_v
h_v	mm	Distance between outside bottom of cup to any ear valley

Symbol	Unit	Definition
$h_{v \min}$	mm	Minimum value of h_v
R_1	mm	Corner radius of the punch
R_2	mm	Inside corner radius of the die
R_a	μm	Surface roughness parameter - arithmetical mean deviation of the profile
Z	%	Height of ear expressed in percentage

3.24 Code 3.01 - Metallic materials - Hardness test - Brinell test

3.24.1 Commonality of symbols and designations:

All standards associated with the Brinell test method and listed in Table 1 of this report refer to and rely on a single set of symbols and designations. These are set out in Table 23 below and are taken from the international standard for the test method itself, ISO 6506.

Symbol	Designation
d	Mean diameter, in millimetres, of indentation
D	Diameter, in millimetres, of the ball
F	Test force, in newtons
h	Depth, in millimetres, of the indentation
HBS	Brinell hardness when a steel indenter ball is used = $0.102 F/\text{Surface area of indentation}$
HBW	Brinell hardness when a tungsten carbide indenter ball is used = $0.102 F/\text{Surface area of indentation}$

3.25 Code 3.02 - *Metallic materials - Hardness test - Vickers test*

3.25.1 *Commonality of symbols and designations:*

All standards associated with the Vickers test method and listed in Table 1 of this report share a common set of symbols and designations. These are set out in Table 24 below and are taken from the international standards for the test methods at different load ranges, ISO 6507-1, ISO 6507-2 and ISO 6507-3.

Symbol	Designation
α	Angle between opposite faces at the vertex of the pyramidal indenter (136°)
d	Arithmetic mean, in millimeters, of the two diagonals d_1 and d_2
F	Test force in Newtons
HV	Vickers hardness = $\frac{0,102 \times F}{\text{Surface area of indentation in mm}^2}$

3.26 Code 3.03 - *Metallic materials - Hardness test - Rockwell test*

3.26.1 *Commonality of symbols and designations:*

All standards associated with the Rockwell test method (scales A-B-C-D-E-F-G-H-K) and listed in Table 1 of this report refer to and rely on a single set of symbols and designations. These are set out in Table 25 below and are taken from the international standard for the test method itself, ISO 6508.

Symbol	Designation
α	Angle of the diamond cone (120°)
D	Diameter of steel ball
e	Permanent increase in depth of indentation under preliminary test force after removal of additional test force, expressed in units of 0,002 mm
F	Total test force
F_0	Preliminary test force

Table 25. Symbols designated in the international standards, code 3.03

Symbol	Designation
F_1	Additional test force
h_0	Depth of indentation under preliminary test force before application of additional test force
h_1	Increase in depth of indentation under additional test force
HRA	Rockwell hardness A scale = 100 - e
HRB	Rockwell hardness B scale = 130 - e
HRC	Rockwell hardness C scale = 100 - e
HRD	Rockwell hardness D scale = 100 - e
HRE	Rockwell hardness E scale = 130 - e
HRF	Rockwell hardness F scale = 130 - e
HRG	Rockwell hardness G scale = 130 - e
HRH	Rockwell hardness H scale = 130 - e
HRK	Rockwell hardness K scale = 130 - e
R	Radius of curvature at the tip of the diamond cone

3.27 Code 3.04 - *Metallic materials - Hardness test - Rockwell superficial test*

3.27.1 Commonality of symbols and designations:

All standards associated with the Rockwell superficial test method (scales N and T) and listed in Table 1 of this report refer to and rely on a single set of symbols and designations. These are set out in Table 26 below and are taken from the international standard for the test method itself, ISO 1024.

Table 26. Symbols designated in the international standards, Code 3.04

Symbol	Definition
α	Angle of the diamond cone (120°)
D	Diameter of steel ball

Symbol	Definition
e	Permanent increase in depth of indentation under preliminary test force after removal of additional test force, expressed in units of 0.001mm
F	Total test force
F_0	Preliminary test force
F_1	Additional test force
h_0	Depth of indentation under preliminary test force before application of additional test force
h_1	Increase in depth of indentation under additional test force
HR..N HR..T	Rockwell superficial hardness - 100 - e
R	Radius of curvature at the tip of the diamond cone

3.28 Code 3.05 - *Metallic materials - Hardness test - Knoop test*

3.28.1 Commonality of symbols and designations:

All international standards associated with the Knoop test method and listed in Table 1 of this report refer to and rely on a single set of symbols and designations. These are set out in Table 27 below and are taken from the international standard for the test method itself, ISO 4545.

Symbol	Definition
c	Indenter Constant relating projected area of the indentation to the square of the length of the long diagonal
d	Length, in millimetres, of the long diagonal
F	Test force, in Newtons
HK	Knoop Hardness = $\frac{0,102 \times F}{d^2 \cdot c}$

3.29 Code 3.06 - *Metallic materials - Hardness test - Macro Rockwell test*3.29.1 *Commonality of symbols and designations:*

All international standards associated with the Macro Rockwell test method and listed in Table 1 of this report refer to and rely on a single set of symbols and designations. These are set out in Table 28 below and are taken from the draft international standard for the test method itself, DIS 11700

Symbol	Unit	Designation
D	mm	Diameter of hard metal ball
F_0	N	Preliminary test force
F_1	N	Additional test force
F	N	Total test force
h_0	mm	Depth of indentation under preliminary test force before application of additional test force
h_1	mm	Increase in depth of indentation under additional test force
h	mm	Permanent increase of depth of indentation under preliminary test force after removal of additional test force.
HMR	-	Macro Rockwell hardness = $1000 - \frac{h}{0,001}$

3.30 Code 4.01 - *Charpy impact test (U-notch)*

Symbol	Definition
a	Thickness of test piece
b	Width of test piece
L	Distance between supports
KU	Absorbed energy with U-notch specimens

3.31 Code 4.02 - *Charpy impact test (V-notch)*

Table 30. Symbols designated in the international standard, Code 4.02	
Symbol	Definition
α	The initial angle of fall of the pendulum
β	The angle of rise of the pendulum
γ	Angle between plane of symmetry of notch and longitudinal axis of testpiece
ϵ	Angle between plane of symmetry of notch and face containing notch
θ	Angle of notch
a	Thickness of test piece
b	Width of test piece from open end of notch to opposite face
c	Depth below notch
KV	Absorbed energy with V-notch specimens
l	Distance of notch from one end of testpiece
L	Length of test piece ($L = 2l$)
P	Distance of the centre of percussion from the axis of rotation of the pendulum
r	Root radius of notch
S	Distance between test piece supports
V	Impact Velocity

3.32 Code 4.03 - *Verification of pendulum impact testing machines*

The international standard ISO R/442:1965 contains no section on definitions or symbols. However, DIS 442 contains both:-

3.32.1 *Definitions.*

anvil: The portion of the base of the machine forming a vertical plane which restrains the testpiece when it is struck by the pendulum. The plane of supports is perpendicular to the plane of the anvils.

base: That part of the framework of the machine located below the horizontal plane of the supports.

centre of percussion: That point in a body at which, on striking a blow, the percussive action is the same as if the whole mass of the body was concentrated at that point. When a simple pendulum delivers a blow along a horizontal line passing through the centre of percussion, there is no resulting horizontal reaction at the axis of rotation.

centre of strike: That point on the striking edge of the pendulum at which, in the free hanging position of the pendulum, the vertical edge of the striker meets the upper horizontal plane of a testpiece of half standard height (ie 5mm) or equivalent gauge bar resting on the testpiece supports.

industrial machine: Impact machines used for general, or industrial, or most research laboratory testing of metallic materials; these machines shall not be used to establish reference values.

reference machine: Pendulum type impact machines used to determine the reference energy of a reference testpiece. The verification requirements for this grade of machine are more stringent than those for general machines.

striker: The portion of the hammer that contacts the testpiece; the edge that actually contacts the testpiece may have a radius of 2mm (the 2mm striker) or a radius of 8mm (the 8mm striker).

testpiece supports: The portion of the base of the machine forming a horizontal plane upon which the testpiece rests prior to being struck by the hammer. The plane of the supports is perpendicular to the plane of the anvils.

actual absorbed energy; absorbed energy A_v : The total energy required to break a testpiece when tested by an impact machine. It is equal to the difference in the potential energy from the starting position of the pendulum to the end of the first half swing during which the testpiece is broken.

actual initial potential energy; potential energy A_p : The value determined by direct verification.

indicated absorbed energy; indicated energy A_s : The energy value indicated by the pointer or other readout device.

nominal indicated potential energy; nominal energy A_N : The energy assigned by the manufacturer of the machine.

reference testpieces: Impact testpieces used to verify the suitability of a general impact machine by comparing the indicated energy measured by that machine to the reference energy associated with the testpieces.

reference energy A_R : The absorbed energy value associated with the reference testpieces, determined from tests using reference machines.

height: Distance between the notched face (of the testpiece) and the opposite face.

width: Dimension (of the testpiece) perpendicular to the height that is parallel to the notch.

length: Largest dimension (of the testpiece) at right angles to the notch.

Table 31. Symbols designated in the international standard, Code 4.03		
Symbol	Units	Designation
A_V	J	Actual absorbed energy, absorbed energy
A_P	J	Actual initial potential energy, potential energy
A_S	J	Indicated absorbed energy; indicated energy
A_N	J	Nominal initial potential energy; nominal energy
A_R	J	Reference energy of a set of Charpy reference testpieces
F	N	Force exerted by the pendulum when measured at a distance of l_2
W	N	Mass (weight) of pendulum
l	m	Distance to point of impact from the axis of rotation
l_1	m	Distance to the centre of percussion from the axis of rotation
l_2	m	Distance to the point of application of the force F from the axis of rotation
p	J	Loss caused by pointer friction
p'	J	Loss caused by bearing friction and air resistance
E_1	J	Indicated energy when the machine is operated in the normal manner without a testpiece in position
β_1	°	Angle of rise when the machine is operated in the normal manner without a testpiece in position
E_2	J	Indicated energy when the machine is operated in the normal manner without a testpiece in position and without resetting the indication mechanism
β_2	°	Angle of rise when the machine is operated in the normal manner without a testpiece in position and without resetting the indication mechanism
E_3	J	Indicated energy after 11 half swings when the machine is operated in the normal manner without a testpiece in position and without resetting the indication mechanism

Table 31. Symbols designated in the international standard, Code 4.03

Symbol	Units	Designation
β_3	°	Angle of rise after 11 half swings when the machine is operated in the normal manner without a testpiece in position and without resetting the indication mechanism
P_β	J	Correction of energy losses for an angle of swing β
E_β	°	Correction of energy losses for an angle of swing β
t	s	Period of the pendulum
T	s	Total time for 100 swings of the pendulum
T_{\max}	s	Maximum value of T
T_{\min}	s	Minimum value of T
α	°	Angle of fall of the pendulum
β	°	Angle of rise of the pendulum
h	m	Height of fall of the pendulum
h'	m	Height of rise of the pendulum

3.33 Code 4.04 - Designation of test piece axes

The international standard contains no section on definitions or symbols.

3.34 Code 4.05 – Determination of the plane-strain fracture toughness

3.34.1 Definitions.

Plane strain stress intensity factor, K_I : The magnitude of the elastic stress field singularity at the tip of a crack subjected to opening mode loading. It is a function of applied force and test specimen size and geometry, having dimensions of force times length^{-3/2}.

Plane strain fracture toughness, K_{Ic} : A measure of a material's resistance to crack extension when the stress state near the crack tip is predominantly plane strain and plastic deformation is limited. It is the critical value of K_I at which significant crack extension occurs under a rising force with high constraint to plastic deformation.

Crack plane orientation: A method for relating the plane and direction of crack extension to the characteristic directions of the product. A hyphenated code is used where the letter(s) preceding the hyphen represents the direction normal to the crack plane and the letter(s) following the hyphen represents the expected direction of crack extension. For wrought metals, the letter X always denotes the direction of principal processing deformation (maximum grain flow) of the product, the letter Y the direction of least deformation and the letter Z the third orthogonal direction. If the specimen directions do not coincide with the product's characteristic directions, then two letters are used to denote the normal to the crack plane and/or the expected direction of crack extension. If there is no grain flow (as in a casting), reference axes may be arbitrarily assigned but must be clearly identified.

Notch opening displacement, V : Notch opening-mode displacement measured at or near the notch mouth.

Table 32. Symbols designated in the international standard, Code 4.05

Symbol	Units	Designation
a	m	Crack length
B	m	Specimen thickness
E	MPa	Young's modulus
F	MN	Applied force
F_Q	MN	Particular value of F
F_5	MN	Particular value of F
K_f	MPa m ^{3/2}	Maximum stress intensity factor during the final stage of fatigue precracking
K_Q	MPa m ^{3/2}	Provisional value of K_{Ic}
K_I	MPa m ^{3/2}	Opening mode stress intensity factor
K_{Ic}	MPa m ^{3/2}	Critical value of K_I (plane strain fracture toughness)

Symbol	Units	Designation
R	-	Ratio of minimum to maximum fatigue cracking force during any single cycle of fatigue operation
$R_{p0,2}$	MPa	0,2% proof strength
S	m	Span between outer loading points
V	mm	Notch opening displacement
W	m	Width for bend specimen or effective width for compact specimen
ΔK_I	MPa m ^{1/2}	Difference between maximum and minimum values of K_I during any single cycle of fatigue operation

3.35 Code 5.01 - Axial load fatigue testing

Symbol	Definition
a	Thickness of test section of test pieces of rectangular cross-section
b	Width of test pieces of rectangular cross-section where the stress is a maximum
B	Width of test pieces of rectangular cross-section at the gripped ends
d	Diameter of the test piece where the stress is a maximum
D	Diameter of the gripped ends of the test piece if plain, or overall diameter of the threaded ends
L_c	Parallel length
r	Radius at the ends of the test section which starts the transition from the test diameter d or test width b to the diameter D or width B of the gripped ends; or the continuous radius between the gripped ends of the test piece

3.36 Code 5.02 - *Rotating bar bending fatigue testing*

Table 34. Symbols designated in the international standard, Code 5.02	
Symbol	Definition
d	Diameter of the test piece where the stress is a maximum
D	Diameter of the gripped or loaded end of the test piece
r	Radius at the ends of the test section which starts the transition from the test diameter d

3.37 Code 5.03 - *Torsional stress fatigue testing*

Table 35. Symbols designated in the international standard, Code 5.03	
Symbol	Definition
d	Diameter of the test piece where the stress is a maximum
D	The diameter or width across flats of the gripped end of the test piece. The value of D may be different for each end of the test piece
L_c	The parallel length of the test piece
r	The transition blending radius at the ends of the test section which starts the transition from the test diameter d to the end diameter D , or the single radius between the gripped ends

3.38 Code 5.04 - Axial load fatigue machines - Dynamic force calibration - Strain gauge technique

Table 36. Symbols designated in the international standard, Code 5.04	
Symbol	Definition
a	The thickness of test section of a rectangular cross-section
b	The width of a rectangular cross-section where the stress is a maximum
B	The width of a rectangular cross-section at the gripped end
d	The diameter of the test piece where the stress is a maximum
D	The diameter of the gripped end of the test piece
$F_{a \max}$	The maximum force amplitude of the machine ($= \frac{1}{2} F_{R \max}$)
F_m	The mean force
$F_{m \max}$	The maximum mean force of the machine
F_{\max}	The maximum force of the machine
F_R	The dynamic force range
$F_{R \max}$	The maximum dynamic force range of the machine
l	The total length of the electrical resistance strain (ERS) gauges used, i.e. the length of the gauge backing material
L_c	The parallel length of the test piece
r	The transition radius from the parallel length to the gripped ends

4. CONCORDANCE OF KEYWORDS

Certain words or phrases in use in international standards and appearing in Clauses 3.1 to 3.38 of this document are listed in Table 37 below. The standards in which these keywords appear are identified by the codes set out in Table 1.

Table 37. : Concordance of keywords	
Keyword	Code Numbers
Absorbed energy	4.03
Angle	2.01, 2.07, 2.09, 2.10, 3.02-3.04, 4.02
Anvil	4.03
Arithmetic mean	1.05, 1.06, 3.02
Average	1.02, 1.04, 2.14
Base	4.03
Bending	2.01, 2.02, 2.04, 2.07, 5.02
Bias error	1.07
Bore diameter	2.06
Centre of percussion	4.03
Centre of strike	4.03
Characteristic dimension	2.03
Corner radius	2.06, 2.10, 2.16
Crack plane orientation	4.05
Creep elongation	1.01
Creep rupture time	1.01
Cross-sectional area	1.01, 1.03, 1.04, 2.15
Depth	2.06, 3.01, 3.03, 3.04, 3.06, 4.02
Diameter	1.01, 1.03, 1.04, 2.01, 2.03, 2.04, 2.06-2.11, 2.13, 2.16, 3.01, 3.03, 3.04, 3.06, 5.01-5.04
Discrimination threshold	1.06
Displacement	1.07
Distance	1.01, 2.01, 2.02, 2.04, 2.08, 2.16, 4.01, 4.02
Dynamic force	5.04
Elongation	1.01, 1.03, 1.04, 2.14
Elongation after creep rupture	1.01
Elongation after fracture	1.03, 1.04
Elongation at maximum force	1.04

Table 37. : Concordance of keywords	
Keyword	Code Numbers
Energy	4.01-4.02
Extension	2.15
External diameter	1.03-1.04
Final gauge length	1.01, 1.03-1.04
Final reference length	1.01
Force	1.01, 1.02-1.06, 2.15, 3.01-3.05, 5.04
Force amplitude	5.04
Force reading	1.05
Free length	2.03, 2.13
Gauge length	1.01, 1.03-1.04, 1.07, 2.14-2.15
Gradient	2.15
Hardness	3.01-3.06
Height of ear	2.16
Height of testpiece	4.03
Impact	4.01-4.03
Indenter	3.01-3.05
Indicated temperature	1.01, 1.03
Initial stress	1.01
Inside diameter	2.16
Inside radius	2.07
Internal diameter	1.04
Internal radius	2.01
Interpolation error	1.02
Length of testpiece	1.04, 2.07-2.11, 4.03
Lever ratio	1.06
Lower yield stress	1.03-1.04
Maximum capacity	1.02, 1.05-1.06
Maximum force	1.03-1.04, 5.04
Mean force	5.04
Mean value	2.16
Modulus of elasticity	1.04
Nominal energy	4.03
Notch opening displacement	4.05
Original gauge length	1.01, 1.03-1.04, 2.14
Outside diameter	2.06-2.11

Table 37. : Concordance of keywords	
Keyword	Code Numbers
Parallel length	1.01, 1.03, 1.04, 5.01, 5.03, 5.04
Permanent elongation	1.04
Permanent set stress	1.04
Planar anisotropy	2.14
Plane strain fracture toughness	4.05
Plane strain stress intensity factor	4.05
Plastic strain ratio	2.14
Potential energy	4.03
Proof stress	1.03, 1.04
Radius	1.01, 2.01, 2.02, 2.04, 2.06, 2.07, 2.10, 2.16, 3.03, 3.04, 4.01, 5.01-5.04
Radius of curvature	3.03, 3.04
Reading on the indicator	1.02
Reduction of area	1.01, 1.03-1.04
Reference energy	4.03
Reference length	1.01
Reference testpiece	4.03
Repeatability error	1.02, 1.05, 1.06
Resolution	1.02, 1.05, 1.07
Reversibility error	1.02
Root radius of notch	4.01
Strain	2.14-2.15
Strain hardening exponent	2.15
Strength coefficient	2.15
Stress	1.01, 1.03, 1.04, 2.14, 2.15, 5.01-5.04
Striker	4.03
Surface roughness	2.16
Temperature	1.01, 1.03
Tensile strength	1.03, 1.04
Test force	1.02, 1.05, 3.01-3.06
Testpiece supports	4.03
Thickness	1.03, 1.04, 2.01, 2.02, 2.04, 2.06-2.11, 2.14, 2.16, 4.01, 4.02, 5.01, 5.04
Total elongation	1.03, 1.04

Keyword	Code Numbers
True force	1.05, 1.06
True strain	2.14, 2.15
True stress	2.14, 2.15
Upper yield stress	1.03, 1.04
Velocity	4.02
Verification range	1.07
Wall thickness of tube	2.07-2.11
Weighted average	2.14
Width	1.01, 1.03, 1.04, 2.01, 2.06, 2.08, 2.14, 4.01-4.03, 5.01, 5.03, 5.04
Yield point elongation	1.04
Yield stress	1.03, 1.04
Zero error	1.02, 1.05

5. ALPHABETICAL LISTING OF SYMBOLS

All the symbols listed in Tables 2 to 36 above are retabulated in Table 38 below. They are listed in a coherent alphabetical order against both the Code that identifies the international standard or draft standard in which they appear and the designation that they are given in that standard.

Symbol	Code	Designation
α	3.04	Angle of the diamond cone (120°)
α	3.03	Angle of the diamond cone (120°)
α	3.02	Angle between opposite faces at the vertex of the pyramidal indenter (136°)
α	2.01	Angle of bend
α	4.02	The initial angle of fall of the pendulum
α	2.15	Gradient of line $\ln \sigma$ versus $\ln \epsilon$
α	4.03	Angle of fall of the pendulum

Table 38. : Alphabetical listing of all symbols in use		
Symbol	Code	Designation
α	2.07	Angle of bend
β	4.03	Angle of rise of the pendulum
β	2.09	Angle of mandrel
β	4.02	The angle of rise of the pendulum
β	2.10	Angle of the first forming tool
β_1	4.03	Angle of rise when the machine is operated in the normal manner without a testpiece in position
β_2	4.03	Angle of rise when the machine is operated in the normal manner without a testpiece in position and without resetting the indication mechanism
β_3	4.03	Angle of rise after 11 half swings when the machine is operated in the normal manner without a testpiece in position and without resetting the indication mechanism
γ	4.02	Angle between plane of symmetry of notch and longitudinal axis of testpiece
ΔK_I	4.05	Difference between maximum and minimum values of K_I during any single cycle of fatigue operation
ΔL	2.15	Instantaneous extension of measurement base
ΔL_{rt}	1.01	Increase in the reference length between a moment t and the zero moment
Δr	2.14	Degree of planar anisotropy
e	4.02	Angle between plane of symmetry of notch and face containing notch
e	2.15	True strain in test piece under action of force F , $e = \ln (L/L_e)$
e_a	2.14	True thickness strain
e_b	2.14	True width strain
θ	4.02	Angle of notch
θ_1	1.03	Indicated temperature
σ	2.15	True stress in test piece under action of force F , $\sigma = F(L/L_e S_o)$
σ_o	1.01	Initial stress
a	2.02	Thickness of test piece
a	2.09	Wall thickness of tube
a	1.04	Thickness of a flat test piece or wall thickness of a tube
a	1.05	Relative resolution of the force indicator of the testing machine

Table 38. : Alphabetical listing of all symbols in use

Symbol	Code	Designation
a	2.01	Thickness or diameter of testpiece (or diameter of the inscribed circle for pieces of polygonal cross section)
a	2.06	Thickness of test piece
a	2.08	Wall thickness of tube
a	2.07	Wall thickness of tube
a	2.04	Minimum thickness of wire of non-circular section capable of being held between parallel grips
a	1.06	Relative discrimination threshold
a	2.11	Wall thickness of tube
a	4.02	Thickness of test piece
a	2.16	Thickness of the testpiece
a	5.01	Thickness of test section of test pieces of rectangular cross-section
a	5.04	The thickness of test section of a rectangular cross-section
a	1.03	Thickness of a flat testpiece or wall thickness of a tube
a	4.05	Crack length
a	2.10	Wall thickness of tube
a	4.01	Thickness of test piece
A	1.04	Percentage elongation after fracture
A	1.03	Percentage elongation after fracture
A_f	1.01	Percentage creep elongation
A_{fu}	1.01	Percentage elongation after stress rupture
A_g	1.04	Percentage non proportional elongation at maximum force F_m
A_{gt}	1.04	Percentage total elongation at maximum force
A_N	4.03	Nominal initial potential energy; nominal energy
A_P	4.03	Actual initial potential energy, potential energy
A_R	4.03	Reference energy of a set of Charpy reference testpieces
A_S	4.03	Indicated absorbed energy; indicated energy
A_t	1.04	Percentage total elongation at fracture
A_t	1.03	Percentage total elongation at fracture
A_V	4.03	Actual absorbed energy, absorbed energy
b	1.04	Width of the parallel length of a flat test piece or average width of the longitudinal strip taken from a tube or the width of a flat wire

Table 38. : Alphabetical listing of all symbols in use		
Symbol	Code	Designation
<i>b</i>	2.06	Width or diameter of test piece
<i>b</i>	4.01	Width of test piece
<i>b</i>	1.05	Relative repeatability error of the force-measuring system of the testing machine
<i>b</i>	2.01	Width of the test piece
<i>b</i>	1.06	Relative repeatability error of the testing machine
<i>b</i>	1.03	Width of the parallel-sided portion of a flat test piece or average width of the longitudinal strip taken from a tube or width of flat wire
<i>b</i>	1.02	Relative repeatability error of the force proving instrument
<i>b</i>	4.02	Width of test piece from open end of notch to opposite face
<i>b</i>	1.01	Width of the cross-section of the parallel length of a test piece of square or rectangular cross-section
<i>b</i>	2.14	Gauge width of the test piece after straining to a specified elongation
<i>b</i>	5.04	The width of a rectangular cross-section where the stress is a maximum
<i>b</i>	5.01	Width of test pieces of rectangular cross-section where the stress is a maximum
<i>b</i>	2.08	Inside width of flattened test piece
<i>B</i>	4.05	Specimen thickness
<i>B</i>	5.04	The width of a rectangular cross-section at the gripped end
<i>B</i>	5.01	Width of test pieces of rectangular cross-section at the gripped ends
<i>b₀</i>	2.14	Original gauge width of the test piece
<i>c</i>	3.05	Indenter Constant relating projected area of the indentation to the square of the length of the long diagonal
<i>c</i>	4.02	Depth below notch
<i>d</i>	2.04	Diameter of round wire
<i>d</i>	1.06	Discrimination threshold
<i>d</i>	3.02	Arithmetic mean, in millimeters, of the two diagonals d_1 and d_2
<i>d</i>	2.03	Diameter of round wire
<i>d</i>	3.01	Mean diameter, in millimetres, of indentation
<i>d</i>	2.13	Diameter of a round wire
<i>d</i>	1.01	Diameter of the cross-section of the parallel length of a cylindrical testpiece

Table 38. : Alphabetical listing of all symbols in use		
Symbol	Code	Designation
d	5.01	Diameter of the test piece where the stress is a maximum
d	5.02	Diameter of the test piece where the stress is a maximum
d	5.03	Diameter of the test piece where the stress is a maximum
d	5.04	The diameter of the test piece where the stress is a maximum
d	3.05	Length, in millimetres, of the long diagonal
d	1.03	Diameter of the parallel-sided portion of a circular test piece, or diameter of round wire or internal diameter of a tube
d	1.04	Diameter of the parallel length of a circular test piece, or diameter of round wire or internal diameter of a tube
D	2.07	Outside diameter of tube
D	3.01	Diameter, in millimetres, of the ball
D	1.04	External diameter of a tube
D	2.01	Diameter of mandrel
D	2.09	Original outside diameter of tube
D	2.03	Characteristic dimension for non-circular wires
D	2.10	Original outside diameter of tube
D	2.08	Outside diameter of tube
D	2.11	Original outside diameter of tube
D	3.04	Diameter of steel ball
D	1.03	External diameter of a tube
D	3.06	Diameter of hard metal ball
D	5.03	The diameter or width across flats of the gripped end of the test piece.
D	5.01	Diameter of the gripped ends of the test piece if plain, or overall diameter of the threaded ends
D	5.02	Diameter of the gripped or loaded end of the test piece
D	3.03	Diameter of steel ball
D	5.04	The diameter of the gripped end of the test piece
d_1	2.16	Diameter of the punch
d_1	2.06	Diameter of the spherical end of the punch
d_1	1.06	Discrimination threshold corresponding to 20% of the force range
d_2	2.16	Inside diameter of the die

Table 38. : Alphabetical listing of all symbols in use		
Symbol	Code	Designation
d_2	2.06	Bore diameter of the die
d_3	2.06	Bore diameter of the blank holder
d_4	2.06	Outside diameter of the die
d_5	2.06	Outside diameter of the blank holder
d_b	2.16	Diameter of the circular blank
d_g	2.04	Diameter of guide hole
$D_{m \min}$	2.11	Minimum diameter of the mandrel
$D_{m \max}$	2.11	Maximum diameter of the mandrel
D_u	2.11	Maximum outside diameter of the expanded part of the test piece
D_u	2.10	Maximum outside diameter of flange
D_u	2.09	Maximum outside diameter after testing
e	3.04	Permanent increase in depth of indentation under preliminary test force after removal of additional test force, expressed in units of 0.001mm
e	3.03	Permanent increase in depth of indentation under preliminary test force after removal of additional test force, expressed in units of 0.002 mm
E	4.05	Young's modulus
E	1.04	Modulus of elasticity
E_β	4.03	Correction of energy losses for an angle of swing β
E_1	4.03	Indicated energy when the machine is operated in the normal manner without a testpiece in position
E_2	4.03	Indicated energy when the machine is operated in the normal manner without a testpiece in position and without resetting the indication mechanism
E_3	4.03	Indicated energy after 11 half swings when the machine is operated in the normal manner without a testpiece in position and without resetting the indication mechanism
E_{\max}	1.07	Maximum limit of verification range
E_{\min}	1.07	Minimum limit of verification range
F	1.06	True force indicated by the force proving instrument
F	3.04	Total test force
F	3.02	Test force in Newtons
F	2.15	Instantaneous force applied to test piece
F	3.03	Total test force
F	3.01	Test force, in newtons
F	3.06	Total test force

Table 38. : Alphabetical listing of all symbols in use

Symbol	Code	Designation
F	4.03	Force exerted by the pendulum when measured at a distance of l_2
F	3.05	Test force, in newtons
F	4.05	Applied force
F	1.05	True force indicated by the force-proving instrument with increasing test force
\bar{F}	1.06	Arithmetic mean of several measurements of F for the same discrete force
\bar{F}	1.05	Arithmetic mean of several measurements of F for the same discrete force
F_0	3.04	Preliminary test force
F_0	3.06	Preliminary test force
F_0	3.03	Preliminary test force
F_1	3.06	Additional test force
F_1	3.03	Additional test force
F_1	3.04	Additional test force
F_5	4.05	Particular value of F
$F_{a \max}$	5.04	The maximum force amplitude of the machine
f_c	1.02	Relative interpolation error
F_c	1.05	True force indicated by the force-proving instrument with increasing test force, for the complementary series of measurements for the smallest range which is used
F_f	1.02	Maximum capacity of the transducer
$F_{i \max}$	1.05	Highest value of F_i for the same discrete force
F_i	1.06	Force applied by the testing machine to be verified - for deadweight machines: $F_i = Mg$ - for lever-type machines: $F_i = MgR$ - for jockey weight machines, the value of F_i is indicated on the scale of the machine
F_i	1.05	Force reading on the force indicator of the testing machine to be verified, with increasing test force
$F_{i \min}$	1.05	Lowest value of F_i for the same discrete force
\bar{F}_i	1.05	Arithmetic mean of several measurements of F_i for the same discrete force
F_{i0}	1.05	Residual indication on the force indicator of the testing machine to be verified after removal of force
F_{ic}	1.05	Force reading on the force indicator of the testing machine to be verified, with increasing test force, for the complementary series of measurements for the smallest range which is used
F_i'	1.05	Force reading on the force indicator of the testing machine to be verified, with decreasing force