

Steel — Conversion of elongation values —

Part 1: Carbon and low alloy steels

The European Standard EN ISO 2566-1:1999 has the status of a
British Standard

ICS 77.040.10

National foreword

This British Standard is the English language version of EN ISO 2566-1:1999. It is identical with ISO 2566-1:1984. It supersedes BS 3894-1:1965 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee ISE/NFE/4, Mechanical testing of metals, to Subcommittee ISE/NFE/4/1, Uniaxial testing of metals, which has the responsibility to:

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Summary of pages

This document comprises a front cover, an inside front cover, the EN ISO title page, the EN ISO foreword page, the ISO title page, the ISO foreword page, pages 1 to 28, an inside back cover and a back cover.

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This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 September 1999

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ISBN 0 580 32678 0

Amendments issued since publication

Amd. No.	Date	Comments

English version

Steel - Conversion of elongation values - Part 1: Carbon and low alloy steels (ISO 2566-1:1984)

Acier - Conversion des valeurs d'allongement - Partie 1:
Aciers au carbone et aciers faiblement alliés (ISO 2566-1:1984)

Stahl - Umrechnung von Bruchdehnungswerten - Teil 1:
Unlegierte und niedrig legierte Stähle (ISO 2566-1:1984)

This European Standard was approved by CEN on 25 April 1999.

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Foreword

The text of the International Standard from Technical Committee ISO/TC 17 “Steel” of the International Organization for Standardization (ISO) has been taken over as an European Standard by Technical Committee ECISS/TC 1 “Steel testing”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 1999, and conflicting national standards shall be withdrawn at the latest by December 1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 2566-1:1984 has been approved by CEN as a European Standard without any modification.

International Standard 2566/1

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Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels

Acier — Conversion des valeurs d'allongement — Partie 1: Aciers au carbone et aciers faiblement alliés

Second edition — 1984-08-01

UDC 669.14 : 620.172

Ref. No. ISO 2566/1-1984 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2566/1 was developed by Technical Committee ISO/TC 17, *Steel*, and was circulated to the member bodies in April 1983.

It has been approved by the member bodies of the following countries:

Australia	Hungary	Poland
Austria	India	Romania
Belgium	Iran	South Africa, Rep. of
Bulgaria	Italy	Spain
Canada	Japan	Tanzania
China	Kenya	Thailand
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Finland	Mexico	USSR
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Germany, F.R.	Norway	

The member body of the following country expressed disapproval of the document on technical grounds:

Sweden

This second edition cancels and replaces the first edition (i.e. ISO 2566/1-1973).

Descriptors : metals, steels, unalloyed steels, low alloy steels, tests, tension tests, test specimens, elongation.

Steel — Conversion of elongation values —

Part 1: Carbon and low alloy steels

0 Introduction

Several different gauge lengths are commonly in use for the determination of percentage elongation of steels in tensile testing. Fixed gauge lengths of 50, 80, 100 and 200 mm are used; proportional gauge lengths of $k\sqrt{S_0}$ are also used for flat and round test pieces, where k may be one of a number of values, i.e. 4; 5,65; 8,16; and 11,3.

The value $5,65\sqrt{S_0}$ is adopted as the internationally preferred proportional gauge length.

Arising from this choice and the existence of specifications stipulating minimum percentage elongations on different gauge lengths, a growing need has been evident for an International Standard which could be used to convert test results into values based on the different gauge lengths. This part of ISO 2566 accordingly includes tables of conversion factors, tables of actual conversions for some of the most commonly used gauge lengths and elongation values, and figures which may also be used for such conversions. When using these conversions, however, note should be taken of the limitations on their applicability as stated in clause 1.

While, as indicated, the conversions are considered to be reliable within the stated limitations, because of the various factors influencing the determination of percentage elongations, they shall be used for acceptance purposes only by agreement between the customer and supplier.

In cases of dispute, the elongation shall be determined on the gauge length stated in the relevant specification.

1 Scope and field of application

This part of ISO 2566 specifies a method of converting room temperature percentage elongations after fracture obtained on various proportional and non-proportional gauge lengths to other gauge lengths.

The formula (see clause 4) on which conversions are based is considered to be reliable when applied to carbon, carbon manganese, molybdenum and chromium molybdenum steels within the tensile strength range 300 to 700 N/mm² and in the hot-rolled, hot-rolled and normalized or annealed conditions, with or without tempering.

These conversions are not applicable to

- a) cold reduced steels;
- b) quenched and tempered steels;
- c) austenitic steels.

Neither should they be used where the gauge length exceeds $25\sqrt{S_0}$ or where the width to thickness ratio of the test piece exceeds 20.

Care should be exercised in the case of strip under 4 mm thickness, as the index in the formula given in clause 4 increases with decreasing thickness; the value to be used shall be the subject of agreement between the customer and the supplier.

2 Symbols

In this part of ISO 2566, the symbols shown in table 1 are used.

Table 1 — List of symbols

Symbol	Description
A	Percentage elongation on gauge length, L_0 , after fracture, obtained on test
A_r	Percentage elongation on a different gauge length, required by conversion
d	Diameter of test piece
L_0	Original gauge length
S_0	Original cross-sectional area of test piece

3 Definitions

For the purpose of this part of ISO 2566, the following definitions apply:

3.1 gauge length: Any length of the parallel portion of the test piece used for measurement of strain.

The term is hereafter used in this part of ISO 2566 to denote the original gauge length, L_0 , marked on the test piece for the determination of percentage elongation after fracture, A .

3.2 proportional gauge length: A gauge length having a specified relation to the square root of the cross-sectional area, for example $5,65\sqrt{S_0}$.

3.3 non-proportional gauge length: A gauge length not specifically related to the cross-sectional area of the test piece, usually expressed in a given dimension, for example 50 mm.

4 Basic formula

The data contained in this part of ISO 2566 are based on the Oliver formula,¹⁾ which is now widely used for such elongation conversions.

The Oliver formula can, in a simplified form, be expressed as

$$A_r = 1,74A \left(\frac{\sqrt{S_0}}{L_0} \right)^{0,4}$$

where

A_r is the required elongation on gauge length L_0 ;

A is the elongation on a gauge length of $4\sqrt{S_0}$;

S_0 and L_0 are defined in table 1.

This formula gives a direct conversion of elongation on $4\sqrt{S_0}$ to the equivalent for a test piece of cross-sectional area S_0 , and a gauge length L_0 . Expressed in terms of $5,65\sqrt{S_0}$, which is now regarded as the internationally accepted standard gauge length, it becomes

$$A_r = 2A \left(\frac{\sqrt{S_0}}{L_0} \right)^{0,4}$$

where A is the elongation on a gauge length of $5,65\sqrt{S_0}$.

Tables 2 to 22 and figures 1 to 5 have been prepared on the basis of the above formulae.

5 Conversion from one proportional gauge length to another proportional gauge length

Simple multiplying factors based on the formula are used for such conversions, and the relationships between a number of the more widely used proportional gauge lengths are given in table 2. Detailed conversions of elongations obtained on $4\sqrt{S_0}$ to $5,65\sqrt{S_0}$ are given in table 6.

6 Conversion from one non-proportional gauge length to another non-proportional gauge length for test pieces of equal cross-sectional area

The conversion of elongation values of different fixed gauge lengths on test pieces of equal cross-sectional area are also made by simple factors. Conversion factors for gauge lengths of 50, 80, 100 and 200 mm are given in table 3.

7 Conversion from a proportional gauge length to a non-proportional gauge length

The conversion factors are variable according to the cross-sectional area of the non-proportional test piece. Table 4 gives the multiplying factors for conversion from elongation on $5,65\sqrt{S_0}$ to the equivalent on fixed gauge lengths of 50, 80, 100 and 200 mm for a range of cross-sectional areas. For conversions in the reverse direction, i.e. elongation on a fixed gauge length to the equivalent of $5,65\sqrt{S_0}$, the reciprocal of the factors is used.

Examples:

a) Elongation of 20 % on $5,65\sqrt{S_0}$ is equivalent to $20 \times 1,139 = 22,78$ % on a 25 mm wide test piece of 6 mm thickness with a 50 mm gauge length (see table 4);

b) Elongation of 25 % on a 40 mm × 10 mm test piece of 200 mm gauge length is equivalent to $25 \times 1/0,796 = 31,4$ % on $5,65\sqrt{S_0}$ (see table 4).

From the examples shown it will be seen that conversions involving other proportional gauge lengths can be obtained by prior or subsequent use of the factors shown in table 2.

Tables 7 to 10 can be used to obtain some of these conversions, whilst tables 15 to 18 can be used to obtain elongations on fixed gauge lengths corresponding to $5,65\sqrt{S_0}$.

Similarly, tables 11 to 14 can be used for conversion to $4\sqrt{S_0}$ and tables 19 to 22 for elongations on fixed gauge lengths corresponding to $4\sqrt{S_0}$.

8 Conversion from a non-proportional gauge length to another non-proportional gauge length for test pieces of different cross-sectional areas

It is preferable for this calculation to be made in two stages with an initial conversion to $5,65\sqrt{S_0}$.

1) OLIVER, D.A. *Proc. Inst. Mech. Eng.*, 11 1928: 827.

Example:

Elongation of 24 % on 200 mm for a 40 mm × 15 mm test piece in terms of equivalent on a 30 mm × 10 mm test piece with gauge lengths equal to 200, 100 and 50 mm.

$$24 \times 1/0,863 = 27,8 \% \text{ on } 5,65\sqrt{S_0} \text{ (see table 4).}$$

$$27,8 \times 0,752 = 20,9 \% \text{ on } 30 \text{ mm} \times 10 \text{ mm with } 200 \text{ mm gauge length}$$

$$27,8 \times 0,992 = 27,6 \% \text{ on } 30 \text{ mm} \times 10 \text{ mm with } 100 \text{ mm gauge length}$$

$$27,8 \times 1,309 = 36,4 \% \text{ on } 30 \text{ mm} \times 10 \text{ mm with } 50 \text{ mm gauge length}$$

Elongation on other proportional gauge lengths can be obtained by using the factors given in table 2.

9 Use of figures 1 to 5

9.1 Figures 1 to 5 may be used as an alternative quick method to obtain elongation conversions.

9.2 Figures 1 to 4 may be used for conversions between $5,65\sqrt{S_0}$ and 50 mm, $5,65\sqrt{S_0}$ and 200 mm, $4\sqrt{S_0}$ and 50 mm and $4\sqrt{S_0}$ and 200 mm gauge lengths, respectively.

Example:

To find the equivalent elongation on $5,65\sqrt{S_0}$ and $4\sqrt{S_0}$ to an elongation of 21 % on a 200 mm gauge length of a 25 mm × 12,5 mm test piece of cross-sectional area 312,5 mm².

The intersection of this ordinate with the abscissa representing an elongation of 21 % on a 200 mm gauge length lies on the sloping line representing an elongation of 28 % on $5,65\sqrt{S_0}$ on figure 2 and at a position relative to the sloping lines on figure 4 approximating to an elongation of 32,2 on $4\sqrt{S_0}$.

9.3 Figure 5 may be used for the calculation of all elongation conversions.

The Oliver formula may be rewritten as

$$A_2 = A_1 \left(\frac{K_1}{K_2} \right)^{0,4}$$

$$= \lambda_{1;2} \times A_1$$

where K_1 and K_2 designate the proportionality ratios of any two test pieces.

$$K_1 = \frac{L_1}{\sqrt{S_1}}$$

$$K_2 = \frac{L_2}{\sqrt{S_2}}$$

Figure 5 shows the values of $\lambda_{1;2} = (K_1/K_2)^{0,4}$.

To use figure 5 it is necessary to perform the following operations:

- calculate the values of proportionality $K_1 = (L_1/\sqrt{S_1})$ and $K_2 = (L_2/\sqrt{S_2})$ for two test pieces;
- read graphically the coefficient $\lambda_{1;2} = (K_1/K_2)^{0,4}$;
- the elongation obtained is $A_2 = \lambda_{1;2} \times A_1$.

Table 2 — Conversion factors: Proportional gauge lengths

Conversion from:	Factor for conversion to:						
	$4\sqrt{S_0}$	$5,65\sqrt{S_0}$	$8,16\sqrt{S_0}$	$11,3\sqrt{S_0}$	$4d$	$5d$	$8d$
$4\sqrt{S_0}$	1,000	0,870	0,752	0,661	0,953	0,870	0,721
$5,65\sqrt{S_0}$	1,149	1,000	0,863	0,759	1,093	1,000	0,828
$8,16\sqrt{S_0}$	1,330	1,158	1,000	0,879	1,268	1,158	0,960
$11,3\sqrt{S_0}$	1,514	1,317	1,137	1,000	1,443	1,317	1,091
$4d$	1,050	0,916	0,790	0,694	1,000	0,916	0,758
$5d$	1,149	1,000	0,863	0,759	1,093	1,000	0,828
$8d$	1,389	1,207	1,042	0,918	1,319	1,207	1,000

Table 3 — Conversion factors¹⁾: Non-proportional gauge lengths

Conversion from:	Factor for conversion to:			
	50 mm	80 mm	100 mm	200 mm
50 mm	1,000	0,829	0,758	0,754
80 mm	1,207	1,000	0,915	0,693
100 mm	1,320	1,093	1,000	0,758
200 mm	1,741	1,443	1,320	1,000

1) Provided cross-sectional areas are the same.

Table 4 — Conversion factors from $5,65\sqrt{S_0}$ to non-proportional gauge lengths

Factors shown under “non-proportional gauge lengths” give the value of

$$2\left(\frac{\sqrt{S_0}}{L}\right)^{0,4}$$

To convert from values on a gauge length of $5,65\sqrt{S_0}$ to a non-proportional gauge length, multiply by the appropriate factor.

To convert from values on a non-proportional gauge length to $5,65\sqrt{S_0}$, divide by the appropriate factor.

See also figures 1 and 2.

Cross-sectional area of test piece	Factor for non-proportional gauge length of:			
	200 mm	100 mm	80 mm	50 mm
5	0,331	0,437	0,478	0,577
10	0,381	0,502	0,549	0,663
15	0,413	0,545	0,596	0,719
20	0,437	0,577	0,631	0,761
25	0,457	0,603	0,660	0,796
30	0,474	0,626	0,684	0,826
35	0,489	0,645	0,706	0,852
40	0,502	0,663	0,725	0,875
45	0,514	0,679	0,742	0,896
50	0,525	0,693	0,758	0,915
55	0,535	0,706	0,772	0,932
60	0,545	0,719	0,786	0,949
70	0,562	0,741	0,811	0,978
80	0,577	0,761	0,833	1,005
90	0,591	0,780	0,852	1,029
100	0,603	0,796	0,871	1,051
110	0,615	0,812	0,887	1,071
120	0,626	0,826	0,903	1,090
130	0,636	0,839	0,917	1,107
140	0,645	0,852	0,931	1,124
150	0,654	0,863	0,944	1,139
160	0,663	0,875	0,956	1,154
170	0,671	0,885	0,968	1,168
180	0,679	0,896	0,979	1,182
190	0,686	0,905	0,990	1,195
200	0,693	0,915	1,000	1,207
210	0,700	0,924	1,010	1,219
220	0,706	0,932	1,019	1,230
230	0,713	0,941	1,028	1,241
240	0,719	0,949	1,037	1,252
250	0,725	0,956	1,046	1,262
260	0,730	0,964	1,054	1,272
270	0,736	0,971	1,062	1,281
280	0,741	0,978	1,070	1,291
290	0,747	0,985	1,077	1,300
300	0,752	0,992	1,084	1,309
310	0,757	0,998	1,092	1,317
320	0,761	1,005	1,099	1,326
330	0,766	1,011	1,105	1,334
340	0,771	1,017	1,112	1,342
350	0,775	1,023	1,118	1,350
360	0,780	1,029	1,125	1,357
370	0,784	1,034	1,131	1,365
380	0,788	1,040	1,137	1,372
390	0,792	1,045	1,143	1,379

Table 4 (concluded) — Conversion factors from $5,65\sqrt{S_0}$ to non-proportional gauge lengths

Cross-sectional area of test piece	Factor for non-proportional gauge length of:			
	200 mm	100 mm	80 mm	50 mm
400	0,796	1,051	1,149	1,386
410	0,800	1,056	1,154	1,393
420	0,804	1,061	1,160	1,400
430	0,808	1,066	1,165	1,406
440	0,812	1,071	1,171	1,413
450	0,815	1,076	1,176	1,419
460	0,819	1,080	1,181	1,426
470	0,822	1,085	1,186	1,432
480	0,826	1,090	1,191	1,438
490	0,829	1,094	1,196	1,444
500	0,833	1,099	1,201	1,450
550	0,849	1,120	1,224	1,477
600	0,863	1,139	1,246	1,503
650	0,877	1,158	1,266	1,528
700	0,891	1,175	1,285	1,550
750	0,903	1,191	1,303	1,572
800	0,915	1,207	1,320	1,592
850	0,926	1,222	1,336	1,612
900	0,936	1,236	1,351	1,630
950	0,947	1,249	1,366	1,648
1 000	0,956	1,262	1,380	1,665
1 050	0,966	1,274	1,393	1,681
1 100	0,975	1,286	1,406	1,697
1 150	0,983	1,298	1,419	1,712
1 200	0,992	1,309	1,431	1,727
1 250	1,000	1,320	1,443	1,741
1 300	1,008	1,330	1,454	1,755
1 350	1,016	1,340	1,465	1,768
1 400	1,023	1,350	1,476	1,781
1 450	1,030	1,359	1,486	1,794
1 500	1,037	1,369	1,496	1,806
1 550	1,044	1,378	1,506	1,818
1 600	1,051	1,386	1,516	1,829
1 650	1,057	1,395	1,525	1,841
1 700	1,063	1,403	1,534	1,852
1 750	1,070	1,411	1,543	1,862
1 800	1,076	1,419	1,552	1,873
1 850	1,082	1,427	1,560	1,883
1 900	1,087	1,435	1,569	1,893
1 950	1,093	1,442	1,577	1,903
2 000	1,099	1,450	1,585	1,913
2 050	1,104	1,457	1,593	1,922
2 100	1,109	1,464	1,600	1,931
2 150	1,115	1,471	1,608	1,941
2 200	1,120	1,477	1,615	1,950
2 250	1,125	1,484	1,623	1,958
2 300	1,130	1,491	1,630	1,967
2 350	1,135	1,497	1,637	1,975
2 400	1,139	1,503	1,644	1,984
2 450	1,144	1,510	1,651	1,992
2 500	1,149	1,516	1,657	2,000
2 550	1,153	1,522	1,664	2,008
2 600	1,158	1,528	1,670	2,016
2 650	1,162	1,533	1,677	2,023
2 700	1,167	1,539	1,683	2,031
2 750	1,171	1,545	1,689	2,038
2 800	1,175	1,550	1,695	2,046
2 850	1,179	1,556	1,701	2,053
2 900	1,183	1,561	1,707	2,060
2 950	1,187	1,567	1,713	2,067
3 000	1,191	1,572	1,719	2,074