

Conversion of elongation values for steel —

Part 2: Method of conversion for application to austenitic steels

[ISO title: Steel — Conversion of elongation values —
Part 2: Austenitic steels]

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- Aluminium Federation
- British Civil Engineering Test Equipment Manufacturers' Association
- British Gas Corporation
- British Non-ferrous Metals Federation
- British Railways Board
- British Steel Industry
- British Steel Industry (Wire Section)
- Copper Development Association
- Department of Trade and Industry (British Calibration Service)
- Department of Trade and Industry (National Engineering Laboratory)
- Department of Trade and Industry (National Physical Laboratory)
- GAMBICA (BEAMA Ltd.)
- Institution of Production Engineers
- Ministry of Defence
- Welding Institute
- Coopted members

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- BCIRA
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National foreword

This Part of BS 3894 has been prepared under the direction of the Iron and Steel and the Non-ferrous Metals Standards Committee and is identical with ISO 2566-2:1984 “*Steel — Conversion of elongation values, Part 2 Austenitic steels*” published by the International Organization for Standardization (ISO).

It is one of two Parts of which Part 1 covers conversions for carbon and low alloy steels. Part 1 is related to ISO 2566-1 “*Steel — Conversions of elongation values, Part 1 Carbon and low alloy steels*”.

Terminology and conventions. The text of the International Standard has been approved as suitable for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Wherever “ISO 2566” appears it should be read as “BS 3894”.

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as a decimal marker.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 29 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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 austenitic stainless steels within the tensile strength range 450 to 750 N/mm² and in the solution treated condition.

These conversions are not applicable to

- a) cold reduced steels;
- b) quenched and tempered steels;
- c) non-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 3 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 a formula obtained from a statistical assessment of international test results, which, in a simplified form, can be expressed as

$$A_r = 1,25A \left(\frac{\sqrt{S_0}}{L_0} \right)^{0,127}$$

where

A_r is the required elongation on gauge length L_0 ;

A is the elongation on a gauge length of $5,65\sqrt{S_0}$ which is the internationally accepted gauge length;

S_0 and L_0 are defined in Table 1.

Expressed in terms of $4\sqrt{S_0}$ the formula becomes

$$A_r = 1,19A \left(\frac{\sqrt{S_0}}{L_0} \right)^{0,127}$$

where A is the elongation on a gauge length of $4\sqrt{S_0}$. Table 2 to Table 22 and Figure 1 to Figure 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.

Example:

Elongation of 20 % on $5,65\sqrt{S_0}$ is equivalent to $20 \times 1,046 = 20,9$ % on a 25 mm wide test piece of 6 mm thickness with a 50 mm gauge length (see Table 4).

From the example 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.

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

Similarly, Table 11 to Table 14 can be used for conversion to $4\sqrt{S_0}$ and Table 19 to Table 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 $5,65\sqrt{S_0}$.

Example:

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

$24 \times 1/0,957 = 25,1$ % on $5,65\sqrt{S_0}$ (see Table 4)

$25,1 \times 0,916 = 23,0$ % on 30 mm $\times$ 10 mm with 200 mm gauge length

$25,1 \times 1,000 = 25,1$ % on 30 mm $\times$ 10 mm with 100 mm gauge length

$25,1 \times 1,093 = 27,4$ % on 30 mm $\times$ 10 mm with 50 mm gauge length

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

9 Use of Figure 1 to Figure 5

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

9.2 Figure 1 to Figure 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 25 % on a 200 mm gauge length of a 25 mm $\times$ 12,5 mm test piece of cross-sectional area 312,5 mm².

The intersection of this ordinate with the abscissa representing an elongation of 25 % on a 200 mm gauge length lies on the sloping line representing an elongation of 27,2 % 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 28,8 % on $4\sqrt{S_0}$.

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

The formula given in clause 4 may be rewritten as

$$A_2 = A_1 \left(\frac{K_1}{K_2} \right)^{0,127} \\ = \lambda_{1,2} \times A_1$$

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 $\lambda_{1,2} = (K_1/K_2)^{0,127}$.

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

- calculate the value 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 $\lambda_{1,2} = (K_1/K_2)^{0,127}$;
- the elongation obtained is $A_2 = \lambda_{1,2} \times A_1$.

Example:

Elongation of 24 % on 200 mm for a 40 mm $\times$ 15 mm test piece in terms of equivalent on a 30 mm $\times$ 10 mm test piece with a gauge length equal to 100 mm.

$$a) \quad K_1 = \frac{L_1}{\sqrt{S_1}} = \frac{200}{\sqrt{600}} = 8,16$$

$$K_2 = \frac{L_2}{\sqrt{S_2}} = \frac{100}{\sqrt{300}} = 5,77$$

- From Figure 5, $\lambda_{1,2} = 1,04$.
- Elongation required is $24 \times 1,04 = 25,0$ %.

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	0,957	0,913	0,876	0,985	0,957	0,902
$5,65\sqrt{S_0}$	1,045	1,000	0,954	0,916	1,029	1,000	0,942
$8,16\sqrt{S_0}$	1,095	1,048	1,000	0,959	1,078	1,048	0,987
$11,3\sqrt{S_0}$	1,141	1,092	1,042	1,000	1,124	1,092	1,029
$4d$	1,015	0,972	0,928	0,890	1,000	0,972	0,916
$5d$	1,045	1,000	0,954	0,916	1,029	1,000	0,942
$8d$	1,109	1,061	1,013	0,972	1,092	1,062	1,000

Table 3 — Conversion factors:^a Non-proportional gauge lengths

Conversion from:	Factor for conversion to:			
	50 mm	80 mm	100 mm	200 mm
50 mm	1,000	0,942	0,916	0,839
80 mm	1,062	1,000	0,972	0,890
100 mm	1,092	1,029	1,000	0,916
200 mm	1,193	1,123	1,092	1,000

^a 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

$$1,25 \left(\frac{\sqrt{S_0}}{L_0} \right)^{0,127}$$

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 Figure 1 and Figure 2.

Cross-sectional area of test piece	Factor for non-proportional gauge length of:			
	200 mm	100 mm	80 mm	50 mm
mm ²				
5	0,706	0,771	0,794	0,842
10	0,738	0,806	0,829	0,880
15	0,757	0,827	0,851	0,903
20	0,771	0,842	0,867	0,920
25	0,782	0,854	0,879	0,933
30	0,792	0,864	0,889	0,944
35	0,779	0,873	0,898	0,953
40	0,806	0,880	0,906	0,961
45	0,812	0,887	0,912	0,969
50	0,818	0,893	0,919	0,975
55	0,823	0,898	0,924	0,981
60	0,827	0,903	0,929	0,986
70	0,835	0,912	0,938	0,996
80	0,842	0,920	0,946	1,005
90	0,849	0,927	0,953	1,012
100	0,854	0,933	0,960	1,019
110	0,860	0,939	0,966	1,025
120	0,864	0,944	0,971	1,031
130	0,869	0,949	0,976	1,036
140	0,873	0,953	0,981	1,041
150	0,877	0,957	0,985	1,045
160	0,880	0,961	0,989	1,050
170	0,884	0,965	0,993	1,054
180	0,887	0,969	0,996	1,058
190	0,890	0,972	1,000	1,061
200	0,893	0,975	1,003	1,065
210	0,896	0,978	1,006	1,068
220	0,898	0,981	1,009	1,071
230	0,901	0,984	1,012	1,074
240	0,903	0,986	1,015	1,077
250	0,906	0,989	1,017	1,080
260	0,908	0,991	1,020	1,083
270	0,910	0,994	1,022	1,085
280	0,912	0,996	1,025	1,088
290	0,914	0,998	1,027	1,090
300	0,916	1,000	1,029	1,093
310	0,918	1,003	1,031	1,095
320	0,920	1,005	1,033	1,097
330	0,922	1,007	1,035	1,099
340	0,923	1,008	1,037	1,101

Table 4 — 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
350	0,925	1,010	1,039	1,103
360	0,927	1,012	1,041	1,105
370	0,928	1,014	1,043	1,107
380	0,930	1,016	1,045	1,109
390	0,932	1,017	1,047	1,111
400	0,933	1,019	1,048	1,113
410	0,935	1,021	1,050	1,114
420	0,936	1,022	1,051	1,116
430	0,937	1,024	1,053	1,118
440	0,939	1,025	1,055	1,119
450	0,940	1,027	1,056	1,121
460	0,941	1,028	1,058	1,123
470	0,943	1,029	1,059	1,124
480	0,944	1,031	1,060	1,126
490	0,945	1,032	1,062	1,127
500	0,946	1,033	1,063	1,129
550	0,952	1,040	1,070	1,135
600	0,957	1,045	1,076	1,142
650	0,962	1,051	1,081	1,148
700	0,967	1,056	1,086	1,153
750	0,971	1,060	1,091	1,158
800	0,975	1,065	1,095	1,163
850	0,979	1,069	1,100	1,167
900	0,982	1,073	1,104	1,171
950	0,986	1,076	1,107	1,176
1 000	0,989	1,080	1,111	1,179
1 050	0,992	1,083	1,114	1,183
1 100	0,995	1,087	1,118	1,187
1 150	0,998	1,090	1,121	1,190
1 200	1,000	1,093	1,124	1,193
1 250	1,003	1,095	1,127	1,196
1 300	1,006	1,098	1,130	1,199
1 350	1,008	1,101	1,132	1,202
1 400	1,010	1,103	1,135	1,205
1 450	1,013	1,106	1,138	1,208
1 500	1,015	1,108	1,140	1,210
1 550	1,017	1,110	1,142	1,213
1 600	1,019	1,113	1,145	1,215
1 650	1,021	1,115	1,147	1,217
1 700	1,023	1,117	1,149	1,220
1 750	1,025	1,119	1,151	1,222
1 800	1,027	1,121	1,153	1,224
1 850	1,028	1,123	1,155	1,226
1 900	1,030	1,125	1,157	1,228
1 950	1,032	1,127	1,159	1,230
2 000	1,033	1,129	1,161	1,232
2 050	1,035	1,130	1,163	1,234
2 100	1,037	1,132	1,165	1,236
2 150	1,038	1,134	1,166	1,238
2 200	1,040	1,135	1,168	1,240