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Method for converting elongation values for steel —

Part 1: Carbon and low alloy steels

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- British Iron and Steel Federation
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Foreword

This British Standard has been prepared under the authority of the Iron and Steel Industry Standards Committee.

Several different gauge lengths are commonly in use for the determination of percentage elongation of steels in tensile testing; 2 inch and 8 inch gauge lengths being widely used for test pieces cut from plate sheet, strip, pipe and tube, and proportional gauge lengths of $4\sqrt{S_0}$ and $5.65\sqrt{S_0}$ for both flat and round test pieces.

Discussion within Technical Committee 17 "Steel" of the International Organization for Standardization (ISO) has resulted in the adoption of $5.65\sqrt{S_0}$ as the international preferred proportional gauge length.

Arising from this agreement and the existence of specifications stipulating minimum percentage elongations on different gauge lengths, a growing need has been evident for a British Standard that could be used to convert test results into values based on the different gauge lengths. This standard accordingly includes tables of conversion factors, tables of actual conversions for some of the more commonly used gauge lengths and elongation values, and charts 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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 15 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.

Section 1. General

1 Scope

This British Standard specifies a method of converting percentage elongations after fracture obtained on various proportional and non-proportional gauge lengths to other gauge lengths.

The formula (see Clause 4), on which the conversions are based, is considered to be reliable when applied to carbon, carbon manganese, molybdenum and chromium molybdenum steels within the tensile strength range 20 tonf/in² to 43 tonf/in² and in the hot-rolled, hot-rolled and normalized or annealed condition, with or without tempering.

These conversions are not applicable to:

- a) cold reduced steels;
- b) quenched and tempered steels;

or c) austenitic steels;

nor should they be used where the gauge length exceeds $25\sqrt{S_0}$ or the width to thickness ratio of the test piece exceeds 20.

Whilst as indicated the conversions are considered to be reliable within the stated limitations and may generally be used for acceptance purposes, because of the various factors influencing the determination of percentage elongations, in cases of dispute the elongation shall be determined on the gauge length stated in the relevant material specification.

2 Symbols

In this British Standard the following symbols apply:

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 purposes of this British Standard the following definitions apply:

gauge length

any length of the parallel portion of the test piece used for measurement of strain. The term is hereafter used in this standard to denote the original gauge length L_0 marked on the test piece for the determination of percentage elongation after fracture (A)

proportional gauge length

a gauge length having a specified relation to the square root of the cross-sectional area, e.g. $5.65\sqrt{S_0}$

non-proportional gauge length

a gauge length not specifically related to the cross-sectional area of the test piece, usually expressed as a given dimension, e.g. 2 inches

4 Basic formula

The data contained in this British Standard are based on the "Oliver" formula¹⁾ which is now widely used for such elongation conversions.

¹⁾ D. A Oliver, *Proc. Inst. Mech. E.*, Vol. 11 (1928), page 827.

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

$$A_r = 1.74A \left(\frac{\sqrt{S_o}}{L_o} \right)^{0.4}$$

where A_r = required elongation on gauge length L_o ,

A = elongation on a gauge length of $4\sqrt{S_o}$,

S_o = cross-sectional area of test piece.

This formula gives a direct conversion of elongation on $4\sqrt{S_o}$ to the equivalent for a test piece of area S_o , and gauge length L_o . Expressed in terms of $5.65\sqrt{S_o}$, which is now regarded as the internationally accepted standard gauge length, it becomes

$$A_r = 2A \left(\frac{\sqrt{S_o}}{L_o} \right)^{0.4}$$

where A = elongation on a gauge length of $5.65\sqrt{S_o}$.

Table 1 to Table 10 and Charts 1 and 2 have been prepared on the basis of the above formulae.

Section 2. Application of the factors and tables

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 relationship between a number of the more widely used proportional gauge lengths are given in Table 1. Detailed conversions of elongations obtained on $4\sqrt{S_o}$ to $5.65\sqrt{S_o}$ are given in Table 4.

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 for different fixed gauge lengths on test pieces of equal cross-sectional area are also made by simple factors. Conversion factors for 2, 4, 6, 8 and 10 inch gauge lengths are given in Table 2.

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 3 gives the multiplying factors for conversion from elongation on $5.65\sqrt{S_o}$ to the equivalent on fixed gauge lengths of 2 in, 4 in, 8 in for a range of sectional areas. For conversions in the reverse direction, i.e. elongation on a fixed gauge length to the equivalent on $5.65\sqrt{S_o}$, the reciprocal of the factor is used.

Examples.

- Elongation of 20 per cent on $5.65\sqrt{S_o}$ is equivalent to $20 \times 1.158 = 23.2$ per cent on a 1 in wide test piece of 0.26 in thickness with a 2 in gauge length (see Table 3).
- Elongation of 24 per cent on $1\frac{1}{2}$ in $\times$ $\frac{1}{2}$ in test piece of 8 in gauge length is equivalent to $24 \times 1/0.822 = 29.2$ per cent on $5.65\sqrt{S_o}$ (see Table 3).

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 1.

Table 5, Table 6 and Table 7 can be used to obtain some of these conversions.

Similarly, Table 8, Table 9 and Table 10 can be used for conversions to $4\sqrt{S_o}$.