



ESDU 84041

Issued December 1984

With Amendment A

July 2008

Properties of common engineering materials

Endorsed by
The Institution of Mechanical Engineers

AVA Documents
Document Sharing Hub

ESDU DATA ITEMS

Data Items provide validated information in engineering design and analysis for use by, or under the supervision of, professionally qualified engineers. The data are founded on an evaluation of all the relevant information, both published and unpublished, and are invariably supported by original work of ESDU staff engineers or consultants. The whole process is subject to independent review for which crucial support is provided by industrial companies, government research laboratories, universities and others from around the world through the participation of some of their leading experts on ESDU Technical Committees. This process ensures that the results of much valuable work (theoretical, experimental and operational), which may not be widely available or in a readily usable form, can be communicated concisely and accurately to the engineering community.

We are constantly striving to develop new work and review data already issued. Any comments arising out of your use of our data, or any suggestions for new topics or information that might lead to improvements, will help us to provide a better service.

THE PREPARATION OF THIS DATA ITEM

The work on this particular Data Item which was monitored and guided by the Tribology Steering Group. This Committee first met in 1973 and now has the following membership:

Chairman	
Dr S.Y. Poon	— I.T. Research Ltd
Members	
Prof. Dr-Ing. W.J. Bartz [*]	— Technische Akademie Esslingen, Federal Republic of Germany
Prof. D. Dowson [†]	— University of Leeds
Mr T.I. Fowle	— Independent
Prof J. Halling	— Independent
Prof Y. Hori [†]	— University of Tokyo
Mr F.A. Martin	— The Glacier Metal Co. Ltd
Mr V.T. Morgan	— GKN Bound Brook Ltd
Dr P.B. Neal	— University of Sheffield
Mr M.J. Neale [‡]	— Michael Neale & Associates
Dr W.H. Roberts	— National Centre of Tribology
Dr R.S. Sayles	— Imperial College of Science and Technology
Dr C.M. Taylor	— University of Leeds
Dr D.F. Wilcock [†]	— Tribolock Incorporated, NY, USA.
Dr S.Y. Poon	— I.T. Research Ltd

* Corresponding Member

† Member Emeritus

The construction and subsequent development of the Data Item was undertaken by

Mr K.A. Waters — Senior Engineer.

The person with overall responsibility for the work in this subject area is Mr Chris Loughton, Head of Mechanical Motion and System Dynamics Group.

PROPERTIES OF COMMON ENGINEERING MATERIALS

CONTENTS

	Page
1. NOTATION AND UNITS	1
2. INTRODUCTION	1
3. DERIVATION AND REFERENCES	2
3.1 Derivation	2
3.2 References	2
4. DENSITY	3
5. TENSILE MODULUS	5
6. POISSON’S RATIO	7
7. LINEAR THERMAL EXPANSION COEFFICIENT	8
8. THERMAL CONDUCTIVITY	10
9. SPECIFIC HEAT CAPACITY	12
10. MELTING OR SOFTENING TEMPERATURE	14

PROPERTIES OF COMMON ENGINEERING MATERIALS

1. NOTATION AND UNITS

The International System of Units (SI) is used in this Item. This is a coherent system. Values for the material properties are also quoted in the equivalent conventional engineering units.

		<i>SI</i>	<i>British</i>
a	linear thermal expansion coefficient	K^{-1}	$^{\circ}F^{-1}$
C	specific heat capacity [†]	$kJ\ kg^{-1}\ K^{-1}$	$BTU\ lb^{-1}\ ^{\circ}F^{-1}$
E	tensile modulus	$N\ m^{-2}$	$lbf\ in^{-2}$
G	shear modulus	$N\ m^{-2}$	$lbf\ in^{-2}$
H	Vickers hardness	—	—
K	bulk modulus	$N\ m^{-2}$	$lbf\ in^{-2}$
k	thermal conductivity	$W\ m^{-1}\ K^{-1}$	$BTU\ ft^{-1}\ h^{-1}\ ^{\circ}F^{-1}$
ν	Poisson's ratio	—	—
ρ	density [†]	$kg\ m^{-3}$	$lb\ in^{-3}$
σ	stress	$N\ m^{-2}$	$lbf\ in^{-2}$

[†] 1 lb is equal to 0.45359237 kg.

2. INTRODUCTION

This Item is intended to provide representative values for a number of material properties required in approximate calculations associated with tribology.

With many materials a wide range of property values is attainable by, for example, heat-treatment or small changes in composition. The quoted values are, therefore, only typical values likely to be met in tribological applications. Where more precise values are required, the user is advised to consult the specification for the particular material of interest.

Unless otherwise stated, all material properties are quoted for room temperature (20°C).

3. DERIVATION AND REFERENCES

3.1 Derivation

–	Materials Data, Cambridge University Engineering Department internal report, 1981.
ESDU	Metallic Materials Data Handbook. AvP932, ESDU International, London, 1982.
BSI	Wrought steels for mechanical and allied engineering purposes. BS 970, British Standards Institution, London, 1983.
–	Handbook of Industrial Materials, First edition, Trade and Technical Press Ltd., Morden, 1978.
SMITHELLS, C.J.	Metals Reference Book, Fourth edition, Butterworths, 1967.
–	Plastics, Machine Design Reference Issue, Vol 38, No 14, Penton Publishing Co., 1966.
WILSON, C. (Ed)	Plastics, Design Engineering, Morgan Grampian (Publishers) Ltd., London, 1969.
HOLLIGAN, P.T. NEALE, M.J. (Ed)	Tribology Handbook, Plain bearing materials, Section C1, Butterworths, London, 1973.

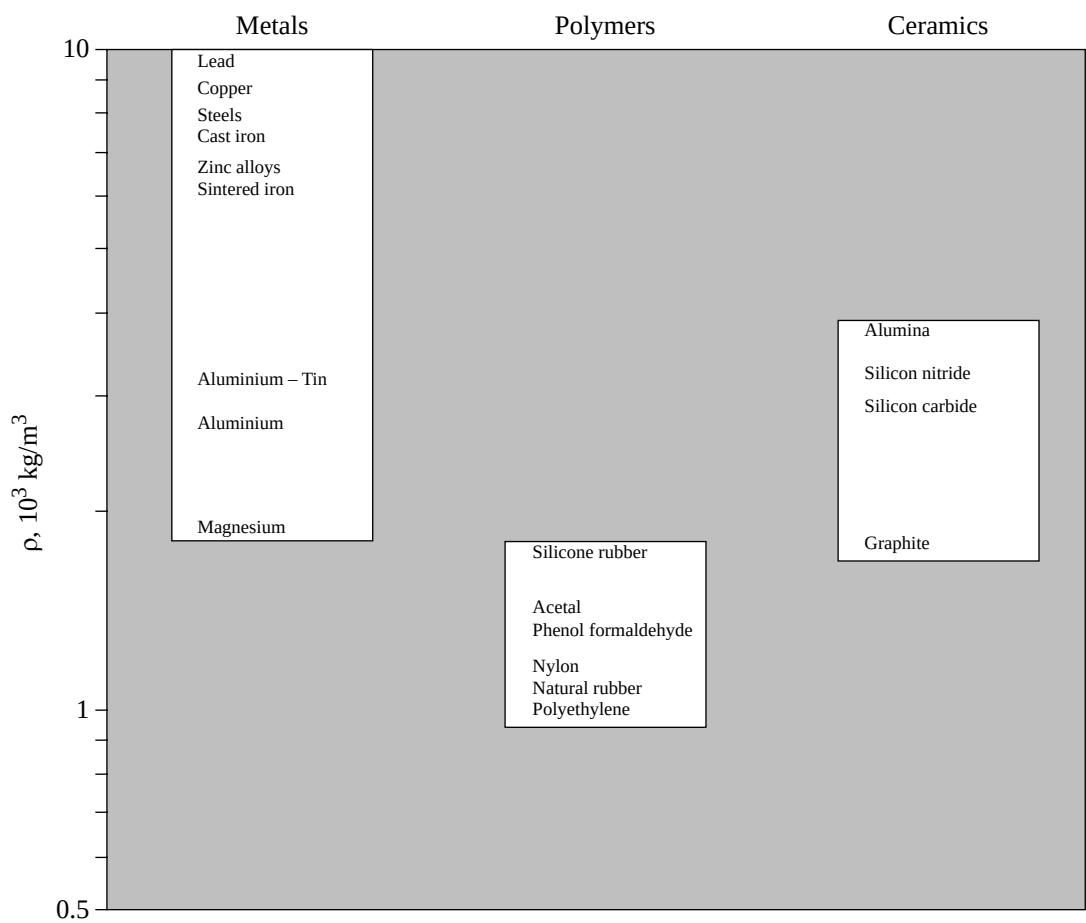
3.2 References

ASHBY, M.F. & JONES, D.R.H.	<i>Engineering Materials: An introduction to their properties and applications.</i> Pergamon Press, 1980.
ASHBY, M.F. & JONES, D.R.H.	<i>Engineering Materials 2: An introduction to microstructures, processing and design.</i> Pergamon Press, 2005.
WYATT, L.M. (Ed)	The Fulmer materials optimizer (second addition) Fulmer Research Institute Ltd., 1981.
–	Aerospace Structural Metals Handbook, Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio, 1967.

4. DENSITY

The density of most materials lies between 10^3 and 10^4 kg/m³. The density of wood and foamed materials is usually less while that of certain elements, most of them rare and expensive, is more.

Alloying changes the density only slightly. To a first approximation, the density of an alloy, or of a composite, is given by a “rule of mixtures” (that is by a linear interpolation between the densities of the two components of the alloy or the materials of the composite). Sketch 4.1 and Table 4.1 show the density of a number of common materials.



CONVERSION
To convert ρ in (kg m ⁻³) into ρ in (lb ft ⁻³) multiply by 0.0624
To convert ρ in (kg m ⁻³) into ρ in (lb in ⁻³) multiply by 36.1×10^{-6} .

Sketch 4.1 Density Ranges

This page Amendment A