WROUGHT MATERIALS

COPPER-ZINC-LEAD ALLOYS
Leaded Brasses

Cu Zn43 Pbl

Common name: Architectural "Bronze"

A copper-zinc-lead alloy with a duplex alpha-plus-beta phase structure containing a dispersion of fine lead particles. A small amount of aluminium is sometimes added to improve the tarnish resistance of the alloy, which is generally supplied only as extruded rod and sections. The material has excellent hot-working properties and good machinability, and is typically used for decorative and architectural applications.

COMPOSITION (weight %)

Cu	54.0–57.5
Pb	0.8– 2.5
Zn	rem.

1 SOME TYPICAL USES

Architectural
Extruded sections; shop and store fronts; door treads; window frames; trim; curtain rails.

Mechanical
Extruded bolt and other sections; hinges and lock bodies.

2 PHYSICAL PROPERTIES

	Metric Units	English Units
2.1 Density at 20 °C *68 °F*	8.4 g/cm³	0.305 lb/in³
2.2 Melting range	870–885 °C	1 600–1 625 °F
2.3 Coefficient of thermal expansion (linear) at:		
20 to 300 °C *68 to 572 °F*	0.000 021 per °C	0.000 012 per °F
2.4 Specific heat (thermal capacity) at:		
20 °C *68 °F*	0.09 cal/g °C	0.09 Btu/lb °F
2.5 Thermal conductivity at:		
20 °C *68 °F*	0.26 cal cm/cm² s °C	63 Btu ft/ft² h °F
2.6 Electrical conductivity (volume) at:		
20 °C *68 °F* (annealed)	18 m/ohm mm²	31% IACS
2.7 Electrical resistivity (volume) at:		
20 °C *68 °F* (annealed)	0.055 ohm mm²/m 5.5 microhm cm	33 ohms (circ mil/ft) 2.2 microhm in
2.8 Temperature coefficient of electrical resistance at:		
20 °C *68 °F* (annealed)	0.001 9 per °C (31% IACS)	0.001 1 per °F (31% IACS)
applicable over range from 0 to 100 °C *31 to 212 °F*		
2.9 Modulus of elasticity (tension) at 20 °C *68 °F* (annealed or cold worked)	8 500 kg/mm²	12 100 000 lb/in²
2.10 Modulus of rigidity (torsion) at 20 °C *68 °F* (annealed or cold worked)	3 100 kg/mm²	4 500 000 lb/in²

N.B.: The values shown in Section 2, which have been appropriately rounded in view of the composition range involved, are based on selected literature references.

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 6): INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

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3 FABRICATION PROPERTIES

The information given in this table is for general guidance only, since many factors influence fabrication techniques.

The values shown are approximate only, since those used in practice are dependent upon form and size of metal, equipment available, techniques adopted and properties required in the material.

	Metric Units	English Units
3.1 Casting temperature range	990–1 040 °C	1 815–1 905 °F
3.2 Annealing temperature range	425– 550 °C	795–1 020 °F
Stress relieving temperature range	250– 350 °C	480– 660 °F
3.3 Hot working temperature range	600– 700 °C	1 110–1 290 °F
3.4 Hot formability	Excellent	
3.5 Cold formability	Limited	
3.6 Cold reduction between anneals	15% max.	
3.7 Machinability:	See General Data Sheet No. 2	
Machinability rating (free-cutting brass = 100)	75	
3.8 Joining methods:	See General Data Sheet No. 3.5	
Soldering	Good	
Brazing	Fair	
Oxy-acetylene welding	Not recommended	
Carbon-arc welding	Not recommended	
Gas-shielded arc welding	Not recommended	
Coated metal-arc welding	Not recommended	
Resistance welding: spot and seam	Not recommended	
butt	Fair	

5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE[(a)]

5.1.1 Typical Tensile Properties and Hardness Values—Metric Units

This table is representative of practice in many European countries. For British and American practices, see tables 5.1.2 and 5.1.3, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength kg/mm²	Proof Stress 0.2% offset kg/mm²	Elongation		Hardness		Shear Strength kg/mm²	Typical Size Related to Properties Shown[(b)]
				%	gauge length	Brinell	Vickers		
Rod	Hot Worked	48	22	18	$5.65\sqrt{S_o}$	115	120	36	10–60 mm diam.
Sections/Shapes	Hot Worked [(c)]	48	22	18	$5.65\sqrt{S_o}$	115	120	36	—

(a) It will be noted that tables 5.1.1, 5.1.2 and 5.1.3, giving typical tensile properties and hardness values in Metric, English and American units, respectively, are not directly comparable. This is because the properties quoted reflect to some extent the metalworking techniques, specification practices, and testing procedures in the countries concerned, and in view of the different sizes of products referred to in these tables. Individual manufacturers of semi-fabricated products can, however, normally meet the requirements of any national standard.

(b) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

(c) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

5.1.2 Typical Tensile Properties and Hardness Values—English Units

This table is based on British practice. For other European and American practices, see tables 5.1.1 and 5.1.3, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper[(a)]	Tensile Strength ton/in²	Proof Stress 0.1% offset ton/in²	Elongation		Vickers Hardness	Shear Strength ton/in²	Typical Size Related to Properties Shown
				%	gauge length			
Sections (extruded)	Hot Worked[(b)]	26	10	25	$5.65\sqrt{S_o}$	110	20	—
Sections (extruded)	Cold Drawn As-Manufactured[(b)]	28	13	20	$5.65\sqrt{S_o}$	130	20	—

(a) The recognised temper designation used in the relevant or nearest British Standards is also given, to clarify the cold-worked temper shown.

(b) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

5.1.3 Typical Tensile Properties and Hardness Values—American Units

This table is based on American practice and the temper designations shown are those referred to in ASTM and other American Standards. For British and other European countries' practices, see tables 5.1.2 and 5.1.1, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength psi	Yield Strength 0.5% extension under load psi	Elongation		Rockwell Hardness			Shear Strength psi	Typical Size Related to Properties Shown [(a)]
				%	gauge length	F	B	30 T		
Rod	As Hot Worked	72 000	20 000	27	2 in.	87	58	—	45 000	1.0 in. diam.
Shapes	As Extruded	72 000	20 000	27	2 in.	87	58	—	45 000	1.0 in. thick

(a) It is possible to obtain sizes different from those given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties—Impact Properties

Form	Temper	Testing Temperature		Tensile Strength			Elongation % on $5.65\sqrt{S_o}$	Reduction of Area %	Impact Strength [(c)]	
		°C	°F	kg/mm²	ton/in²	psi			kg m/cm²	ft lb
— [(1) (a)]	— [(b)]	20	68	36.5	23	**51 900**	**22.3**	**19.9**	**5.23**	18.9
		–183	–297	51	32.5	**72 300**	**26.9**	**19.2**	**5.18**	18.7

(a) Not stated in original document; alloy containing Cu 57.14%, Zn 40.75%, Pb 0.69%, Fe 0.90% (i.e. just outside composition range of Cu Zn43 Pb1).

(b) Not stated in original document.

(c) Charpy test, 10 × 8 × 100 mm specimen, 45° V-notch, 3 mm deep; cross-sectional area at the notch 0.5 cm².

N.B.:—Original values are printed in **bold type**; other values are converted.

—All converted values for impact strength are to be taken as indicative only; the impact energy has been converted from kg m/cm² into ft lb taking into account the actual cross-sectional area of the specimen at the notch.

—Data not available:
Proof stress, 0.1% and 0.2% offset.
Yield Strength, 0.5% extension under load.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties—Impact Properties

At the date of publication of this sheet, no data relating to this material have been traced.

5.3.2 Creep Properties

At the date of publication of this sheet, no data relating to this material have been traced.

5.4 FATIGUE PROPERTIES

5.4.1 Fatigue Strength at Room Temperature

At the date of publication of this sheet, no data relating to this material have been traced.

REFERENCES

MECHANICAL PROPERTIES (SECTION 5)

(1) Smith, C.S. Mechanical Properties of Copper and its Alloys at Low Temperatures: a Review. Proc. ASTM, Vol. 39 (1939), pp. 642–648.

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