Cu Zn40 Pb

Common names: 60/40 Brass (Leaded)
Leaded Muntz Metal

A copper-zinc-lead alloy with a duplex alpha-plus-beta phase structure containing a dispersion of fine lead particles. The alloy has excellent hot-working properties and is generally supplied as hot-rolled plate. The material has somewhat inferior cold-working and joining properties, but is more readily machined than the similar non-leaded alloy, Cu Zn40.

COMPOSITION (weight %)

Cu	59.0–62.0
Pb	0.3– 0.8
Zn	rem.

1 SOME TYPICAL USES

Chemical and Marine

Condenser and heat-exchanger tubeplates; porthole windows and surrounds.

Mechanical and Miscellaneous

Hot forged components and 'upset' products with fair machinability and requiring limited bending or riveting; brake shoe rivets; bending and blanking alloy for decorative brassware trade; extruded sections, including angles, channels and trim.

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	885–900 °C	1 625–1 650 °F
2.3 Coefficient of thermal expansion (linear) at:		
20 to 100 °C *68 to 212 °F*	0.000 020 per °C	0.000 011 per °F
20 to 300 °C *68 to 572 °F*	0.000 021 ,, ,,	0.000 012 ,, ,,
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*	0.29 cal cm/cm² s °C	70 Btu ft/ft² h °F
2.6 Electrical conductivity (volume) at:		
20 °C *68 °F* (annealed)	16 m/ohm mm²	27% IACS
2.7 Electrical resistivity (volume) at:		
20 °C *68 °F* (annealed)	0.064 ohm mm²/m	38 ohms (circ mil/ft)
	6.4 microhm cm	2.5 microhm in
2.8 Temperature coefficient of electrical resistance at:		
20 °C *68 °F* (annealed)	0.001 6 per °C (27% IACS)	0.000 9 per °F (27% IACS)
applicable over range from 0 to 100 °C *32 to 212 °F*		
2.9 Modulus of elasticity (tension) at 20 °C *68 °F* (annealed or cold worked)	10 000 kg/mm²	14 200 000 lb/in²
2.10 Modulus of rigidity (torsion) at 20 °C *68 °F* (annealed or cold worked)	3 700 kg/mm²	5 300 000 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 8): 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	1 000–1 050 °C	1 830–1 920 °F
3.2 Annealing temperature range	450– 650 °C	840–1 200 °F
Stress relieving temperature range	250– 350 °C	480– 660 °F
3.3 Hot working temperature range	650– 750 °C	1 200–1 380 °F
3.4 Hot formability	Good	
3.5 Cold formability	Limited	
3.6 Cold reduction between anneals	35% max	
3.7 Machinability:	See General Data Sheet No. 2	
Machinability rating (free-cutting brass = 100)	60	
3.8 Joining methods:	See General Data Sheet No. 3.5	
Soldering	Excellent	
Brazing	Good	
Oxy-acetylene welding	Fair	
Carbon-arc welding	Not recommended	
Gas-shielded arc welding	Fair	
Coated metal-arc welding	Not recommended	
Resistance welding: spot and seam	Not recommended	
butt	Fair	

4 NATIONAL SPECIFICATIONS FOR MANUFACTURED FORMS

and ISO Recommendation

Country	Designation of Standards	Designation of Material in Standards	Specification for Chemical Composition [a]	Plate Sheet Strip	Rod	Wire	Tube	Sections / Shapes	Forgings
Australia	SAA	—	—	—	—	—	—	—	—
Belgium	NBN	—	—	—	—	—	—	—	—
Canada	CSA	HC ZP391 (or 365)	—	HC .4.6	—	—	—	—	—
Chile	INDITECNOR	Cu Zn40 Pb	247n./68	—	—	—	—	—	—
France	NF	—	—	—	—	—	—	—	—
Germany	DIN	Cu Zn38 Pb1 (2.0370) Cu Zn40 (2.0360)	17 660	17 670	17 672	17 672	17 671	17 674	17 673
India	IS	—	—	—	—	—	—	—	—
Italy	UNI	—	—	—	—	—	—	—	—
Japan	JIS	Pb BsP 1 Pb BsR 1 Pb BsW 1	—	H 3202 H 3322	—	H 3523	—	—	—
Netherlands	N or NEN [b]	—	—	—	—	—	—	—	—
South Africa	SABS	—	—	—	—	—	—	—	—
Spain	UNE	—	—	—	—	—	—	—	—
Sweden	SIS	51 63	—	14 51 63	—	—	—	—	—
Switzerland	VSM	—	—	—	—	—	—	—	—
United Kingdom	BS	CZ123	—	1541 2870 2875	1949 2872 2874	—	—	1949 2874	1949 2872
United States	ASTM	Nos. 365, 366, 367 and 368	—	B171	—	—	—	—	—
International Organization for Standardization	ISO	R 426	—	—	—	—	—	—	—

(a) Applicable when the chemical composition is not given in the specifications for wrought forms.
(b) Older specifications bear prefix N; for new specifications the NEN prefix is used.

5. MECHANICAL PROPERTIES

5.1 Mechanical properties at room temperature

Tensile properties	see tables 5.1.1/2/3
Hardness	„ „ 5.1.1/2/3
Shear strength	„ „ 5.1.1/2/3
Modulus of elasticity (tension)	see 2.9
Modulus of rigidity (torsion)	„ 2.10

5.2 Mechanical properties at low temperature

Tensile properties	see table 5.2.1
Impact properties	„ „ 5.2.1

5.3 Mechanical properties at elevated temperature

Short-time tensile properties	no data traced
Impact properties	„ „ „
Creep properties	„ „ „

5.4 Fatigue properties

Fatigue strength at room temperature	no data traced

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 may 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		
Plate Sheet	Annealed	38	16	35	$5.65\sqrt{S_o}$	85	89	29	—
	Hot Rolled	38	16	30	$5.65\sqrt{S_o}$	85	89	29	20–60 mm thick
	Typical Cold Worked Temper	43	30	20	$5.65\sqrt{S_o}$	125	130	32	5–20 mm thick
Forgings	Hot Worked [c]	38	16	30	$5.65\sqrt{S_o}$	85	89	29	—

(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 testjng 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 %	Elongation gauge length	Vickers Hardness	Shear Strength ton/in²	Typical Size Related to Properties Shown[b]
Plate Sheet	Annealed	24	10	45	$5.65\sqrt{S_o}$	95	18	—
	Hot Rolled	25	11	40	$5.65\sqrt{S_o}$	110	19	0.5–2 in. thick
	Cold Rolled	27	16	30 35	$5.65\sqrt{S_o}$ 2 in.	130	19	0.25–0.75 in. thick
Rod	Annealed	23	8	45	$5.65\sqrt{S_o}$	90	17	—
	Hot Worked	24	9	40	$5.65\sqrt{S_o}$	100	18	0.5–2 in. diam. or equivalent area
	Cold Worked As-Manufactured	25 27 30	10 14 18	40 35 25	$5.65\sqrt{S_o}$ $5.65\sqrt{S_o}$ $5.65\sqrt{S_o}$	110 125 140	18 19 21	1–2 in. diam. or equivalent area 0.375–1 in. diam. or equivalent area 0.125–0.375 in. diam or equivalent area
Wire	Annealed	23	—	40	2 in.	—	17	0.04–0.25 in. diam.
	Cold Drawn Half Hard Hard	 30 36	 — —	 22 —	 2 in. —	 — —	 21 23	 0.125–0.25 in. diam. "
	Half Hard Hard	32 40	— —	18 —	2 in. —	— —	22 26	0.04–0.125 in. diam. "
Sections (extruded)	Hot Worked[c]	24	9	40	$5.65\sqrt{S_o}$	100	18	—
	Cold Drawn As-Manufactured[c]	26	12	35	$5.65\sqrt{S_o}$	120	19	—
Forgings	Hot Worked[c]	24	9	40	$5.65\sqrt{S_o}$	100	18	—

[a] The recognised temper designations used in the relevant or nearest British Standards are also given, to clarify the cold-worked tempers shown.

[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.

5.1.3 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		
Flat Products (Plate)	As Hot Rolled	54 000	20 000	45	2 in.	80	—	—	40 000	1.0 in. thick
Tube	Light Annealed	56 000	23 000	50	2 in.	82	—	47	42 000	1.0 in. O.D. × 0.065 in. wall
	Cold Worked Hard Drawn (30%)	74 000	55 000	10	2 in.	—	80	—	48 000	1.0 in. O.D. × 0.065 in. wall

(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 [a]			Elongation % on $11.3\sqrt{S_o}$	Reduction of Area %	Impact Strength [b]	
		°C	°F	kg/mm²	ton/in²	psi			kg m/cm²	ft lb
Rod [(1)] [(c)]	Annealed	20 – 78 –183	68 –108 –297	**37.1** **38.4** **48.5**	23.5 24.5 31	53 000 54 500 69 000	**50.2** **49.8** **50.6**	**62.5** **64.0** **62.1**	**4.40** **4.91** **4.61**	15.9 17.8 16.7
	Cold Worked 12%	20 – 78 –183	68 –108 –297	**44.8** **49.5** **60.8**	28.5 31.5 38.5	63 500 70 500 86 500	**28.2** **27.0** **30.8**	**57.0** **59.0** **57.0**	**2.23** **2.48** **2.19**	8.1 9.0 7.9

(a) 5 mm (0.2 in.) diam. test specimen.

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

(c) Alloy containing Zn 40% Pb 1.3% Cu rem. (i.e. outside the composition range of Cu Zn40 Pb). The results are presented for guidance only, since other information has not been traced.

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) Broniewski, W. and Wesolowski, K. L'influence de la température sur les propriétés mécaniques des laitons.—Part 2. Rev. Mét., Vol. 30 (1933), pp. 453–457.