COPPER-ZINC-LEAD ALLOYS
Leaded Brassess

Cu Zn43 Pb1

Common name: Architectural "Bronze"
A copper-zinc-lead alloy with a duplex alpha-beta+delta phase structure containing a dispersion of fine lead particles. A small amount of aluminium is sometimes added to improve the brittleness 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 %)

<table>
<thead>
<tr>
<th>Element</th>
<th>Cu</th>
<th>Zn</th>
<th>Pb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>54.0-57.0</td>
<td></td>
<td>0.8-2.5</td>
</tr>
<tr>
<td>Material</td>
<td>rem.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 SOME TYPICAL USES

Architectural
Extruded sections; shop and store fronts; door treats; window frames; bins; curtain rails.

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

2 PHYSICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Metric Units</th>
<th>English Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density at 20 °C</td>
<td>7.8 g/cm³</td>
<td>0.335 lb/in³</td>
</tr>
<tr>
<td>Melting range</td>
<td>770-950 °C</td>
<td>1,400-1,832 °F</td>
</tr>
<tr>
<td>Coefficient of thermal expansion (linear) at:</td>
<td>0.000 001 per °C</td>
<td>0.000 0012 per °F</td>
</tr>
<tr>
<td>Coefficient of thermal expansion (linear) at:</td>
<td>20 °C</td>
<td>0.09 cal/g °C</td>
</tr>
<tr>
<td>Coefficient of thermal expansion (linear) at:</td>
<td>20 °C</td>
<td>0.26 cal/cm/cm°C</td>
</tr>
<tr>
<td>Electrical conductivity (volume) at:</td>
<td>20 °C</td>
<td>18 m/ohm mm²</td>
</tr>
<tr>
<td>Electrical resistivity (volume) at:</td>
<td>20 °C</td>
<td>0.055 ohm mm²/m</td>
</tr>
<tr>
<td>Temperature coefficient of electrical resistance at:</td>
<td>0.001 9 per °C</td>
<td>0.001 9 per °F (37.3% IACS)</td>
</tr>
<tr>
<td>Modulus of elasticity (tension) at 20 °C</td>
<td>68 GPa</td>
<td>100 GPa (annealed or cold worked)</td>
</tr>
<tr>
<td>Modulus of rigidity (torsion) at 20 °C</td>
<td>30 GPa</td>
<td>100 GPa (annealed or cold worked)</td>
</tr>
</tbody>
</table>

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

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 5); Dashes RELATE TO FOOTNOTES AT END OF TABLE
3 FABRICATION PROPERTIES

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

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

<table>
<thead>
<tr>
<th>Metric Units</th>
<th>English Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Cooling temperature range</td>
<td>960-1 040 °C</td>
</tr>
<tr>
<td>2.2 Annealing temperature range</td>
<td>425- 550 °C</td>
</tr>
<tr>
<td>Stress relief temperature range</td>
<td>250- 300 °C</td>
</tr>
<tr>
<td>2.3 Hot working temperature range</td>
<td>600- 700 °C</td>
</tr>
</tbody>
</table>

2.4 Hot formability | Excellent |

2.5 Cold formability | Limited |

2.6 Cold reduction between anneals | 15% max. |

2.7 Machinability | See General Data Sheet No. 2 |

Machinability rating (free-cutting brass = 100) | 75 |

2.8 Joining methods: | See General Data Sheet No. 35 |

Spotting | 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 | Fair |

but | |
## 4 NATIONAL SPECIFICATIONS FOR MANUFACTURED FORMS
and ISO Recommendation

<table>
<thead>
<tr>
<th>Country</th>
<th>Designation of Standards</th>
<th>Designation of Material in Standards</th>
<th>Specification for Chemical Composition (a)</th>
<th>Plate Sheet Strip</th>
<th>Rod</th>
<th>Wire</th>
<th>Tube</th>
<th>Sections Shapes</th>
<th>Forgings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>SAA</td>
<td></td>
<td></td>
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<tr>
<td>Belgium</td>
<td>NEN</td>
<td>Li 55 Pu</td>
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<tr>
<td>Canada</td>
<td>CSA</td>
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<tr>
<td>Chile</td>
<td>INTECOB</td>
<td>Cu Zn43 Pst1</td>
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<tr>
<td>Germany</td>
<td>DVM</td>
<td>Cu Zn44 Pst2 (2.0210)</td>
<td>17 660</td>
<td>17 672</td>
<td>17 672</td>
<td>17 672</td>
<td>17 672</td>
<td>01.2</td>
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<tr>
<td>Netherlands</td>
<td>NEN or NEN 50</td>
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<tr>
<td>Sweden</td>
<td>SIS</td>
<td>52 72</td>
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<tr>
<td>Switzerland</td>
<td>VSM</td>
<td>Cu Zn43 Pst1</td>
<td>10 832</td>
<td>11 854</td>
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<tr>
<td>United Kingdom</td>
<td>BS</td>
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<tr>
<td>United States</td>
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</tr>
<tr>
<td>International Organization for Standardization</td>
<td>ISO</td>
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<td></td>
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</tr>
</tbody>
</table>

(a) Applicable when the chemical composition is not given in the specifications for wrought forms.  
(b) Other specifications are given in the table below: the NEN prefix is used.

## 5 MECHANICAL PROPERTIES

### 5.1 Mechanical properties at room temperature

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile properties</td>
<td>see table 5.1.1/2/3</td>
</tr>
<tr>
<td>Hardness</td>
<td>5.1.1/2/3</td>
</tr>
<tr>
<td>Shear strength</td>
<td>5.1.1/2/3</td>
</tr>
<tr>
<td>Modulus of elasticity (tension)</td>
<td>2.9</td>
</tr>
<tr>
<td>Modulus of rigidity (tension)</td>
<td>2.10</td>
</tr>
</tbody>
</table>

### 5.2 Mechanical properties at low temperature

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile properties</td>
<td>see table 5.2.1</td>
</tr>
<tr>
<td>Impact properties</td>
<td>5.2.1</td>
</tr>
</tbody>
</table>

### 5.3 Mechanical properties at elevated temperature

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-time tensile properties</td>
<td>no data traced</td>
</tr>
<tr>
<td>Impact properties</td>
<td></td>
</tr>
<tr>
<td>Creep properties</td>
<td></td>
</tr>
</tbody>
</table>

### 5.4 Fatigue properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatigue strength at room temperature</td>
<td>no data traced</td>
</tr>
</tbody>
</table>
### 5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE

#### 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 kgf/mm² | Proof Stress 0.2% offset kgf/mm² | Elongation % | Hardness Brinell | Vickers | Shear Strength kgf/mm² | Typical Size Related to Properties Shown
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hot Worked</td>
<td>46</td>
<td>22</td>
<td>18</td>
<td>45.6% S</td>
<td>115</td>
<td>120</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Sections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hot Worked</td>
<td>46</td>
<td>22</td>
<td>18</td>
<td>45.6% S</td>
<td>115</td>
<td>120</td>
<td>36</td>
</tr>
<tr>
<td>Shapes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(0) 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 succeed to some extent the metalworking techniques, specification standards, and testing procedures. The values quoted are approximate, and vary with the make and type of product concerned, and in view of such a large range of products referred to in these tables. Individual manufacturers of specified products may also have variations in composition and mechanical properties.

(1) 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.

(2) The mechanical properties will be largely dependent on the site and cross-sectional area and 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.

<table>
<thead>
<tr>
<th>Form</th>
<th>Temper(2)</th>
<th>Tensile Strength kgf/mm²</th>
<th>Proof Stress 0.2% offset kgf/mm²</th>
<th>Elongation %</th>
<th>Hardness Brinell</th>
<th>Vickers</th>
<th>Shear Strength kgf/mm²</th>
<th>Typical Size Related to Properties Shown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sections</td>
<td>Hot Worked(2)</td>
<td>26</td>
<td>10</td>
<td>25</td>
<td>5.65% S</td>
<td>110</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cold Draw</td>
<td>As-Manufactured(2)</td>
<td>25</td>
<td>13</td>
<td>5.65% S</td>
<td>130</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

(0) The recognized temper designation used in the element or material Brinell readouts is also given, to clarify the cold-worked temper shown.

(1) The mechanical properties will be largely dependent on the size and cross-sectional area and 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 round-number 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.

<table>
<thead>
<tr>
<th>Form</th>
<th>Temper</th>
<th>Tensile Strength psi</th>
<th>Yield Strength 0.5% extension under load psi</th>
<th>Elongation</th>
<th>Rockwell Hardness</th>
<th>Shear Strength psi</th>
<th>Typical Size Related to Properties Shown (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As Hot Worked</td>
<td>72 000</td>
<td>20 000</td>
<td>27</td>
<td>2 in.</td>
<td>67</td>
<td>56</td>
</tr>
<tr>
<td>Shapes</td>
<td>As Extruded</td>
<td>72 000</td>
<td>20 000</td>
<td>27</td>
<td>2 in.</td>
<td>67</td>
<td>56</td>
</tr>
</tbody>
</table>

(a) It is possible to obtain sizes different from those shown 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

<table>
<thead>
<tr>
<th>Form</th>
<th>Temper</th>
<th>Testing Temperature</th>
<th>Tensile Strength</th>
<th>Elongation % on 5.65% $E_b$</th>
<th>Reduction of Area %</th>
<th>Impact Strength ft lb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As Rolled</td>
<td>-30°F</td>
<td>10</td>
<td>65</td>
<td>36.5</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>As Rolled</td>
<td>-30°F</td>
<td>-100</td>
<td>-297</td>
<td>32.5</td>
<td>29</td>
</tr>
</tbody>
</table>

(a) Not stated in original document; alloy containing Cu 62%, Ni 38%. (b) Not stated in original document.

---

N.B. — Original values are printed in bold type; other values are corrected.--- All corrected values for impact strength are to be taken as indicative only; the impact energy has been converted from kg m/sq ft into ft lb taking into account the actual cross-sectional area of the specimen at the notch.

--- Data not available: Proof stress, 0.150; 0.2% offset. Tensile strength, 0.2%; elongation 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}: