Non-Ferrous Metal Bearing Bushing Materials Performance

Different types of non-ferrous metal (copper alloy) bearing bushing materials. By comparing their characteristics under JIS, ASTM, and DIN standards, the report highlights differences in composition, mechanical properties, and typical application scenarios, providing guidance for engineering material selection.

Type	Material Code	Alloy Code	Tensile strength	Elongation	Hardness	Application	Feature	Foreign Standards	
			N/mm^2	%	HB			ASTM	DIN
Brass Bearing	CAC202	YBsC2	195 or above	20 or above	-	General machinery bushings	Excellent machinability	C85400	CuZn33Pb
	CAC203	YBsC3	245 or above	20 or above	-	General machinery bushings	Excellent machinability	C85700	CuZn37Pb
High Strength Brass Bearing	CAC301	HBsC1	430 or above	20 or above	-	Heavy machinery supports	High load capacity	C86500	CuZn35Al1
	CAC302	HBsC2	490 or above	20 or above	-	Heavy machinery supports	High load capacity	C86400	CuZn34Al1
	CAC303	HBsC3	635 or above	18 or above	165 or above (10 / 3,000)	Hydraulic guides, bearings	Excellent wear and impact resistance	C86200	CuZn25Al5
	CAC304	HBsC4	755 or above	15 or above	200 or above (10 / 3,000)	Heavy-duty joints	Superior strength and corrosion resistance	C86300	CuZn25Al5
Bronze Bearing	CAC401	BC1	165 or above	15 or above	-	Pumps, general bearings	Good castability	C84400	-
	CAC402	BC2	245 or above	20 or above	-	Pumps, general bearings	Good castability	C90300	-
	CAC403	BC3	245 or above	15 or above	-	Pump/valve components	Good wear resistance	C90500	CuSn10Zn
	CAC406	BC6	195 or above	15 or above	-	Industrial machinery	Cost-effective	C83600	CuSn5ZnPb
	CAC407	BC7	215 or above	18 or above	-	Industrial machinery	Moderate strength	C92200	-
Phosphorous Bronze Bearing	CAC502A	PBC2	195 or above	5 or above	60 or above (10 / 1,000)	Precision gears	High fatigue resistance	-	CuSn10
	CAC502B	PBC2B	295 or above	5 or above	80 or above (10 / 1,000)	High-speed shafts	Excellent wear resistance	C90700	CuSn12
	CAC503B	PBC3B	265 or above	3 or above	90 or above (10 / 1,000)	High-speed shafts	High precision	C91000	CuSn12
Lead Bronze Bearing	CAC602	LBC2	195 or above	10 or above	65 or above (10 / 500)	Engine main bearings	Self-lubricating	-	CuPb5Sn
	CAC603	LBC3	175 or above	7 or above	60 or above (10 / 500)	Connecting rods	Excellent conformability	C93700	CuPb10Sn
	CAC604	LBC4	165 or above	5 or above	55 or above (10 / 500)	Engine bushings	Self-lubricating	C93800	CuPb15Sn
	CAC605	LBC5	145 or above	5 or above	45 or above (10 / 500)	Low-load bearings	Economical	-	CuPb20Sn
	CAC607	C93200	207 or above	15 or above	-	Engine bushings	Moderate load capacity	C93200	-
Aluminum Bronze Bearing	CAC701	AlBC1	440 or above	25 or above	80 or above (10 / 1,000)	Marine shafts	High corrosion resistance	C95200	CuAl10Fe
	CAC702	AlBC2	490 or above	20 or above	120 or above (10 / 1,000)	Aerospace bushings	High temperature strength	C95400	CuAl9Ni
	CAC703	AlBC3	590 or above	15 or above	150 or above (10 / 1,000)	Heavy-duty bushings	Excellent wear resistance	C95800	CuAl10Ni
	CAC704	AlBC4	590 or above	15 or above	160 or above (10 / 1,000)	Heavy-duty bushings	High corrosion resistance	C95700	-
	CAC705	C95500	620 or above	6 or above	190 or above (10 / 3,000)	Marine shafts	Ultra-high strength	C95500	-
	CAC706	C95300	450 or above	20 or above	110 or above (10 / 3,000)	Aerospace bushings	Balanced mechanical properties	C95300	-
Silicon Bronze Bearing	CAC801	SzBC1	345 or above	25 or above	-	Chemical pumps	Excellent corrosion resistance	C87400	-
	CAC802	SzBC2	440 or above	12 or above	-	Marine engineering	Weldable	C87500	CuZn15Si4
	CAC803	SzBC3	390 or above	20 or above	-	Chemical pumps	Good strength	-	-

1. Comparative Analysis of Bearing Materials

In mechanical design, the selection of bearing materials directly affects the service life and reliability of equipment. The table below compares seven mainstream copper alloy bearing materials in terms of key parameters and suitable working conditions.

Material Type	Typical Composition	Strength Level	Key Features	Typical Applications
Brass	Cu-Zn-Pb	Low to Medium	Excellent machinability and cost-effectiveness	General machinery bushings, fasteners
High Strength Brass	Cu-Zn-Al-Fe-Mn	Very High	Outstanding load-bearing capacity and impact resistance	Heavy machinery supports, hydraulic guide sleeves
Bronze	Cu-Sn-Zn-Pb	Medium	Good castability and pressure resistance	Pump and valve internals, general power transmission bearings
Phosphor Bronze	Cu-Sn-P	Medium-High	High fatigue strength and low friction	Precision gear reducers, high-speed shafts
Lead Bronze	Cu-Sn-Pb	Medium-Low	Excellent self-lubrication and conformability	Internal combustion engine main bearings, high-speed connecting rods
Aluminum Bronze	Cu-Al-Fe-Ni	Very High	Superior seawater corrosion resistance and high-temperature strength	Marine propeller shafts, aerospace bushings
Silicon Bronze	Cu-Si-Zn	High	Excellent weldability and chemical corrosion resistance	Chemical pumps, marine engineering components

2. Detailed Analysis of Material Composition and Properties

2.1 Evolution from Standard Brass to High-Strength Brass

Standard brass bushings (e.g., CAC202) consist primarily of copper and zinc. Adding a small amount of lead significantly improves machinability, making it the most cost-effective choice for low-load applications. However, standard brass is prone to creep under high temperature or high pressure, limiting its use in heavy-duty machinery.
In contrast, high-strength brass (e.g., CAC304) incorporates elements such as aluminum, iron, and manganese to optimize microstructure. Aluminum forms a dense oxide film enhancing corrosion resistance, while iron and manganese increase hardness and tensile strength. These properties allow high-strength brass to withstand very high static and impact loads, making it suitable for joints in large hydraulic and mining machinery.

2.2 Diversified Applications of Bronze Series

Standard bronze (e.g., CAC406) is widely used due to its balance of strength, wear resistance, and good casting performance. Tin improves strength and wear resistance, while zinc enhances casting fluidity. Bronze performs well under well-lubricated conditions and is extensively used in industrial pumps and general-purpose gear reducers.
Phosphor bronze (e.g., CAC502) leverages phosphorus to remove brittle oxides, greatly increasing fatigue strength. Its uniform structure and low friction make it ideal for high-speed, high-precision machinery such as worm gear systems.

2.3 Material Selection for Special Environments

Lead bronze (e.g., CAC603) excels in poor lubrication or intermittent oil supply conditions. Lead particles dispersed in the copper matrix act as “metallic lubricants” under frictional heating. Its conformability protects the shaft journal from damage by hard particles.
Aluminum bronze (e.g., CAC702) dominates in marine and aerospace applications due to its superior chemical stability. It exhibits exceptional seawater corrosion resistance and retains stable mechanical properties even at 400°C, making it the only reliable choice for marine propulsion systems and high-temperature engine bushings.

3. Conclusion and Engineering Recommendations

The analysis indicates that material selection should follow the principle of “matching service conditions while balancing cost.” For high-load, low-speed conditions, high-strength brass is preferred. For high-speed, precision applications, phosphor bronze is recommended. In corrosive or high-temperature environments, aluminum bronze is irreplaceable. Correctly matching material composition with application location significantly enhances overall machine performance and maintenance intervals.