GB/T 1176-2013 Cast Copper & Copper Alloys: Complete Technical Data & Engineering Insights

—— For Material Engineers, Foundry Specialists & Product Designers

Stop searching through fragmented data sheets. This guide consolidates 36 validated cast copper alloy designations from GB/T 1176-2013 into one unified reference. You get cross-linked chemical composition limits, mechanical properties, and real-world application data—plus three actionable engineering insights not obvious from the tables alone.

What you'll find here:

- ☑ 36 alloys with full composition (major + impurity) and mechanical properties
- ☑ Side-by-side casting method comparisons (sand, permanent mold, centrifugal, investment)
- ☑ Selection guides by component type (bearings, seawater service, structural parts)
- ☑ Practical insights on strength-ductility trade-offs, SCC risk prediction, and alloy quadrant mapping

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Key Engineering Insights

1. Tin Bronzes: How Centrifugal Casting Breaks the Strength-Ductility Rule

Conventional metallurgy says you trade strength for ductility. Not true for ZCuSn10P1 when cast centrifugally.

Casting Method	Tensile Strength (MPa)	Elongation (%)	Strength × Ductility
Sand (S)	220	3	660
Permanent Mold (J)	310	2	620
Vertical Centrifugal (Li)	330	4	1320
Horizontal Centrifugal (La)	360	6	2160

Why this happens: Centrifugal force continuously feeds solidification shrinkage, producing a dense, fine-grained structure without segregation bands.

Selection guidance:
- Small batch, complex geometry → Permanent mold (310 MPa is adequate)
- High-volume cylindrical parts (bushings, rings) → Horizontal centrifugal (best strength-ductility)
- Large diameter, thick wall → Sand casting with risers

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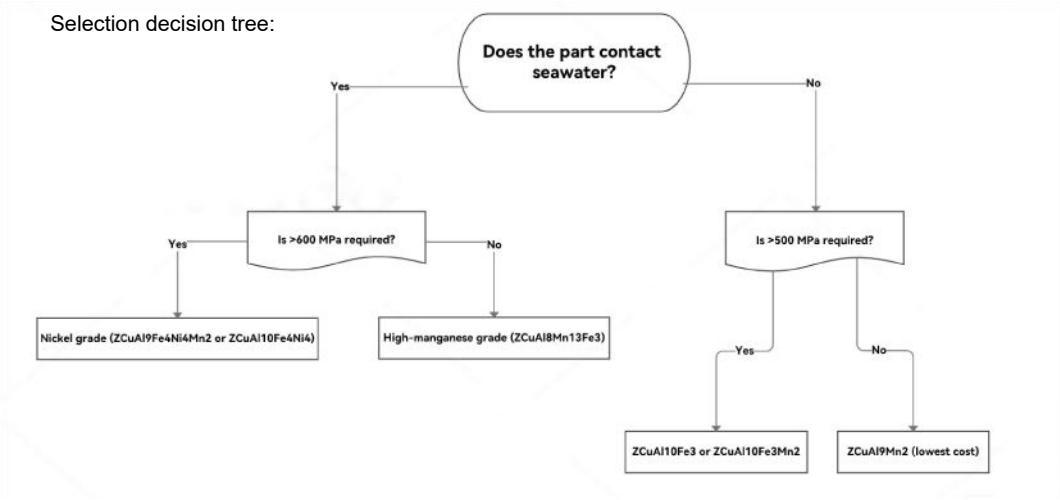
2. Aluminum Bronzes: The Composition-Performance Quadrant

Plot strength vs. seawater resistance—nickel and manganese clearly separate the grades.

Quadrant	Strength (MPa)	Seawater Resistance	Key Element	Representative Alloy
Upper Right	600–670	High	Ni	ZCuAl9Fe4Ni4Mn2, ZCuAl10Fe4Ni4
Upper Left	600–650	High	Mn	ZCuAl8Mn13Fe3
Lower Right	490–540	Moderate	Fe+Mn	ZCuAl10Fe3, ZCuAl10Fe3Mn2
Lower Left	390–440	Moderate	—	ZCuAl9Mn2

Selection decision tree:



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3. Brasses: Predicting Stress Corrosion Cracking (SCC) Risk

Table B.1 explicitly warns of SCC tendency for some brasses (e.g., ZCuZn38, ZCuZn25Al6Fe3Mn3) but not others (e.g., ZCuZn31Al2). The difference is zinc equivalent (Zn_eq).

Shop-floor estimation formula: **Zn_eq = Zn% + (2 × Al%) + (0.5 × Mn%) + (0.3 × Fe%)**

Microstructure	Zn_eq Range	SCC Risk
α-phase	<35%	Low
α+β	35–47%	Significant
β-phase	>47%	Extreme (rare)

Test the formula:

- ZCuZn38 (40% Zn, no Al) → Zn_eq ≈ 40 → α+β → SCC risk (matches warning)
- ZCuZn31Al2 (32% Zn + 2.5% Al) → Zn_eq ≈ 37 → still α → Low risk (matches no warning)

Mitigation strategies for Zn_eq >38%:

Strategy	Method	Effectiveness	Cost Impact
Stress relief anneal	250–300°C hold, air cool	Reduces residual stress 60–80%	Low
Environmental control	Avoid NH_3 + humidity + tensile stress	Prevention only	Variable
Material substitution	Switch to ZCuAl10Fe3 or CuNi alloy	Eliminates risk	+30–50% material cost

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Complete Data Tables

Table 1 — Major Element Chemical Composition (Mass Fraction / %)

No.	Alloy Designation	Sn	Zn	Pb	P	Ni	Al	Fe	Mn	Si	Be	Co	Cu
1	ZCu99												≥99.0
2	ZCuSn3Zn8Pb6Ni1	2.0-4.0	6.0-9.0	4.0-7.0		0.5-1.5							Remainder
3	ZCuSn3Zn11Pb4	2.0-4.0	9.0-13.0	3.0-6.0									Remainder
4	ZCuSn5Pb5Zn5	4.0-6.0	4.0-6.0	4.0-6.0	≤0.05[1]	≤2.5[2]	≤0.01[1]	≤0.3[1]		≤0.01[1]			Remainder
5	ZCuSn10P1	9.0-11.5			0.5-1.0[3]			≤0.1[1]					Remainder
6	ZCuSn10Pb5	9.0-11.0		4.0-6.0									Remainder
7	ZCuSn10Zn2	9.0-11.0	1.0-3.0					≤0.25[1]					Remainder
8	ZCuPb9Sn5	4.0-6.0		8.0-10.0									Remainder
9	ZCuPb10Sn10	9.0-11.0		8.0-11.0				≤0.25[1]					Remainder
10	ZCuPb15Sn8	7.0-9.0		13.0-17.0				≤0.25[1]					Remainder
11	ZCuPb17Sn4Zn4	3.5-5.0	2.0-6.0	14.0-20.0				≤0.4[1]					Remainder

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No.	Alloy Designation	Sn	Zn	Pb	P	Ni	Al	Fe	Mn	Si	Be	Co	Cu
12	ZCuPb20Sn5	4.0-6.0		18.0-23.0									Remainder
13	ZCuPb30			27.0-33.0									Remainder
14	ZCuAl8Mn13Fe3						7.0-9.0	2.0-4.0	12.0-14.5				Remainder
15	ZCuAl8Mn13Fe3Ni2					1.8-2.5	7.0-8.5[4]	2.5-4.0	11.5-14.0				Remainder
16	ZCuAl8Mn14Fe3Ni2		≤0.5			1.9-2.3	7.4-8.1	2.6-3.5	12.4-13.2				Remainder
17	ZCuAl9Mn2						8.0-10.0		1.5-2.5				Remainder
18	ZCuAl8Be1Co1						7.0-8.5	≤0.4			0.7-1.0	0.7-1.0	Remainder
19	ZCuAl9Fe4Ni4Mn2			≤0.02[1]		4.0-5.0	8.5-10.0	≤Ni[5]	0.8-2.5	≤0.15[1]			Remainder
20	ZCuAl10Fe4Ni4					3.5-5.5	9.5-11.0	3.5-5.5					Remainder
21	ZCuAl10Fe3						8.5-11.0	2.0-4.0					Remainder
22	ZCuAl10Fe3Mn2						9.0-11.0	2.0-4.0	1.0-2.0				Remainder
23	ZCuZn38		Remainder										60.0-63.0
24	ZCuZn21Al5Fe2Mn2	≤0.5	Remainder				4.5-6.0	2.0-3.0	2.0-3.0				67.0-70.0
25	ZCuZn25Al6Fe3Mn3		Remainder				4.5-7.0	2.0-4.0	2.0-4.0				60.0-66.0

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No.	Alloy Designation	Sn	Zn	Pb	P	Ni	Al	Fe	Mn	Si	Be	Co	Cu
26	ZCuZn26Al4Fe3Mn3		Remainder				2.5-5.0	2.0-4.0	2.0-4.0				60.0-66.0
27	ZCuZn31Al2		Remainder				2.0-3.0						66.0-68.0
28	ZCuZn35Al2Mn2Fe1		Remainder				0.5-2.5	0.5-2.0	0.1-3.0				57.0-65.0
29	ZCuZn38Mn2Pb2		Remainder	1.5-2.5					1.5-2.5				57.0-60.0
30	ZCuZn40Mn2		Remainder						1.0-2.0				57.0-60.0
31	ZCuZn40Mn3Fe1		Remainder					0.5-1.5	3.0-4.0				53.0-58.0
32	ZCuZn33Pb2		Remainder	1.0-3.0									63.0-67.0
33	ZCuZn40Pb2		Remainder	0.5-2.5				0.2-0.8					58.0-63.0
34	ZCuZn16Si4		Remainder							2.5-4.5			79.0-81.0
35	ZCuNi10Fe1Mn1					9.0-11.0		1.0-1.8	0.8-1.5				Remainder
36	ZCuNi30Fe1Mn1					29.5-31.5		0.25-1.5	0.8-1.5				Remainder

Table 1 Notes: [1] Maximum limit as impurity element

[2] Nickel is a beneficial element, not an impurity

[3] For centrifugal and continuous casting, P may be increased up to 1.5%

[4] For permanent mold casting, Al may be 7.0-9.0%

[5] Iron content shall not exceed nickel content

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Table 2 — Impurity Element Limits (Mass Fraction / % max)

No.	Alloy Designation	Fe	Al	Sb	Si	P	S	As	C	Bi	Ni	Sn	Zn	Pb	Mn	Others	Total
1	ZCu99									0.07				0.4			1
2	ZCuSn3Zn8Pb6Ni1	0.4	0.02	0.3	0.02	0.05											1
3	ZCuSn3Zn11Pb4	0.5	0.02	0.3	0.02	0.05											1
4	ZCuSn5Pb5Zn5	0.3	0.01	0.25	0.01	0.05	0.1				2.5*						1
5	ZCuSn10P1	0.1	0.01	0.05	0.02		0.05				0.1		0.05	0.25	0.05		0.75
6	ZCuSn10Pb5	0.3	0.02	0.3		0.05								1.0*			1
7	ZCuSn10Zn2	0.25	0.01	0.3	0.01	0.05	0.1						2.0*	1.5*	0.2		1.5
8	ZCuPb9Sn5			0.5		0.1					2.0*		2.0*				1
9	ZCuPb10Sn10	0.25	0.01	0.5	0.01	0.05	0.1				2.0*		2.0*		0.2		1
10	ZCuPb15Sn8	0.25	0.01	0.5	0.01	0.1	0.1				2.0*		2.0*		0.2		1
11	ZCuPb17Sn4Zn4	0.4	0.05	0.3	0.02	0.05											0.75
12	ZCuPb20Sn5	0.25	0.01	0.75	0.01	0.1	0.1				2.5*		2.0*		0.2		1
13	ZCuPb30	0.5	0.01	0.2	0.02	0.08		0.1		0.005			1.0*		0.3		1

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No.	Alloy Designation	Fe	Al	Sb	Si	P	S	As	C	Bi	Ni	Sn	Zn	Pb	Mn	Others	Total
14	ZCuAl8Mn13Fe3					0.15		0.1					0.3*	0.02			1
15	ZCuAl8Mn13Fe3Ni2					0.15		0.1					0.3*	0.02			1
16	ZCuAl8Mn14Fe3Ni2					0.15		0.1						0.02			1
17	ZCuAl9Mn2			0.05	0.2	0.1		0.05				0.2	1.5*	0.1			1
18	ZCuAl8Be1Co1			0.05	0.1			0.1						0.02			1
19	ZCuAl9Fe4Ni4Mn2					0.15		0.1						0.02			1
20	ZCuAl10Fe4Ni4			0.05	0.2	0.1		0.05				0.2	0.5	0.05	0.5		1.5
21	ZCuAl10Fe3				0.2								3.0*	0.3	0.4	0.2	1
22	ZCuAl10Fe3Mn2			0.05	0.1	0.01		0.01				0.1	0.5*	0.3		0.75	
23	ZCuZn38	0.8	0.5	0.1		0.01				0.002			2.0*			1.5	
24	ZCuZn21Al5Fe2Mn2			0.1										0.1		1	
25	ZCuZn25Al6Fe3Mn3					0.1							3.0*	0.2		0.2	2
26	ZCuZn26Al4Fe3Mn3					0.1							3.0*	0.2		0.2	2
27	ZCuZn31Al2	0.8											1.0*	1.0*	0.5		1.5
28	ZCuZn35Al2Mn2Fe1					0.1							3.0*	1.0*	0.5	0.40[1]	2

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No.	Alloy Designation	Fe	Al	Sb	Si	P	S	As	C	Bi	Ni	Sn	Zn	Pb	Mn	Others	Total
29	ZCuZn38Mn2Pb2	0.8	1.0*	0.1									2.0*				2
30	ZCuZn40Mn2	0.8	1.0*	0.1									1				2
31	ZCuZn40Mn3Fe1			1.0*	0.1								0.5		0.5		1.5
32	ZCuZn33Pb2	0.8	0.1		0.05	0.05					1.0*	1.5*			0.2		1.5
33	ZCuZn40Pb2	0.8		0.05							1.0*	1.0*			0.5		1.5
34	ZCuZn16Si4	0.6	0.1	0.1									0.3		0.5	0.5	2
35	ZCuNi10Fe1Mn1				0.25	0.02	0.02		0.1					0.01			1
36	ZCuNi30Fe1Mn1				0.5	0.02	0.02		0.15					0.01			1

Table 2 Notes:

Elements marked with "*" shall not be included in the total impurity sum

[1] For No. 28, combined limit for Sb + P + As is 0.40%

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Table 3 — Room Temperature Mechanical Properties (Minimum Values)

No.	Alloy Designation	Casting Method	Rm (MPa)	Rp0.2 (MPa)	A (%)	HBW
1	ZCu99	S	150	40	40	40
2	ZCuSn3Zn8Pb6Ni1	S	175		8	60
		J	215		10	70
3	ZCuSn3Zn11Pb4	S, R	175		8	60
		J	215		10	60
4	ZCuSn5Pb5Zn5	S, J, R	200	90	13	60*
		Li, La	250	100	13	65*
5	ZCuSn10P1	S, R	220	130	3	80*
		J	310	170	2	90*
		Li	330	170	4	90*
		La	360	170	6	90*
6	ZCuSn10Pb5	S	195		10	70
		J	245		10	70

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No.	Alloy Designation	Casting Method	Rm (MPa)	Rp0.2 (MPa)	A (%)	HBW
7	ZCuSn10Zn2	S	240	120	12	70*
		J	245	140	6	80*
		Li, La	270	140	7	80*
8	ZCuPb9Sn5	La	230	110	11	60
9	ZCuPb10Sn10	S	180	80	7	65*
		J	220	140	5	70*
		Li, La	220	110	6	70*
10	ZCuPb15Sn8	S	170	80	5	60*
		J	200	100	6	65*
		Li, La	220	100	8	65*
11	ZCuPb17Sn4Zn4	S	150		5	55
		J	175		7	60
12	ZCuPb20Sn5	S	150	60	5	45*
		J	150	70	6	55*
		La	180	80	7	55*

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No.	Alloy Designation	Casting Method	Rm (MPa)	Rp0.2 (MPa)	A (%)	HBW
13	ZCuPb30	J				25
14	ZCuAl8Mn13Fe3	S	600	270	15	160
		J	650	280	10	170
15	ZCuAl8Mn13Fe3Ni2	S	645	280	20	160
		J	670	310	18	170
16	ZCuAl8Mn14Fe3Ni2	S	735	280	15	170
17	ZCuAl9Mn2	S, R	390	150	20	85
		J	440	160	20	95
18	ZCuAl8Be1Co1	S	647	280	15	160
19	ZCuAl9Fe4Ni4Mn2	S	630	250	16	160
20	ZCuAl10Fe4Ni4	S	539	200	5	155
		J	588	235	5	166
21	ZCuAl10Fe3	S	490	180	13	100*
		J	540	200	15	110*
		Li, La	540	200	15	110*

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No.	Alloy Designation	Casting Method	Rm (MPa)	Rp0.2 (MPa)	A (%)	HBW
22	ZCuAl10Fe3Mn2	S, R	490		15	110
		J	540		20	120
23	ZCuZn38	S	295	95	30	60
		J	295	95	30	70
24	ZCuZn21Al5Fe2Mn2	S	608	275	15	160
25	ZCuZn25Al6Fe3Mn3	S	725	380	10	160*
		J	740	400	7	170*
		Li, La	740	400	7	170*
26	ZCuZn26Al4Fe3Mn3	S	600	300	18	120*
		J	600	300	18	130*
		Li, La	600	300	18	130*
27	ZCuZn31Al2	S, R	295		12	80
		J	390		15	90
28	ZCuZn35Al2Mn2Fe1	S	450	170	20	100*
		J	475	200	18	110*
		Li, La	475	200	18	110*

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No.	Alloy Designation	Casting Method	Rm (MPa)	Rp0.2 (MPa)	A (%)	HBW
29	ZCuZn38Mn2Pb2	S	245		10	70
		J	345		18	80
30	ZCuZn40Mn2	S, R	345		20	80
		J	390		25	90
31	ZCuZn40Mn3Fe1	S, R	440		18	100
		J	490		15	110
32	ZCuZn33Pb2	S	180	70	12	50*
33	ZCuZn40Pb2	S, R	220	95	15	80*
		J	280	120	20	90*
34	ZCuZn16Si4	S, R	345	180	15	90
		J	390		20	100
35	ZCuNi10Fe1Mn1	S, J, Li, La	310	170	20	100
36	ZCuNi30Fe1Mn1	S, J, Li, La	415	220	20	140

Table 3 Notes:

Values marked with "*" are for reference only

Casting method codes: S = Sand, J = Permanent mold, R = Investment casting, Li = Vertical centrifugal, La = Horizontal centrifugal

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Table B.1 — Main Characteristics and Typical Applications

No.	Alloy Designation	Main Characteristics	Typical Applications
1	ZCu99	Very high electrical and thermal conductivity, good ductility; good corrosion resistance in atmosphere, fresh water, and low-velocity seawater; narrow solidification range; suitable for sand, permanent mold, and continuous casting	Blast furnace tuyeres, slag nozzles, cooling plates, cooling staves; oxygen lance tips, electrode holders; flash furnace cooling components; large motor shielding covers; drinking water pipes; copper crucibles
2	ZCuSn3Zn8Pb6Ni1	Good wear resistance and machinability; good castability and airtightness; corrosion resistant; suitable for flowing seawater	Components in liquid fuels, seawater, fresh water, steam (≤225°C); valves and pipe fittings (pressure ≤2.5 MPa)
3	ZCuSn3Zn11Pb4	Good castability and machinability; corrosion resistant	Pipe fittings for seawater, fresh water, steam (pressure ≤2.5 MPa)
4	ZCuSn5Pb5Zn5	Good wear and corrosion resistance; good machinability, castability, airtightness	Moderate load, moderate speed wear parts: bearing shells, bushings, cylinder liners, piston clutches, pump covers, worm gears
5	ZCuSn10P1	High hardness and wear resistance; low seizure tendency; good castability and machinability; good corrosion resistance in atmosphere and fresh water	High load (≤20 MPa) and high speed (≤8 m/s) wear parts: connecting rods, bushings, bearing shells, gears, worm gears
6	ZCuSn10Pb5	Corrosion resistant, especially to dilute sulfuric acid, hydrochloric acid, fatty acids	Structural materials; corrosion/acid-resistant fittings; crusher bushings, bearing shells
7	ZCuSn10Zn2	Good corrosion/wear resistance and machinability; good castability; high density; good airtightness	Moderate to high load, low speed pipe fittings; valves, cocks, pump bodies, gears, impellers, worm gears

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No.	Alloy Designation	Main Characteristics	Typical Applications
8	ZCuPb9Sn5	Good lubricity and wear resistance; good machinability; good solderability; not recommended for oxy-fuel or arc welding	Bearings and bushings; automotive bearing liners
9	ZCuPb10Sn10	Good lubricity, wear resistance, corrosion resistance; suitable for bimetal casting	High surface pressure + side pressure bearings: rolling mill bearings, vehicle bearings, impact parts (peak 60 MPa), bimetal engine bearings (peak 100 MPa), piston pin bushings, friction plates
10	ZCuPb15Sn8	Good sliding and self-lubrication under poor or water lubrication; good machinability, poor castability; good dilute sulfuric acid resistance	High surface pressure + side pressure bearings; copper cooling tubes for cold rolling mills; impact parts (≤50 MPa); bimetal engine bearings; piston pin bushings (≤70 MPa); acid-resistant fittings
11	ZCuPb17Sn4Zn4	Good wear resistance and self-lubrication; good machinability, poor castability	General wear parts; high speed bearings
12	ZCuPb20Sn5	High sliding properties; excellent self-lubrication under poor or water lubrication; suitable for bimetal casting; sulfuric acid resistant; good machinability, poor castability	High speed bearings; crusher, water pump, rolling mill bearings; parts ≤40 MPa; corrosion-resistant parts; bimetal bearings; piston pin bushings ≤70 MPa
13	ZCuPb30	Good self-lubrication; good machinability, poor castability; gravity segregation tendency	Bimetal bearings requiring high sliding speed; anti-friction parts
14	ZCuAl8Mn13Fe3	High strength and hardness; good wear resistance and castability; high density; good corrosion resistance; service temperature ≤400°C for wear parts; weldable, difficult to braze	Heavy machinery bushings; high-strength, wear/pressure-resistant parts: bushings, flanges, valve bodies, pump bodies
15	ZCuAl8Mn13Fe3Ni2	High mechanical properties; good corrosion resistance in atmosphere, fresh water, seawater; high corrosion fatigue strength; good castability; dense, airtight; weldable, difficult to braze	High-strength, corrosion-resistant castings: ship propellers, high-pressure valve bodies, pump bodies; pressure/wear parts: worm gears, gears, flanges, bushings

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No.	Alloy Designation	Main Characteristics	Typical Applications
16	ZCuAl8Mn14Fe3Ni2	High mechanical properties; good atmospheric/fresh/seawater corrosion resistance; high corrosion fatigue strength; good castability; dense, airtight; weldable, difficult to braze	High-strength, corrosion-resistant castings; primary material for ship propellers
17	ZCuAl9Mn2	High mechanical properties; good atmospheric/fresh/seawater corrosion resistance; good castability; dense, airtight; good wear resistance; weldable, difficult to braze	Corrosion/wear parts; simple large castings: bushings, gears, worm gears; pipe fittings ≤250°C; high-airtightness castings
18	ZCuAl8Be1Co1	High mechanical properties; good atmospheric/fresh/seawater corrosion resistance; high corrosion fatigue strength; excellent cavitation resistance; good castability; dense; weldable (Note: beryllium vapor toxic during melting)	High-strength, corrosion-resistant, cavitation-resistant castings; small high-speed boat propellers
19	ZCuAl9Fe4Ni4Mn2	High mechanical properties; good atmospheric/fresh/seawater corrosion resistance; good castability; heat resistant to 400°C; heat treatable; good weldability, difficult to braze	High-strength, corrosion-resistant castings; ship propellers; wear parts and parts ≤ 400°C: bearings, gears, worm gears, nuts, flanges, valve bodies, guide bushings
20	ZCuAl10Fe4Ni4	High mechanical properties; good corrosion resistance; high corrosion fatigue strength; heat treatable for strengthening; heat resistant to 400°C	High-temperature corrosion parts: gears, spherical seats, flanges, valve guides, aircraft valve seats; corrosion parts: bearing shells, worms, pickling hooks/baskets, agitators
21	ZCuAl10Fe3	High mechanical properties; good wear/corrosion resistance; weldable, difficult to braze; air cool large castings at 700°C to prevent embrittlement	High-strength, wear/corrosion-resistant heavy castings: bushings, nuts, worm gears; pipe fittings ≤250°C
22	ZCuAl10Fe3Mn2	High mechanical properties and wear resistance; heat treatable; good high-temperature corrosion/oxidation resistance; good atmospheric/fresh/seawater corrosion resistance; weldable, difficult to braze; air cool large castings at 700°C to prevent embrittlement	High-strength, wear/corrosion parts: gears, bearings, bushings, nozzles; heat-resistant pipe fittings
23	ZCuZn38	Excellent castability; high mechanical properties; good machinability; weldable; good corrosion resistance; stress corrosion cracking tendency	General structural and corrosion parts: flanges, valve seats, brackets, handles, nuts

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No.	Alloy Designation	Main Characteristics	Typical Applications
24	ZCuZn21Al5Fe2Mn2	High mechanical properties; good castability; good corrosion resistance; stress corrosion cracking tendency	High-strength, wear parts; small ship and auxiliary propellers
25	ZCuZn25Al6Fe3Mn3	High mechanical properties; good castability; good corrosion resistance; stress corrosion cracking tendency; weldable	High-strength, wear parts: bridge support plates, nuts, screws, wear plates, slides, worm gears
26	ZCuZn26Al4Fe3Mn3	High mechanical properties; good castability; good air/fresh/seawater corrosion resistance; weldable	High-strength, corrosion parts
27	ZCuZn31Al2	Good castability; good air/fresh/seawater corrosion resistance; good machinability; weldable	Pressure die castings for motors and instruments; corrosion parts for shipbuilding and machinery
28	ZCuZn35Al2Mn2Fe1	High mechanical properties; good castability; good atmospheric/fresh/seawater corrosion resistance; good machinability; weldable	Pipe fittings; general wear parts with moderate requirements
29	ZCuZn38Mn2Pb2	High mechanical properties; good corrosion/wear resistance; good machinability	General structural parts; simple castings for ships and instruments: sleeves, bushings, bearing shells, slides
30	ZCuZn40Mn2	High mechanical properties; good corrosion resistance and castability; stable structure when heated	Parts in air, fresh water, seawater, steam (<300°C), liquid fuels; valve bodies, stems, pumps, joints; Babbitt-lined or tin-plated parts
31	ZCuZn40Mn3Fe1	High mechanical properties; good castability and machinability; good air/fresh/seawater corrosion resistance; stress corrosion cracking tendency	Seawater corrosion parts; pipe fittings ≤300°C; large castings: ship propellers

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No.	Alloy Designation	Main Characteristics	Typical Applications
32	ZCuZn33Pb2	Good oxidation resistance at 90°C feed water; electrical conductivity 10-14 MS/m	Gas and water supply housings; machinery, electronics, precision/optical instrument components
33	ZCuZn40Pb2	Good castability, wear resistance, machinability; good corrosion resistance; stress corrosion tendency in seawater	General wear/corrosion parts: bushings, gears
34	ZCuZn16Si4	High mechanical properties; good corrosion resistance and castability; high fluidity; dense, airtight	Seawater pipe fittings; water pumps, impellers, cocks; parts in air, fresh water, oil, fuel, steam (≤250°C, 4.5 MPa)
35	ZCuNi10Fe1Mn1	High mechanical properties; good seawater corrosion resistance; good castability; weldable	Seawater corrosion structural parts and pressure equipment; seawater pumps, valves, fittings
36	ZCuNi30Fe1Mn1	High mechanical properties; good seawater corrosion resistance; good castability; dense; weldable	Seawater corrosion valves, pump bodies, cams, elbows

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Casting Method Reference

Code	Method	Typical Use	Relative Cost	Surface Finish
S	Sand casting	Large parts, complex shapes, low volume	Low	Rough
J	Permanent mold	Medium volume, good finish	Medium	Smooth
R	Investment casting	Complex geometry, near-net shape	High	Very smooth
Li	Vertical centrifugal	Symmetrical parts, flanges	Medium	Smooth
La	Horizontal centrifugal	Long cylinders, bushings, tubes	Medium	Smooth

Selection Guide by Component Type

Bearings & Bushings

Operating Condition	Recommended Alloy	Preferred Casting Method
High load (20+ MPa), high speed (8+ m/s)	ZCuSn10P1	La (horizontal centrifugal)
Moderate load, good lubrication	ZCuPb10Sn10	J (permanent mold)
Poor or water lubrication	ZCuPb15Sn8	J or La
Heavy duty, high temperature (to 400°C)	ZCuAl10Fe3	S or J

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Seawater Service

Component	Recommended Alloy	Critical Feature
Pump housing	ZCuAl9Fe4Ni4Mn2	High strength + pitting resistance
Small boat propeller	ZCuAl8Be1Co1	Cavitation resistance (use ventilation during melting)
Large ship propeller	ZCuAl8Mn13Fe3 or ZCuAl8Mn14Fe3Ni2	Proven track record
Piping, valves	ZCuNi10Fe1Mn1	Excellent seawater resistance, weldable

General Structural Parts (No Seawater, Low Wear)

Requirement	Recommended Alloy	Cost Level
Highest strength, moderate corrosion	ZCuZn25Al6Fe3Mn3	High
Good castability + machinability	ZCuZn38	Low
Pressure-tight castings	ZCuZn16Si4	Medium

References

1. GB/T 1176-2013 — Cast copper and copper alloys. China National Standardization Committee on Foundry, 2013.

2. Copper Development Association Inc. — Copper alloy datasheets.

3. ASM Handbook, Volume 2: Properties and Selection of Nonferrous Alloys. ASM International.