

Choosing the Right Heavy-Hitter: A Deep Dive into Industrial Bronze Slide Bearings

The Power of "Built-In" Lubrication: Cast Bronze Bearings with Solid Lubricants

In the world of heavy machinery and demanding industrial applications, bearings are the unsung heroes. They bear immense loads, endure harsh environments, and ensure that everything from steel rolling mills to massive ship cranes operates smoothly. But not all bearings are created equal. The choice of material and design is critical to performance, longevity, and cost-effectiveness. Self-lubricating cast bronze bearings and machined (rolled) bronze bearings. Understanding their fundamental differences is key to selecting the optimal solution for your specific needs.



Technical data

Material	Bronze bearing with a steel shell and embedded graphite	
Composition	CuZn25Al5Mn4Fe3	
Yield point ($R_{p0,2}$)	approx. 350 N/mm ²	
Tensile strength (R_m)	approx. 750 N/mm ²	
Hardness	> 210HB	
Friction	0,03-0,20μ	
Max load	Movement (Static)	150 N/mm ²
	Movement (Dynamic)	90 N/mm ²
Max speed	No lubrication	< 0,5 m/s
	Oil lubrication	< 1,0 m/s
Temperature range	-100 / +300 °C	

Tolerances

Housing	Tolerance H7
Cylindrical bearing	According to drawing or standard: Inside: F7, outside m6. (push fit)
Flanged bearing	According to drawing or standard: Inside: E7, outside r6.
Shaft	Recommended tolerances: d8, e7 or f7.
Lubrication	The bearing is designed to run without lubrication. but the bearings feature will improve with additional lubrication.

Benefits

Imagine a bearing that lubricates itself. That's the core concept behind cast bronze bearings embedded with solid lubricant plugs. These powerhouses are designed for applications where conventional lubrication is difficult, undesirable, or impossible. The base metal, a strong cast bronze, is engineered to withstand extremely high loads. What makes them unique are the special solid lubricants, like graphite, that are embedded into the bearing surface. These lubricants are strategically distributed in patterns or grooves, covering approximately 25-30% of the sliding surface. As the bearing operates, a microscopic lubricating film is constantly transferred to the mating surface, ensuring smooth, low-friction movement without the need for grease or oil.

There are two primary forms of this technology:

Solid Cast Bronze: The entire bearing is made from a cast bronze alloy, offering excellent durability and load-bearing characteristics.

Bimetallic (Cast Bronze on Steel): This innovative structure involves casting a layer of bronze onto a steel shell. This creates a metallurgical bond that combines the strength and rigidity of steel with the superior bearing properties of bronze. This design is particularly cost-effective for bearings with a diameter over 100mm, as it significantly reduces the amount of expensive bronze required while boosting overall load capacity.

Key Advantages of Cast Bronze with Solid Lubricants:

Extremely High Load Capacity: The robust bronze or bimetallic structure is built for heavy-duty applications.

Maintenance-Free Operation: The self-lubricating nature eliminates the need for external grease or oil, reducing downtime and labor costs.

Wide Temperature Range: They perform exceptionally well in extreme heat or cold where liquid lubricants would fail.

Ideal for Specific Motions: Perfectly suited for low-speed, high-load conditions, as well as reciprocating, oscillating, or intermittent movements.

Excellent Corrosion Resistance: Bronze alloys naturally resist corrosion, making them suitable for marine or chemical environments.

Typical applications

Casting and Steel Rolling Machines
Metallurgical Industry
Turbines
Shipbuilding and Marine Cranes
Hydroelectric and Structural Projects

Precision and Adaptability: Machined Turned Bronze Bearings



Technical data

Material	Bronze bearing with graphite	
Yield point ($R_{p0,2}$)	approx. 450 N/mm ²	
Tensile strength (R_m)	approx. 750 N/mm ²	
Hardness	> 210HB	
Friction	0,03-0,20μ	
Max speed	No lubrication	< 0,3 m/s
	Oil lubrication	<1,0 m/s
Temperature range	-100 / +300 °C	
Max load	Movement (Static)	150 N/mm ²
	Movement (Dynamic)	90 N/mm ²

Tolerances	
Housing	Tolerance H7
Cylindrical bearing	According to drawing or standard: Inside: F7, outside m6. (push fit)
Flanged bearing	According to drawing or standard: Inside: E7, outside r6.
Shaft	Recommended tolerances: d8, e7 or f7.
Lubrication	The BWG-bearing is designed to run without lubrication. but the bearings feature will improve with additional lubrication.

Benefits

In contrast to their self-lubricating cousins, machined bronze bearings are all about precision and customization. These bearings are typically turned or "rolled" from various solid bronze alloys and are manufactured according to exact customer specifications.

The primary strength of this category lies in its versatility. Engineers can select from a wide range of bronze alloys to perfectly match the application's demands for corrosion resistance, strength, and durability. Because they are machined, these bearings can be produced with tighter tolerances than cast or wrapped bearings, allowing for the precise clearances needed in high-performance machinery.

Unlike the embedded lubricant type, machined bronze bearings generally require an external lubricant like oil or grease. However, their design is highly optimized to manage this lubrication effectively. Features like lubrication grooves, channels, and oil holes are custom-machined into the bearing surface. These designs act as reservoirs and distribution networks, ensuring a consistent lubricant film is maintained across the entire load-bearing surface. With the right material selection and design, lubrication intervals can be significantly extended.

Key Advantages of Machined Bronze Bearings:

- High Precision: Can be manufactured to very tight tolerances, enabling precise shaft alignment and clearance.
- Total Customization: Designs are based on client drawings, allowing for specific groove patterns, hole configurations, and dimensions.
- Wide Material Selection: A vast array of copper alloys can be used to optimize for corrosion resistance, load, or other specific conditions.
- Excellent Performance in Harsh Environments: With the right alloy, these bearings offer superior resistance to corrosion and wear.
- High Load Capacity: Bronze alloys are inherently strong and wear-resistant.

Typical applications

Forestry and Agricultural Machinery
Offshore Oil & Gas and Marine Industries
Dump Trucks and Heavy Construction Equipment
Industrial Pumps and Valves

Head-to-Head: Choosing the Right Bearing

The choice between a self-lubricating cast bronze bearing and a machined bronze bearing comes down to the specific demands of your application. The following table provides a clear contrast of their core attributes:

Material	DIN: CuSn10Pb10 (CC493K / G-CuSn10Pb10) ASTM: C93800	CuAl10Fe5Ni5 (CC333G / G-Al10Fe5Ni5) C95500	CuZn25Al6Fe3Mn3	CuAl9Fe4Ni4Mn2	DIN: RG7 (CC491K) / CuSn5Pb5Zn5 ASTM: C83600 (Leaded Red Brass) JIS: BC6	DIN: CuSn12 (CC483K) ASTM: C90700 (Tin Bronze) JIS: BC3
Feature	Cast Bronze w/ Solid Lubricants		Machined Bronze			
Lubrication	Self-lubricating; no external lubrication needed.		Requires external lubrication (grease/oil).			
Primary Advantage	Maintenance-free operation under high loads.		High precision and design customization.			
Load Capacity	Extremely High, especially bimetallic versions.		High, dependent on the selected alloy.			
Speed	Best for low-speed, oscillating movements.		Suitable for a wider range of speeds.			
Temperature Range	Excellent in extreme high and low temperatures.		Dependent on the lubricant's properties.			
Precision/Tolerances	Standard industrial tolerances.		Tighter, more precise tolerances are possible.			
Cost (Large Diameter)	Bimetallic design is highly cost-effective.		Can be more costly due to material volume.			
Corrosion Resistance	Very Good to Excellent.		Very Good to Excellent, depends on the alloy.			

Solid Lubricants Overview

Solid Lubricants Lubricant Type	Key Properties	Typical Applications
SL1 Graphite+add	Excellent chemical resistance Very low friction coefficient Effective up to 400°C	Ideal for general-purpose applications in dry or above-water environments
SL4 PTFE+MOS2+CF	Ultra-low friction Performs exceptionally in wet or submerged conditions Effective up to 300°C	Best suited for underwater or moisture-exposed applications, such as ships, dam gates, turbines, and cranes

Bronze Bushing Type:

Cylindrical Bushing	Flange Bushing	WASHER	Plate and Rail
			

Bronze bearing types made to order.cylindrical bushes with non-standard dimensions, flanged bushes, thrust washer, wear plate,sliding plates, customized bearing designs



The Ultimate Guide to Bronze Alloys for High-Performance Bearings

Turned bearings are often technically and economically favourable bearing solutions.

High loading capability, low weight, good corrosion resistance and small radial diameters are some good properties for turned bearings.

The choice of the suitable material and the arrange of additional lubrication properly are important when using turned bearings.



Material:

Turned bearings and bearing components can be produced from various copper alloys. The material selection is made to suit the specific requirements of each application, which is crucial for achieving optimal performance in terms of service life, reliability, and overall cost-effectiveness. Properties of standard materials are listed in the table. In addition to these standard alloys, many other materials are available when needed. In the demanding world of industrial machinery, the right bearing material isn't just a component—it's the foundation of reliability, performance, and longevity. Among the most trusted materials for heavy-duty applications are bronze alloys. Renowned for their strength, corrosion resistance, and wear characteristics, bronzes are a diverse family of materials.

Tolerances

Turned bearings can be manufactured with tighter tolerances compared to wrapped thin-walled bearings. These tolerances can be adjusted according to the design requirements, allowing precise control over the desired clearance.

Design:

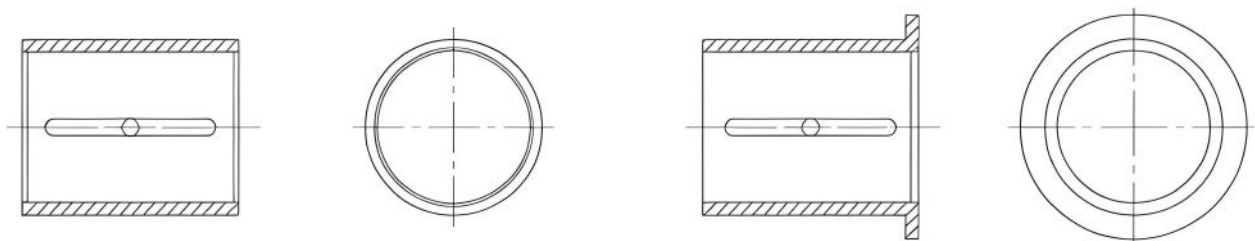
Choosing the correct alloy is a critical engineering decision that hinges on load, speed, environment, and required maintenance. This guide will explore the primary families of bronze alloys used in bearings, demystify their specifications, and help you understand which type is right for your application. Turned bearings are always manufactured according to the customer's drawings. This enables the bearing to be tailored to the specific needs of the application. Features such as lubrication grooves, the number of lubrication holes, tolerances, and chamfers can all be customized based on customer requirements.

Lubrication

Copper alloy turned bearings are typically intended for use with additional lubrication. The need for supplementary lubrication depends on the bearing material and the overall operating conditions. The design of lubrication grooves, choice of lubricant, and the general bearing conditions all influence how the additional lubrication should be managed. With the proper material selection and design, turned bearings can also achieve relatively long lubrication intervals.

Design:

Turned bearings are always manufactured according to customer drawings. Thus, the design of lubrication grooves, the quantity of lubrication holes, tolerances, and chamfering can be produced to meet specific customer needs.



Understanding the Bronze Families

Bronze is primarily a copper alloy, but its properties are dramatically altered by the addition of other elements like tin, aluminum, phosphorus, and nickel. These alloys are broadly categorized into families, each with distinct advantages.

1. Aluminum Bronzes (C61400, C95400, C64200)

Aluminum bronzes are the heavyweights, known for exceptional strength and corrosion resistance. The addition of aluminum (typically 5-12%) creates a tough, protective alumina film on the surface, making these alloys particularly resilient in marine and chemical environments.

Key Characteristics: High strength and hardness, excellent wear and abrasion resistance, and outstanding resistance to corrosion and cavitation. They are the strongest of the copper-based bearing alloys.

Common Applications: Marine hardware, pump components, valve seats, high-strength clamps, and heavy-duty wear plates. The popular C95400 is a go-to choice for high-load, high-wear applications requiring good ductility and weldability.

2. Nickel Aluminum Bronzes (C63000, C63200, C95500)

Adding nickel to aluminum bronze takes its performance to the next level. Nickel enhances the alloy's strength without sacrificing its inherent toughness and ductility. This makes nickel aluminum bronzes ideal for the most demanding applications.

Key Characteristics: Superior strength at elevated temperatures, exceptional corrosion resistance, and high resistance to wear, shock, and abrasion.

3. Phosphor Bronzes / Tin Bronzes (C51000, C54400, C90300)

Also known as tin bronzes, this family is valued for its combination of strength, ductility, and excellent bearing qualities. Tin is added to increase strength and corrosion resistance, while a small amount of phosphorus boosts wear resistance, hardness, and stiffness.

Key Characteristics: Good strength and ductility, superior fatigue resistance (springiness), low coefficient of friction, and high wear resistance.

Common Applications: Sleeve bushings, thrust washers, clutch disks, electrical connectors, and components requiring good spring characteristics. C51000 is one of the most widely used phosphor bronzes due to its versatile engineering properties.

4. Manganese Bronzes (C67500, C86300)

Technically a type of high-tensile brass, manganese bronzes are included here because of their frequent use in bearing applications. This family is known for extremely high strength and good corrosion resistance.

Key Characteristics: Very high tensile strength, good mechanical properties, and saltwater corrosion resistance. They are ideal for high-load, low-speed applications.

Common Applications: Bridge pins, heavily stressed gears, hydraulic cylinder parts, and large valve stems. It's important to note that C86300 requires reliable lubrication and hardened shafts to prevent rapid wear.

Wrought vs. Cast: What's the Difference?

The manufacturing process significantly impacts an alloy's final properties. Bronze bearings are typically either "wrought" or "cast."

Wrought Alloys (e.g., C63000): These are mechanically worked into shape through processes like extrusion, rolling, or forging. This process aligns and refines the material's grain structure, resulting in higher tensile strength, greater durability, and a better surface finish compared to cast equivalents. Wrought alloys are designated with UNS numbers below C80000.

Cast Alloys (e.g., C95400): These are produced by pouring molten metal into a mold. Casting is ideal for creating complex shapes and is the basis for many self-lubricating bearing designs. While very strong, they may have lower ductility than their wrought counterparts.

Your Guide to Bronze Bearing Alloys

The table below consolidates the information for a quick comparison of common bearing alloys, their specifications, and key characteristics.

Alloy Family	UNS Designation	Common Name/Type	Key Characteristics	Typical Specifications	Form
Phosphor Bronze	C51000	Phosphor Bronze 5% A, CuSn5	Excellent strength, fatigue resistance, and good bearing qualities.	ASTM B139	Bearing forms made to order. cylindrical bushes with non-standard dimensions, flanged bushes, sliding plates, customized bearing designs
Phosphor Bronze	C54400	Leaded Phosphor Bronze	Excellent machinability, good spring properties.		
Aluminum Bronze	C61400	Aluminum Bronze	High strength, excellent corrosion resistance.		
Aluminum Bronze	C62300	Aluminum Bronze	High strength and wear resistance.	ASTM B150	
Nickel Al. Bronze	C63000	Nickel Aluminum Bronze	Superior strength, toughness, and wear resistance, especially at high temps.	ASTM B150	
Nickel Al. Bronze	C63200	Nickel Aluminum Bronze	High strength and excellent seawater corrosion resistance.	ASTM B150	
Aluminum Bronze	C64200	Aluminum Silicon Bronze	Good strength and corrosion resistance.	ASTM B150	
Silicon Bronze	C65500	High Silicon Bronze	Good strength and excellent corrosion resistance.	ASTM B98, ASTM B124	
Manganese Bronze	C67500	Manganese Bronze	High strength, good corrosion resistance.		
Manganese Bronze	C86300	High-Tensile Manganese Bronze	Extremely high strength for heavy loads and low speeds.	ASTM B505, SAE 430B	
Tin Bronze	C90300	High Tin Bronze, "Navy G"	High ductility, good load capacity, and seawater corrosion resistance.		
Leaded Tin Bronze	C93200	660 Bearing Bronze	General-purpose bearing alloy with good anti-friction properties.	ASTM B505, SAE 660	
Leaded Tin Bronze	C93600	Modified SAE 64	High lead content for lubricity.		
Aluminum Bronze	C95400	Aluminum Bronze	Most popular cast aluminum bronze; high strength and wear resistance.	ASTM B271, ASTM B505, QQ-C-390	
Nickel Al. Bronze	C95500	Nickel Aluminum Bronze	Higher strength than C95400 due to nickel content; heat treatable.	ASTM B505, ASTM B271, QQ-C-390	

ASTM International (American Society for Testing and Materials) provides standards for materials and processes. For instance, ASTM B505 covers continuous cast bronzes, while ASTM B271 applies to centrifugal castings, ensuring the material meets specific chemical and mechanical properties. By referencing these standards, you ensure that the material you're using is consistent, reliable, and has the properties required for your engineering project.

Conclusion

Selecting the right industrial bearing is a critical engineering decision that balances performance, maintenance, and cost. Choose a Self-Lubricating Cast Bronze or Bimetallic Bearing if: your application involves very high loads at low speeds, requires operation in extreme temperatures, or is in a location where regular maintenance is impractical or impossible. The "fit and forget" nature of these bearings is their defining strength. Choose a Machined Bronze Bearing if: your application demands high precision, tight tolerances, and custom-designed lubrication systems. When you have the ability to manage lubrication and need a bearing tailored perfectly to your unique geometry and operating conditions, the versatility of a machined bearing is unparalleled. By understanding these fundamental differences, you can ensure you are equipping your heavy-duty machinery with the most effective, reliable, and economical bearing solution for the job.