Industrial/Structural

Lubron® SL

Self-Lubricating Bearings

Lubron Bearing Systems

Bearings to move the world.

SL

Lubron SL
Self-Lubricating Bearings

LUBRON® SL self-lubricating bearings are specifically designed to satisfy the demanding requirements of heavy duty industrial and structural applications. LUBRON SL bearings are available in a wide variety of bearing alloys, and employ solid lubricants compressed into trepanned or circular recesses for long-term lubrication.

CONSTRUCTION

The key to LUBRON SL bearing's superior performance is its unique structure, composition and method of manufacture. LUBRON SL bearings are comprised of a bronze substrate and a bronze-lubricant inner structure. The bronze substrate provides a high load carrying capacity with excellent dimensional and structural rigidity. The bronze-lubricant inner structure supplies a permanent reservoir of lubricant for continuous restoration of the low friction bearing surface.

LUBRON SL self-lubricating bearings feature a proprietary graphite solid lubricant embedded in a cast bronze backing. Specifically designed for heavy duty industrial and structural applications, LUBRON SL bearings require no maintenance and provide superior perfomance throughout long service life.

Cast Bronze Alloys

Cast bronze alloys have been used for centuries in a broad spectrum of bearing applications. Other bearing materials have been unable to match their versatility. By alloying copper with other elements, the properties of bronze can be altered to suit the requirements of most any application. The choice of a bronze alloy for a particular application is determined by the desired physical, mechanical and metallurgical properties needed.

A wide selection of bronze alloys are available for industrial and structural applications. Aluminum bronze and manganese bronze are generally preferred for high loads, especially where toughness and shock resistance are necessary. For high temperature applications, Meehanite® and other heat resistant materials are available.

LUBRON SL bearing alloys are manufactured in strict compliance with ASTM and ISO material specifications. Centrifugal, continuous, sand, and forged castings are available, depending on the size and shape required. Physical and chemical test reports are available upon request.

Lubron SL
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Permanent Lubrication

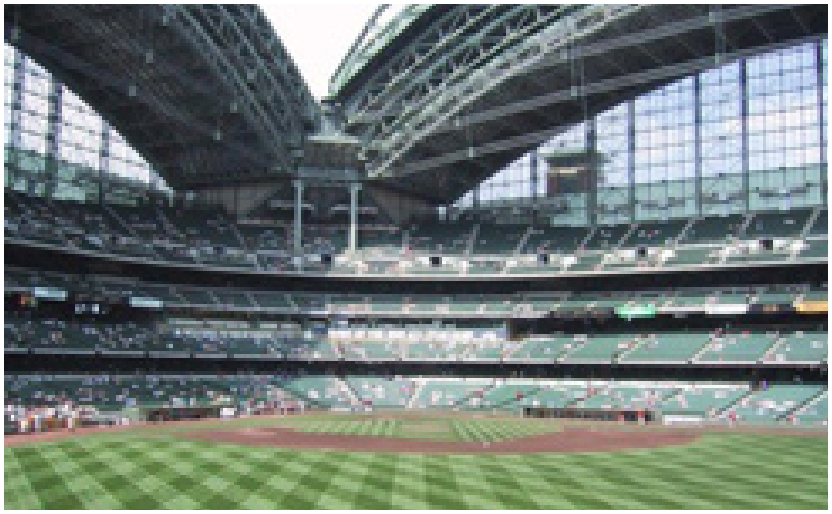
LUBRON SL lubricants are available for a wide range of operating temperatures. Depending on the intended use, operating temperatures, size and configuration of the bearing, LUBRON SL30 and LUBRON SL40 solid lubricants are suitable for most industrial and structural applications.

LUBRON SL30 lubricants consist of graphite powders compounded with epoxy resins and hardeners, and are specially formulated to achieve optimum bearing performance. The natural lubricity and high concentration of the graphite powders result in low coefficient of friction, while the epoxy resins combine to provide excellent wear and chemical resistance. LUBRON SL30 lubricants are recommended for operating temperatures up to 500°F (260°C).

LUBRON SL30 lubricants are embedded into circular recesses provided for containment of the lubricant. Covering 30% to 40% of the bearing surface, these recesses securely anchor the lubricant and provide permanent reservoirs for restoring the bearing surface.

LUBRON SL30 lubricants are machined flush with the bronze substrate surface. The lubricated surface is continuously replenished by relative movement between the bearing and mating surfaces.

LUBRON SL40 lubricants consist of solid graphite plugs compressed into circular recesses. LUBRON SL40 graphite lubricants are capable of resisting high temperatures up to 2000°F (1093°C).



DESIGN CRITERIA

The overall performance of LUBRON SL bearings is directly influenced by a variety of operating factors which in particular include bearing load, speed, PV and type of movement. The following section describes the design criteria needed to properly specify a LUBRON SL bearing. For unusual design problems, additional assistance will be provided.

Alloy Selection

Proper alloy selection is necessary to attain maximum resistance to wear and corrosion. Selection of a suitable alloy depends on a variety of factors, which include bearing load, velocity, type of movement, temperature, environment, shear strength, fatigue strength, deformability, compatibility, hardness differential, corrosion resistance, wear resistance, and cost. These factors should be evaluated with regard to all bearing system components to obtain long bearing life and maintenance-free operation. High strength bronze alloys frequently used in industrial and structural applications are shown in Table 1. Other alloys are available to satisfy special requirements.

TABLE 1

Alloy No.	Generic Description	ASTM Specification	Maximum Recommended Bearing Load	Maximum Recommended PV
614	Aluminum Bronze	B169-C61400	5000 psi 35 N/mm^2	60,000 psi-ft/min 130 N/mm^2-m/min
862	Manganese Bronze	B584-C86200	6000 psi 41 N/mm^2	72,000 psi-ft/min 150 N/mm^2-m/min
863	Manganese Bronze	B22-C86300	8000 psi 55 N/mm^2	80,000 psi-ft/min 170 N/mm^2-m/min
865	Manganese Bronze	B584-C86500	4000 psi 27.5 N/mm^2	48,000 psi-ft/min 100 N/mm^2-m/min
905	Tin Bronze	B22-C90500	2000 psi 14 N/mm^2	30,000 psi-ft/min 65 N/mm^2-m/min
911	Tin Bronze	B22-C91100	2500 psi 17.5 N/mm^2	36,000 psi-ft/min 75 N/mm^2-m/min
924	Leaded Tin Bronze	B22-C90500M	2000 psi 14 N/mm^2	30,000 psi-ft/min 65 N/mm^2-m/min
932	High Leaded Tin Bronze	B584-C93200	1500 psi 10 N/mm^2	24,000 psi-ft/min 50 N/mm^2-m/min
937	High Leaded Tin Bronze	B22-C93700	1000 psi 7 N/mm^2	20,000 psi-ft/min 45 N/mm^2-m/min
954	Aluminum Bronze	B148-C95400	4000 psi 27.5 N/mm^2	48,000 psi-ft/min 100 N/mm^2-m/min
955	Nickel Aluminum Bronze	B148-C95500	6000 psi 41 N/mm^2	72,000 psi-ft/min 150 N/mm^2-m/min
958	Alpha Nickel Aluminum Bronze	B148-C95800	5000 psi 35 N/mm^2	60,000 psi-ft/min 130 N/mm^2-m/min
GA50	Meehanite®	A48(50)	8000 psi 55 N/mm^2	80,000 psi-ft/min 170 N/mm^2-m/min

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Bearing Pressure

Bearing pressure (P) is defined as the total load applied on the supporting or projected area of the bearing, and is expressed as psi (pounds per square inch), kg/cm^2 or N/mm^2. For uniformly loaded bearings, bearing pressure can be calculated as follows:

$$P = \frac{\text{LOAD}}{\text{PROJECTED AREA}} = \frac{\text{LOAD}}{\text{ID X LENGTH}} \quad \text{(Bushings)}$$

$$= \frac{\text{LOAD}}{.0785 \text{ X } (\text{OD}^2 - \text{ID}^2)} \quad \text{(Thrust washers \& flange thrust surfaces)}$$

$$= \frac{\text{LOAD}}{\text{WIDTH X LENGTH}} \quad \text{(Plates)}$$

Bearings should be sized to accommodate the total applied load without exceeding the maximum design load. Recommended maximum design loads are shown on Table 1, having been determined by dividing the yield strength of each alloy by an appropriate safety factor. In most cases, the safety factor is extremely high, and actual loads may occasionally exceed the design load with no detrimental effect on bearing life.

Velocity

Surface velocity of a bearing is expressed in surface feet per minute (SFM) or meters per minute (m/min). For rotational motion, the formula for converting revolutions per minute (RPM) into SFM is:

$$V = SFM = RPM \times (\pi d)/12 = RPM \times 0.262 \times d$$

where for sleeve bearings d = ID and for thrust washers
d = mean diameter = (ID+OD)/2

For oscillating motion, cycles per minute (CPM) are converted into SFM using:

$$V = SFM = (4\alpha c)/360 \times (\pi d)/12 = 0.00291 \times \alpha \times c \times d$$

where α = amplitude of motion either side of mean position in degrees
c = frequency in cycles per minute

For linear or reciprocating motion, velocity is generally expressed in SFM or m/min.

The maximum allowable surface velocity for LUBRON SL bearings depends on the applied load and other operating and environmental variables. In general, surface velocity should not exceed 35 SFM for continuous operation.

PV Limit

PV is the product of bearing pressure (P) and surface velocity (V), and is used as a means of measuring bearing performance. Values for pressure and velocity must be considered individually, as well as their combined product. Temperature is the most important factor in determining a bearings PV limit. For most cases, the PV limit reflects the point where surface temperatures are at a maximum, but still stable. Therefore, anything affecting surface temperature–coefficient of friction, running clearance, hardness and surface finish of the mating material–will also affect the PV limit. Bearings which operate at higher at a PV limit will perform best when the bearing assembly is designed for maximum heat dissipation and the recommended mating materials are used.

SHAPES

LUBRON SL bearings are available in many different configurations depending on the application, direction of load, and type of movement. Most common shapes are listed below.

Bushings – One-piece sleeve bushings are used extensively to accommodate all types of rotary and linear motion. Sleeve or journal bushings are employed when the shaft load is essentially perpendicular to the axis of the shaft (radial loads). Depending on the bearing size, the lubricating recesses may extend completely through the bearing wall, or for larger bushings, the lubricating recesses will only extend partially through the wall. Where disassembly and reassembly make split bushings advantageous, LUBRON SL bearings are available either matched (split before final machining providing perfect 180° halves) or unmatched (split after final machining varying slightly from perfect 180° halves). Perfect halves are match-marked for proper assembly to assure maintenance of concentricity.

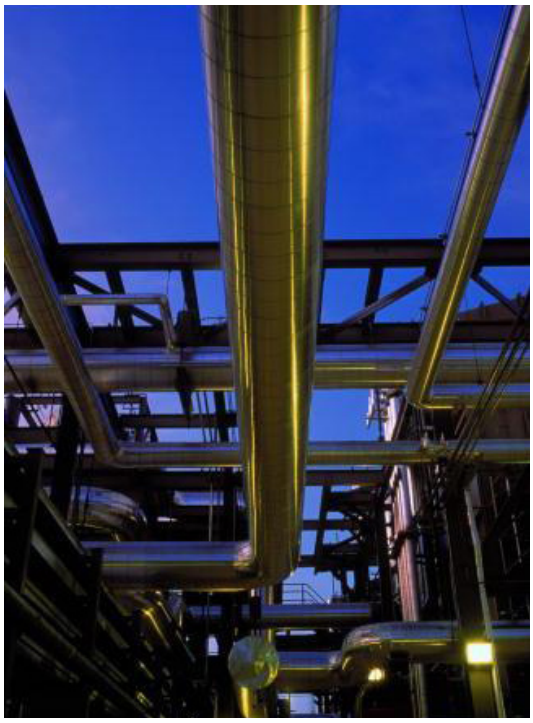
Washers – Washers are used to accommodate end thrust when the shaft load is in the direction of the axis of the shaft. Used alone or in conjunction with sleeve bushings, LUBRON SL washers can be lubricated on one or both sides.

Flange Bushings – Flange bushings combine the features of sleeve bushings and washers into one unit. Flange bushings are used when the shaft load has both an axial and a perpendicular component. The flanges may be lubricated for thrust load applications, or provided without lubrication when required to function only as a spacer.

Spherical Bearings – Self-aligning spherical bearing assemblies are designed primarily to accommodate radial loads and some misalignment. Misalignment may be caused by structural or shaft deflections under load. LUBRON SL spherical bearings consist of an inner component (gimbal) with a cylindrical inside diameter for shaft rotation and a spherical convex outside diameter, and a two-piece outer component (race) with a mating spherical concave inside diameter and a cylindrical concave outside diameter for mounting in a housing. Either component can be lubricated.

Plates – Bearing plates are used to accommodate longitudinal and transverse movement under vertical and horizontal loads. LUBRON SL bearing plates are available in single piece construction up to 144" for most bearing alloys. LUBRON SL bearing plates are generally fastened with machine screws or retained with welded bars.

Radial bearing plates have both a curved radial surface and a flat surface. Either or both surfaces can be lubricated. The radial surface, installed with a matching curved mating plate, is designed to permit deflection and rotation. The flat surface will accommodate linear expansion and contraction. Spherical bearing plates have lubricated concave or convex spherical surfaces to allow rotation in any direction. Spherical bearings plates are available to accommodate sliding, rotation, and severe angular misalignment. Mating spherical components, sole plates, base plates and anchorage are also available.



SIZING

While many factors affect bearing design, the following data is applicable for most LUBRON SL bearings. Available in both inch and metric sizes, LUBRON SL bearings are usually supplied finished machined to meet the exacting requirements of each application.

Inside Diameter – The nominal inside diameter of a bushing is dependent on the shaft diameter. To obtain the lowest frictional resistance and power loss, the shaft strength and rigidity should be as high as practical to permit the smallest possible shaft diameter.

Outside Diameter – The outside diameter of a bushing is dependent on the required wall thickness and size of the housing bore. To determine the outside diameter, add twice the recommended wall thickness of the inside diameter of the bushing. The following Tables provide the recommended wall thickness for LUBRON SL bushings. The minimum and maximum values shown are suitable for most applications, and are based on the permissible shaft load, bushing diameter and yield strength of the bearing material. In general, lower strength alloys should require the maximum wall thickness, while higher strength alloys can utilize the minimum wall thickness.

LUBRON SL BUSHINGS

CLEARANCE & INTERFERENCE LIMITS BEFORE PRESS FIT

TABLE 2 (INCHES)

NOMINAL SIZE RANGE OVER TO	SHAFT DIA. (f7)	BEARING I.D.	LIMITS OF CLEARANCE	BEARING O.D. (r7)	HOUSING I.D. (H7)	LIMITS OF INTERFERENCE	RECOMMENDED WALL THICKNESS
1.00 - 2.00	- .001 - .002	+ .008 + .007	.008 .010	+ .003 + .002	+ .001 - .000	.001 .003	.125 .375
2.00 - 3.00	- .0010 - .0025	+ .0100 + .0095	.0105 .0125	+ .003 + .002	+ .001 - .000	.001 .003	.250 .500
3.00 - 5.00	- .001 - .0030	+ .0130 + .0115	.013 .016	+ .0035 + .0025	+ .0015 - .0000	.0010 .0035	.375 .625
5.00 - 7.00	- .0015 - .0030	+ .016 + .014	.0155 .0190	+ .0040 + .0025	+ .0015 - .0000	.001 .004	.500 .750
7.00 - 10.00	- .002 - .004	+ .021 + .017	.019 .023	+ .005 + .003	+ .002 - .000	.001 .005	.625 .875
10.00 - 12.00	- .0025 - .0045	+ .0215 + .0195	.022 .026	+ .0055 + .0035	+ .002 - .000	.0015 .0055	0.750 1.000
12.00 - 16.00	- .003 - .005	+ .0245 + .0220	.0250 .0295	+ .0065 + .0045	+ .0025 - .0000	.0020 .0065	0.875 1.125
16.00 - 20.00	- .0040 - .0065	+ .0275 + .0250	.029 .034	+ .0075 + .0050	+ .0025 - .0000	.0025 .0075	1.000 1.250
20.00 - 30.00	- .005 - .008	+ .033 + .028	.033 .038	+ .010 + .008	+ .003 - .000	.005 .010	1.000 1.500

TABLE 3 (MM)

NOMINAL SIZE RANGE OVER TO	SHAFT DIA. (f7)	BEARING I.D.	LIMITS OF CLEARANCE	BEARING O.D. (r7)	HOUSING I.D. (H7)	LIMITS OF INTERFERENCE	RECOMMENDED WALL THICKNESS
30 - 50	- .025 - .051	+ .209 + .185	.210 .260	+ .076 + .051	+ .025 - .000	.025 .076	3.2 9.5
50 - 80	- .025 - .063	+ .264 + .242	.267 .327	+ .076 + .051	+ .025 - .000	.025 .076	6.3 12.7
80 - 120	- .038 - .076	+ .326 + .294	.332 .402	+ .089 + .063	+ .038 - .000	.025 .089	9.5 15.9
120 - 180	- .038 - .076	+ .404 + .362	.400 .480	+ .102 + .063	+ .038 - .000	.025 .102	12.7 19.1
180 - 250	- .051 - .102	+ .472 + .431	.482 .574	+ .127 + .076	+ .051 - .000	.025 .127	15.9 22.2
250 - 315	- .063 - .114	+ .551 + .498	.561 .665	+ .140 + .089	+ .051 - .000	.038 .140	19.1 25.4
315 - 400	- .076 - .127	+ .629 + .566	.642 .756	+ .165 + .114	+ .063 - .000	.051 .165	22.2 28.6
400 - 500	- .102 - .165	+ .696 + .633	.735 .861	+ .190 + .127	+ .063 - .000	.063 .190	25.4 31.8
500 - 765	- .127 - .203	+ .763 + .701	.828 .966	+ .254 + .203	+ .076 - .000	.127 .254	25.4 38.1

Lubron SL
Self-Lubricating Bearings

Length – Bearing length is usually determined by the amount of projected area necessary to accommodate the radial load, and can be calculated by dividing the shaft load by the desired bearing pressure times the inside diameter. In general, the length-to-diameter (L/D) ratio of a bushing should be between 1.0 and 2.0 for best performance. Shorter lengths may cause the bearings to become over-stressed, while longer lengths may induce edge loading. Bearings designed within the recommended L/D ratio will usually tolerate shaft misalignment and shock load without excessive wear.

Flange and Washer Thickness – The thickness for a bushing flange or thrust washer is generally the same as the corresponding wall thickness for a bushing listed in Tables 2 and 3.

Plate Thickness – Plate thickness should be consistent with the overall plate size. A minimum of one-half inch (12.7 mm) is recommended for most flat plates.

Running Clearance – Running or diametrical clearance, which is the amount the bushing inside diameter exceeds the shaft diameter after press fit closure allowance, is dependent on several factors, including bearing load, speed, size, temperature, and type of application. Tables 2 and 3 provide recommended clearance limits for LUBRON SL bushings prior to assembly for sizes ranging from 1 inch (30 mm) to 30 inches (765 mm). The clearance limits must be adjusted for any closure due to press fit by adding the maximum interference to the limits of clearance. These adjusted values will normally permit adequate running clearance after assembly for static to slow speeds and intermediate to heavy loads. LUBRON SL bushings may require larger clearances for special conditions.

Press Fit – LUBRON SL bushings are usually press fit or chill fit into their housings. The bushing outside diameter is slightly larger than the housing bore, resulting in a press or interference fit. The interference fitting will cause the inside diameter of the bushing to close-in, usually in direct ratio of the magnitude of the interference fit. This close-in must be compensated for in the bearing design to achieve the proper running clearance after installation.

Tolerances – Machining tolerances for most LUBRON SL bearings range from ±.001 to ±.002 inches (.025 to .050 mm) for inside diameters, and ±.0005 to ±.001 inches (.012 to .025 mm) for outside diameters. Surface finishes will generally not exceed 63 µ inch (1.6 µ m).

MATING SURFACES

LUBRON SL bearings will operate against most metals, but best performance is achieved with the hardest possible mating surface. A minimum hardness of Rc 20 (BHN 228) is desirable, although softer materials will generally provided satisfactory performance. Smoother finishes are normally required for harder materials, higher loads, and higher surface speeds. For maximum wear resistance, mating materials should be machined and polished to a surface finish between 16 to 63 µ inch (0.4 to 1.6 µ m).

INSTALLATION

LUBRON SL bearings are generally supplied fully machined and ready for installation. Even though LUBRON SL bearings are extremely durable, care must be taken to ensure that the lubricated bearing surfaces are not damaged before or during installation.

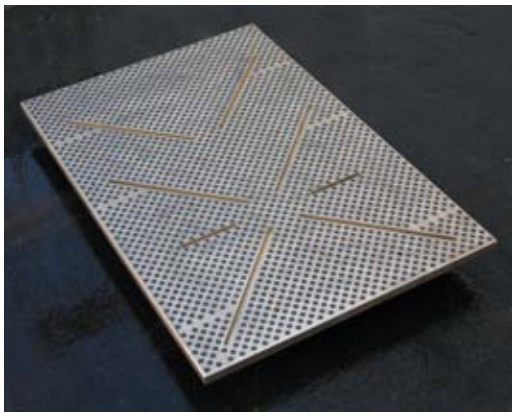
LUBRON SL bushings are most often press fit into their housings. The sizes recommended in Tables 2 and 3 provide the proper interference fits for ssembly. The bushings must be inserted squarely into the housings. Accurate alignment is particularly important for self-lubricating bearings. Misalignment over the length of the bushing or over the diameter of a thrust washer should not exceed .001 inches per inch. Chamfers are provided on the outside diameter of the bushing to facilitate proper alignment. Shouldered arbor plugs should be used to install smaller bushings. For larger sizes, LUBRON SL bearings can be refrigerated or packed in dry ice prior to installation. Immersion in liquid nitrogen is generally permitted provided the temperature of the bearing does not fall below –112°F (–80°C). LUBRON SL bearings can also be retained in the housings with countersunk set screws, dowel pins, or keyways.

LUBRON SL bearings should be wiped clean and free of all debris prior to installation of the shafts. Proper housing design and sealing of the bearing will prevent the ingress of foreign debris during operation. Application of a supplementary non-soluble lubricant during assembly will permit easier installation and provide better initial performance. The shaft ends should be burr-free and have a minimum of .060 inch (1.5 mm) radius or 15° chamfer. LUBRON SL bearing inside diameters are normally furnished with 30° chamfers. Unlike most other self-lubricating bearings, LUBRON SL bearings can be machined after assembly to control running clearance or correct minor misalignment. When circumstances necessitate field machining the lubricated bearing surface, consult a LUBRON engineer for specific recommendations.

Lubron SL
Self-Lubricating Bearings

SUPPLEMENTARY LUBRICATION

LUBRON SL bearings are frequently used where oil and grease lubrication are impractical. However, special operating conditions may exist that require the use of a supplementary lubricant. In such cases, LUBRON SL bearings can be furnished with one of several groove patterns to accommodate most types of loading, movement and lubricating requirements. Typical patterns include straight, circular, figure 8, and oval grooves. Grooves may be specified in any width and depth, and can run out one or both ends. Seals and seal grooves can also be added for applications subject to ingress of foreign debris.



MANUFACTURING CAPABILITIES

Our manufacturing facilities are modern, flexible, and complete, capable of complex tasks with precision accuracy. Our diverse design and manufacturing skills combine to assure consistent quality and reliable performance from small bushings to large bearing assemblies.

QUALITY ASSURANCE

Every LUBRON bearing is guaranteed to meet or exceed the quality requirements for each job. From procurement and fabrication to final inspection, every phase of manufacturing is monitored by our quality control personnel. Every step is planned, performed, checked, and certified in writing. All LUBRON bearings are manufactured and inspected in strict accordance with the requirements of ISO 9002. Material certifications are normally provided at no additional cost. Non-destructive testing, including radiograph, ultrasonic, hydrostatic, magnetic particle and liquid penetrate examination, are performed to comply with the specifications of ASTM by certified independent testing laboratories.

ENGINEERING & TESTING

LUBRON engineers have extensive product knowledge and experience in metallurgical, mechanical and structural structural disciplines. We offer our customers a variety of engineering services, from selection of bearing alloys and mating materials, to prototype and full size production testing to simulate load, movement, temperature, and other environmental conditions present during the actual operation of LUBRON bearings. Coefficient of friction and wear testing is performed in-house or by independent testing laboratories. Bearing design, AutoCAD® drawing preparation, testing, consulting, and on-site engineering services are available upon request.

STANDARD SPECIFICATION FOR LUBRON SL30 SELF-LUBRICATING BUSHINGS

The following specification is recommended for heavy duty industrial and structural applications. Specifications for other applications and bearing configurations are available upon request.

Self-lubricating bronze bushings shall be equal to “LUBRON SL30” as manufactured by Lubron Bearing Systems, Huntington Beach, California, USA. The bushings shall be composed of supporting metal and a solid lubricant suitable for long-term maintenance-free operation. The bushings shall be one-piece construction with a self-lubricating bearing surface on the inside diameter. The supporting metal shall be high strength manganese bronze, Copper Alloy UNS No. C86300, manufactured in strict accordance with ASTM B22 Alloy C86300, ASTM B271-C86300, ASTM B505-C86300 or ASTM B584-C86300. Circular recesses for containment of the lubricant shall be machined perpendicular to the bearing surface, be at least .25 inches (6.4 mm) deep, or extend completely through the supporting metal, and be arranged in a uniform, overlapping geometric pattern in the direction of the rotating motion. The pattern of recesses shall have a net cross-sectional area that is not less than 30% of the total area of the surface and shall normally extend to within .125 inches (3.2 mm) of the chamfers at each end of the bushings

The solid lubricant shall be a dense combination of solids and binders having non-deteriorating characteristics as well as lubricating qualities and shall be capable of withstanding the effects of long-term atmospheric exposure. The self-lubricating compound shall be integrally molded and compressed into recesses provided for containment, and be free of detrimental pits, pinholes and other imperfections that will impair the design load capacity. The lubricant shall have a Type D Durometer hardness of at least 60 when tested in accordance with ASTM D2240.

The bushings shall not be damaged, scraped, or machined on the lubricating surface after manufacture. The surface finish of the bushing shall not exceed 63 microinches (1.6 micrometers) as measured in accordance with ANSI Standard B46.1. The bearing manufacturer shall recommend the housing and shaft tolerances to assure proper interference fit and running clearance of the bushings. The bushings shall have a design load capacity of at least 8 ksi (55 MPa) of projected bearing area at surface speeds not exceeding 10 fpm (.05 m/s). The static and dynamic coefficients of friction shall not exceed 0.15 when subjected to loads up to 8 ksi.

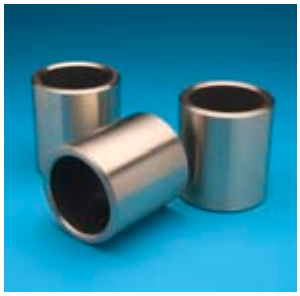
LUBRON Self-Lubricating Bearings for Industrial/Structural Applications

LUBRON SL

LUBRON SL bearings are used extensively for moderate to heavy load industrial and structural applications. LUBRON SL bearings are permanently lubricated with graphite solid lubricants compounded and compressed into trepanned or circular recesses, and are available in a variety of bronze and Meehanite® bearing alloys. Most sizes are suitable for operating temperatures up to 1200ºF.

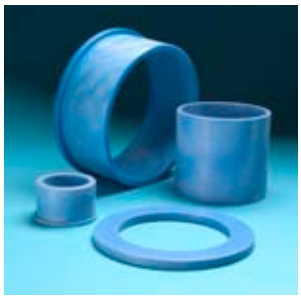
LUBRON TF

LUBRON TF bearings are constructed of woven PTFE fabric liners permanently bonded and mechanically locked to rigid bronze, stainless steel or composite backings. Capable of extremely low coefficient of friction and high wear resistance, LUBRON TF bearings offer exceptional performance for industrial, structural, military and aerospace high load applications.



LUBRON TX

LUBRON TX bearings consist of synthetic fiber reinforced PTFE polyester materials capable of high loads and low friction. LUBRON TX bearings have excellent dimensional stability in water, and are ideally suited for many marine and hydro turbine applications. LUBRON TX bearings can be machined on-site, and are a lower cost alternative to many other self-lubricating bearings.



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