

Please Reference Bearing Selection Manual While Referring to this Guide

There are many types of bearings, each used for different purposes. These include ball bearings, roller bearings, ball thrust bearings, roller thrust bearings, tapered roller thrust bearings and linear bearings.

What loads or movements will the bearing need to support or allow?

Radial Load (weight of car)

Thrust Load (cornering forces)

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Ball bearings like the one illustrated above are used in applications like conveyor belt rollers, where they must hold heavy radial loads. In these bearings, the roller is a cylinder, so the contact between the inner and outer races is not a point but a line. This spreads the load out over a larger area, allowing the bearing to handle much greater loads than a ball bearing. However, this type of bearing is not designed to handle much thrust loading.

Radial Load (weight of car)

Thrust Load (cornering forces)

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Tapered roller bearings are used in car hubs, where they are usually mounted in pairs facing opposite directions so that they can handle thrust in both directions.

Thrust Load

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Roller thrust bearings like the one illustrated below can support large thrust loads. They are often found in gear sets like car transmissions between gears, and between the housing and the rotating shafts. The helical gears used in most transmissions have angled teeth -- this causes a thrust load that must be supported by a bearing.

Thrust Load

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Linear bearings are used primarily where something needs to be moved along a high accuracy. In other words, the object needs to only translate in one direction, move back to its starting position with high repeatability. The implications for roller bearings are obvious, as are uses for optical test fixture and calibration.

Life Factors

Type of Machine	Life in Hours of Operation
instruments and apparatus which are only infrequently used; demonstration apparatus, devices for operation of sliding doors.	500
raft engines.	500-2000
shafts for service of short duration or intermittent operation, are service interruptions are of major importance; hand tools, lifting tackle in machinery shops, hand-driven shafts in general, farm machinery, assembly cranes, charging machines, foundry cranes, household machines.	4000-8000
shafts for intermittent service where dependable operation is most important; auxiliary machines in power stations, conveying-equipment in factory lines, elevators, general-cargo cranes, machine tools frequently used.	8000-12000
shafts for 8-hour service which are not always fully utilized; machines in general in the mechanical industries, cranes for hoisting service, blowers, jackshafts.	20000-30000
shafts for continuous operation (24-hour service); separators, compressors, pumps, machine-shafting, roller shafts and conveyor rollers, mine hoists, stationary electric motors.	40000-60000
shafts for 24-hour service where dependability is of great importance; pulp and paper machines, public power stations, mine pumps, etc. pumping stations, machines for continuous service aboard ships.	100000-200000

Life of a rolling element bearing depends to a large extent on the smoothness of the contacting surfaces -- the balls, rollers, and races. Typical surface roughness dimensions for lubrication bearings are as follows:

- Balls 2-3 μin. rms
- Ball races 6-10 μin. rms
- Roller 6-12 μin. rms
- Roller races 10-20 μin. rms

See in terms of micro-inches or millioths of an inch. The unit of measurement of the surface roughness is rms which stands for "root-mean-square height". This value is obtained by drawing a diamond point instrument over the surface with a magnified readout. These measurements are taken at equidistant points on the profile, squaring these values, adding them up, dividing the sum by the number of readings taken and taking the square root of this value.

General PV Guidelines

Table 2-1 General Guidelines for the PV Factor in Process Metal Bearings

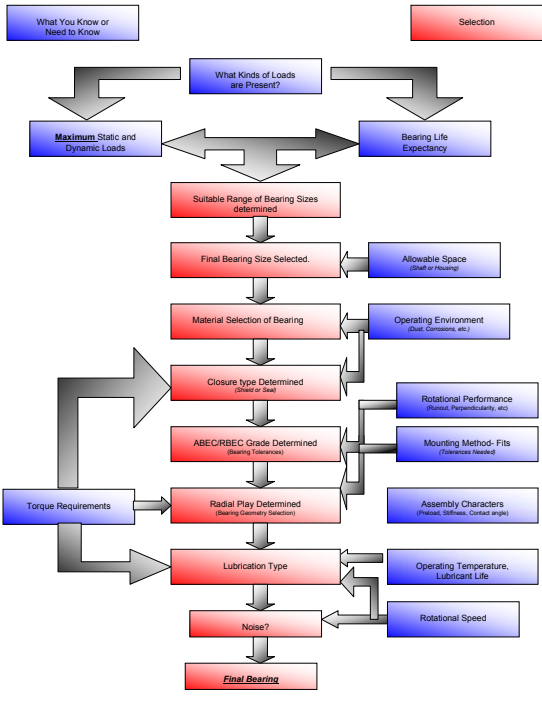
Limiting conditions for operation of porous bearings can be expressed as a PV factor. Since $P = \text{load} / \text{area}$, and $V = \text{surface velocity}$, the PV factor gives an index of frictional heat generated on a unit area of the bearing surface. A maximum value of 50000 is common for porous bearings. For long-time running with no additional lubrication, 20000 should be a limit in starting loads for various speeds. For thrust bearings, a maximum PV of 10000 should be used.

Provision to replenish the oil of healthy is desirable when the PV factor approaches the limiting continuous operation for extended periods of time, or for high temperatures. For such cases, oil can be applied to the CD or ends of the bearing. From there it is drawn, by capillary action, into the bearing and maintained to the shaft. A reservoir of grease next to the bearing also can be helpful.

Material	PV	Static PV (psi)	Dyn. PV (psi)	V (ft/min)
Lead-Bronze	6000	3500	800	1500
Copper-bronze	3000	2000	400	1500
Hardenable Copper-Iron	7500	5000	800	225
Iron	3000	1000	300	85
Bronze-iron	3500	1000	250	80
Lead-iron	8000	4000	1000	850
Aluminum	5000	4000	2000	1200

Under certain conditions these recommended values can be exceeded but with a sacrifice in service life.

Selection Path



Fit Tolerances

Table 1-8 Deviation of Housing Bore from Nominal Dimensions (inches)

Fit	Housing bore (in)	Housing bore (in)		Housing bore (in)		Housing bore (in)		Housing bore (in)		Housing bore (in)	
		ES	EI	FS	FI	ES	EI	FS	FI	ES	EI
H7/g6	0.0001 - 0.0004	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001
	0.0004 - 0.0009	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001
H7/h6	0.0001 - 0.0004	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001
	0.0004 - 0.0009	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001	+0.0001	-0.0001

Table 1-9 Available Lubricants

Lubricant Code	Brand Name	Basic Type Oil	Operating Range	Uses
01	Mineral-LUBE (ML-L-2002A)	Synthetic oil	+25 to +300	Light general purpose instrument
15	Quaker Hyster 147 AC	Fluorinated oil	+20 to +550	High temperature stability with good lubricity properties
49	Hydrex 443	Grease	+100 to +300	Wide temperature range, good general purpose grease
24	Texaco-Low Temp EP (ML-L-2002A)	Synthetic Ester	+50 to +250	Low torque at cold temperature
20	Torrin-Bearon 325	Synthetic grease	+50 to +250	General purpose grease
39	Tri-Ton-Avalon-C	Channelling synthetic	+25 to +200	Smooth running, long life with minimum migration
13	Torrin-SHM4M	Silicone grease	+25 to +365	Higher temperature stability
48	Mobil 29 (ML-L-04102)	Synthetic hydrocarbon	+50 to +300	Wide temperature range, good at temperature torque, general purpose
72	Mobilus PG No. 3	Mineral grease	+50 to +300	Low torque, general purpose grease
75	Chemrol SPS-2	Mineral grease	+20 to +300	High speed, high load application
83	Shell Alvania X2	Mineral grease	+30 to +250	Long life
10	Dynalloy Xpress 254C (ML-L-2001T)	Fluorinated grease	+20 to +550	High temperature stability with good lubricity properties
12	HYDROL	Synthetic grease	+20 to +300	Low noise and low torque application
25	INDACE W	Synthetic grease	+20 to +250	High speed, low torque grease
40	Indolux AL 150M	Synthetic grease	+40 to +300	High speed, low torque grease
63	ULTRA	Synthetic grease	+40 to +300	High speed, high load application

*Most popular and readily available lubrication.
†This lubrication is called out. GBC will ship bearings with one of these general purpose lubricants.

Typical Lubricants

General Selection Table

Bearing type	Deep groove ball bearings	Angular contact ball bearings	Double row angular contact ball bearings	Self-aligning ball bearings	Cylindrical roller bearings	Single row cylindrical roller bearings	Double row cylindrical roller bearings	Needle roller bearings	Tapered roller bearings	Spherical roller bearings	Thrust ball bearings	Thrust roller bearings with wavy rings	Double row angular contact ball bearings	Cylindrical roller bearings	Spherical roller bearings	Reference page
Deep groove ball bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-77
Angular contact ball bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-77
Double row angular contact ball bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-77
Self-aligning ball bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-78
Cylindrical roller bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-74
Single row cylindrical roller bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-74
Double row cylindrical roller bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-74
Needle roller bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-74
Tapered roller bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-74
Spherical roller bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-74
Thrust ball bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-74
Thrust roller bearings with wavy rings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-74
Double row angular contact ball bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-77
Cylindrical roller bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-77
Spherical roller bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A-77

Useful References

- Bearing Selection Guide (Found in Mind Works)
- Quality Bearing and Components Catalog B605
- www.3Dcontentcentral.com
- Mechanical Engineering Design 5th Edition, Shigley and Mischke
- www.howstuff works.com
- www.skf.com
- www.dynaroll.com/bearing-selection
- If you are going to incorporate bearings into your solid modeling this website provides free SolidWorks Downloads of

Shields and Seal Types

Z2 TYPE SHIELD This is the most common type of shield. It is non-removable, being permanently staked to the bearing outer race with a small gap of approximately .005 inches between the inside diameter of the shield and the bearing inner ring. Since there is no contact with the inner ring, the torque and speed limitations are virtually unaffected and the performance of the bearing is almost identical to that of an open bearing. Standard material is 300 series stainless steel. Plastic fixed shields are also available on a limited basis. Most Dynaroll shielded bearings have metal Z type shields.

ZS TYPE SHIELD The ZS shield is identical to the fixed Z type shield, except that it is retained by an external snap wire that locates in a groove inside the rim of the bearing outer race. This is only an advantage if the user needs to remove the shield after manufacture of the bearing.

TS TYPE SEAL The TS type seal is made from glass-reinforced Teflon. It is retained by an external snap wire to the bearing outer ring, but also tightly contacts the inner race land. This gives a high degree of protection from contamination, with a modest increase in torque.

D TYPE SEAL The D type seal consists of a modified Buna-N rubber lip seal.