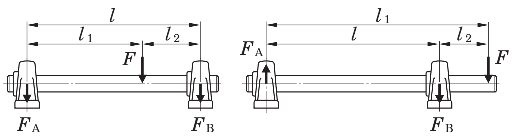
5.2 Distribution of Bearing Load

In order to determine the radial load distribution to each bearing attached to a shaft, use the procedure shown below. Use the load factors shown in **Table 5.1** to account for vibration and impact.

A standard radial ball bearing bears an axial load component in addition to the radial component. The total vectored load can be calculated by taking the square root of the sum of the squares of each load as shown in the previous calculation.



$$F_A = \frac{l_2}{l} \cdot F \quad \text{......} \quad (5.7)$$

$$F_B = \frac{l_1}{l} \cdot F \quad \text{......} \quad (5.8)$$

Fig. 5.1 Distribution of load to bearings

5.3 Dynamic Equivalent Load

In many cases, a bearing is exposed to the combined vector load of both radial and axial load components. It may also be used under more severe conditions such as vibration and shock load. In this case, a direct comparison to the dynamic load rating is not appropriate.

In such a case, find the load equivalent to a direct radial load only and compare this with the basic dynamic load rating.

The converted virtual load is called dynamic equivalent load (P).

5.3.1 Calculation of dynamic equivalent load

The dynamic equivalent radial load (P_r) of a bearing that bears radial and axial loads as well as vibration and impact is found by the following formula.

$$P_r = XF_r + YF_a \quad \text{......} \quad (5.9)$$

Whereas,

P_r: Dynamic equivalent radial load, N
F_r: Radial load, N
F_a: Axial load, N
X: Radial load factor (see **Table 5.4**)
Y: Axial load factor (see **Table 5.4**)

Table 5.4 Radial load factor (X) and axial load factor (Y)

$\frac{f_0 F_a}{C_{0r}}$	e	$F_a/F_r \le e$		$F_a/F_r > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22				1.99
0.689	0.26				1.71
1.03	0.28				1.55
1.38	0.30				1.45
2.07	0.34				1.31
3.45	0.38				1.15
5.17	0.42				1.04
6.89	0.44				1.00

Remarks 1. C_{0r} (basic static radial load rating) and f_0 (factor) are shown in the dimensional tables.
2. If $f_0 F_a / C_{0r}$ does not conform to the table above, find by interpolation.

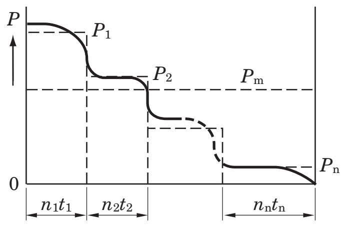
5.3.2 Average dynamic equivalent load in the case of fluctuating loads

If the level or direction of the load applied to a bearing is fluctuating, it is necessary to find the average dynamic equivalent load to calculate the bearing life.

Table 5.5 shows the method of finding the average dynamic equivalent load under various types of fluctuating conditions.

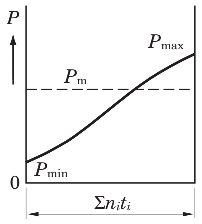
Table 5.5 Calculation of average dynamic equivalent load in case of fluctuated load

(1) Graduated fluctuation



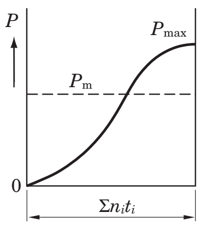
$$P_m = \sqrt[p]{\frac{P_1{}^p\, n_1 t_1 + P_2{}^p\, n_2 t_2 + \cdots\cdots\cdots + P_n{}^p\, n_n t_n}{n_1 t_1 + n_2 t_2 + \cdots\cdots\cdots + n_n t_n}} \quad \cdots\cdots\cdots\cdots\cdots (5.10)$$

(2) Monotone fluctuation



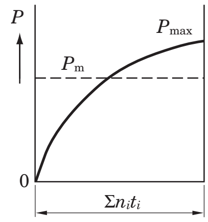
$$P_m = \frac{P_{min} + 2\,P_{max}}{3} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (5.11)$$

(3) Sine curve fluctuation



$$P_m = 0.68\,P_{max} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (5.12)$$

(4) Sine curve fluctuation (upper half of sine curve)



$$P_m = 0.75\,P_{max} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (5.13)$$

Whereas,

P_m: Average dynamic equivalent load, N

P_1: Dynamic equivalent load actuating for t_1 hours at rotating speed of n_1, N

P_2: Dynamic equivalent load actuating for t_2 hours at rotating speed of n_2, N

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P_n: Dynamic equivalent load actuating for t_n hours at rotating speed of n_n, N

P_{min}: Minimum dynamic equivalent load, N

P_{max}: Maximum dynamic equivalent load, N

$\Sigma n_i t_i$: Total rotating frequency for t_1 to t_i hours

5.4 Basic Static Load Rating and Static Equivalent Load

5.4.1 Basic static load rating

If a bearing is exposed to excessive static or impact load even when running at low rotational speed, partial permanent deformation occurs to the contact surface of the raceways of the bearing. The amount of permanent deformation increases with increased loads, and at some point, the bearing will no longer rotate smoothly.

The basic static load rating of a bearing is the static load that generates the calculated contact stresses shown below at the center of the contact surfaces of the raceways.

(1) Self aligning ball bearings .... 4,600 MPa
(2) Other ball bearings
(mounted ball bearings included) ...... 4,200 MPa
(3) Roller bearings .... 4,000 MPa

The total permanent deformation that occurs to the raceways and the balls under the above critical contact stresses is 0.0001 times the diameter of the ball.

In ball bearing units, this is indicated as the basic static radial load rating (C_{0r}) and these values are shown in the dimensional tables.

5.4.2 Static equivalent loads

Static equivalent load is the equivalent of the combined (vectored) load converted to the equivalent direct radial load. The term “static” refers to no rotation or very little rotation.

Static equivalent radial load (P_{0r}) can be calculated by using the formula below.

$$P_{0r} = 0.6F_r + 0.5F_a \quad \cdots\cdots (5.14)$$

$$P_{0r} = F_r \quad \cdots\cdots (5.15)$$

Whereas,

P_{0r}: Static equivalent radial load, N

F_r: Radial load, N

F_a: Axial load, N

5.4.3 Safety factor

The static equivalent load that can be withstood by a bearing, in addition to the above considerations, is sometimes dependent upon unforeseen conditions in the operating environment. Therefore, a safety factor is always built in to insure success in the application.

$$f_s = \frac{C_{0r}}{P_{0r}} \quad \cdots\cdots (5.16)$$

Whereas,

f_s: Safety factor (see **Table 5.6**)

C_{0r}: Basic static radial load rating, N

P_{0r}: Static equivalent radial load, N

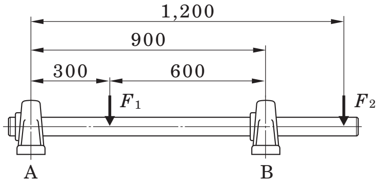
Table 5.6 Safety factor f_s (recommended)

Operating conditions		f_s (Min.)
Being rotated	High rotating accuracy is required	2
	Ordinary operating conditions	1
	Impact	1.5
Not always being rotated (sometimes oscillated)	Ordinary operating conditions	0.5
	Impact, unevenly distributed load	1

5.5 Example of Applied Calculation

Example 1 Distributing load

Find the load applied to the bearing A and bearing B, if the radial load F_1 ($F_1 = 1.5$ kN) and F_2 ($F_2 = 4.5$ kN) are applied.



(1) Find the radial load F_{1A} applied to the bearing A by F_1, with **Formula (5.7)** and **Formula (5.8)**.

$$F_{1A} = \frac{600}{900} \times 1.5 = 1.0 \text{ (kN)}$$

In a similar manner, find the radial load F_{2A} applied to the bearing A by F_2.

$$F_{2A} = -\frac{1{,}200 - 900}{900} \times 4.5 = -1.5 \text{ (kN)}$$

Remark: Negative load is the upward load.

Radial load F_A applied to the bearing A:

$$F_A = F_{1A} + F_{2A} = 1.0 + (-1.5) = -0.5 \text{ (kN)}$$

(2) In a similar manner to (1), find the radial load F_B applied to the bearing B.

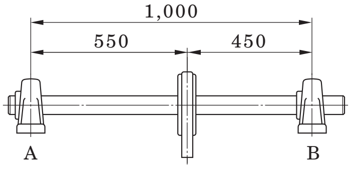
$$F_{1B} = \frac{300}{900} \times 1.5 = 0.5 \text{ (kN)}$$

$$F_{2B} = \frac{1{,}200}{900} \times 4.5 = 6.0 \text{ (kN)}$$

$$F_B = F_{1B} + F_{2B} = 0.5 + 6.0 = 6.5 \text{ (kN)}$$

Example 2 Calculating load by V-belt transmission

Find the load applied to the bearing A and bearing B when the shaft is driven by the V-belt, transmission power W is 7.5 kw (W = 7.5 kW), rotating speed n is 300 min^{-1} (n = 300 min^{-1}), effective diameter of pulley D_p is 300 mm (D_p = 300 mm).



(1) Find the load actually applied to the pulley shaft F_b with **Formula (5.2)**.

From **Table 5.1**, load factor f_w is 1.2 (f_w = 1.2), and the belt factor f_b is 2.5 (f_b = 2.5), from **Table 5.2**.

$$F_b = \frac{19.1 \times 10^6\, W}{D_p \cdot n} \cdot f_w \cdot f_b$$

$$= \frac{19.1 \times 10^6 \times 7.5}{300 \times 300} \times 1.2 \times 2.5 = 4.78 \text{ (kN)}$$

(2) Find the load actually applied to the bearing A and bearing B (F_A and F_B) with **Formulas (5.7)** and **(5.8)**.

$$F_A = \frac{450}{1,000} \times 4.78 = 2.15 \text{ (kN)}$$

$$F_B = \frac{550}{1,000} \times 4.78 = 2.63 \text{ (kN)}$$

Example 3 Calculating dynamic equivalent radial load

Find the dynamic equivalent radial load P_r when the radial load F_r, 1.5 kN (F_r = 1.5 kN), and the axial load F_a, 0.85 kN, (F_a = 0.85 kN) are applied to the pillow type unit UCP306J (bearing UC306).

(1) Find the radial load factor (X) and the axial load factor (Y) with using the static radial load rating C_{0r} of UCP306J (bearing UC306), 15.0 kN (C_{0r} = 15.0 kN), and **Table 5.4**.

Find the solutions of the following formulas:

$$\frac{f_0 F_a}{C_{0r}} = \frac{13.3 \times 0.85}{15.0} = 0.754,\ e = 0.264$$

$$\frac{F_a}{F_r} = \frac{0.85}{1.5} = 0.567 > e\ (0.264)$$

Therefore, $X = 0.56$, $Y = 1.68$

(2) Find the dynamic equivalent radial load P_r with **Formula (5.9)**.

$$P_r = XF_r + YF_a = 0.56 \times 1.5 + 1.68 \times 0.85$$

$$= 2.27 \text{ (kN)}$$

Example 4 Calculating bearing life

Under the conditions shown in **Example 3**, find the bearing life L_{10h} when a bearing is used for a blower with a rotating speed n, 1,000 min^{-1}.

(1) Select the load factor f_w is 1.2 (f_w = 1.2) from **Table 5.1**, and find the bearing load P_r.

$$P_r = f_w \cdot F = 1.2 \times 2.27 = 2.72 \text{ (kN)}$$

(2) The dynamic radial load rating of UCP306J (bearing UC306), C_r, is 26.7 kN (C_r = 26.7 kN), and calculate the bearing life L_{10h} with the **Formula (4.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left(\frac{C_r}{P_r}\right)^3 = \frac{10^6}{60 \times 1,000} \times \left(\frac{26.7}{2.72}\right)^3$$

$$\approx 15,800 \text{ (hr)}$$

(3) Calculate bearing life L_{10h} with the nomogram shown in **Fig. 4.1**.

When the rotating speed n is 1,000 min^{-1} (n = 1,000 min^{-1}), rotating factor f_n is 0.32 (f_n = 0.32). Next, find the life factor f_h by speed factor f_n, dynamic radial load rating of bearing C_r, and the bearing load P_r.

$$\text{Life factor } f_h = f_n \cdot \frac{C_r}{P_r} = 0.32 \times \frac{26.7}{2.72} = 3.14$$

From life factor f_h, bearing life $L_{10h} \approx$ 16,000 hours.

Example 5 Selecting ball bearing units

If a bearing is operated under the following conditions, select the flange type unit (UCF) with at least two years (5,000 hours) or longer rating life: rotating speed of shaft n is 1,500 min^{-1} (n = 1,500 min^{-1}), and radial load F_r is 5 kN (F_r = 5 kN). The radial load F_r includes the load factor and gear factor.

(1) From the nomogram shown in **Fig. 4.1**, when life time L_h is 5,000 hr (L_h = 5,000 hr), life factor f_h can be found as 2.16 ($f_h \approx$ 2.16), and speed factor f_n can be found as 0.28 ($f_n \approx$ 0.28) when the rotating speed n is 1,500 min^{-1} (n = 1,500 min^{-1}).

$$\text{Dynamic radial load rating } C_r = F_r \cdot \frac{f_h}{f_n} = 5 \times \frac{2.16}{0.28}$$

$$\approx 38.6 \text{ (kN)}$$

(2) Find the flange type unit that meets the following condition: dynamic radial load rating C_r is 38.6 kN (C_r = 38.6 kN). For the 200 series. UCF211J (dynamic radial load rating C_r is 43.4 kN (C_r = 43.4 kN)) can be selected.

Example 6 Selecting pillow type units for low speed

If a bearing is used for a dolly under the following conditions, select the pillow type unit (UCP) with 10,000 hours rating life: radial load F_r is 12 kN ($F_r = 12$ kN), and rotating speed is 8 min^{-1}.

(1) Find the required dynamic radial load rating C_r with using **Formulas (4.4)** and **(4.5)**.

Speed factor $f_n = (0.03n)^{-1/p} = (0.03 \times 8)^{-1/3} \approx 1.61$

Life factor $f_h = \left(\frac{L_{10h}}{500}\right)^{1/p} = \left(\frac{10{,}000}{500}\right)^{1/3} \approx 2.71$

Dynamic radial load rating $C_r = P_r \cdot \frac{f_h}{f_n} = 12 \times \frac{2.71}{1.61}$

≈ 20.2 (kN)

(2) From **Table 5.6**, define safe factor f_s as 2 ($f_s = 2$), and find the static radial load rating of bearing required C_{0r}.

$C_{0r} = f_s \cdot P_r = 2 \times 12 = 24$ (kN)

(3) The unit is used for a dolly, and vibration or impact may occur. Thus, select UCP308J ($C_r = 40.7$ kN, $C_{0r} = 24.0$ kN).

Example 7 Calculating bearing life in high temperature applications

Find the bearing life if the heat resistant pillow type unit (UCP215D1K2) is operated under the following conditions: operating temperature is 175 ℃, radial load F_r is 4 kN ($F_r = 4$ kN), and the rotating speed n is 800 min^{-1} ($n = 800\ \text{min}^{-1}$). Note that the radial load F_r includes load factor and gear factor.

(1) From **Table 4.1**, find the dynamic load rating C_r in the case that a bearing is used at 175 ℃.

$C_r = 67.4 \times 0.95 = 64.0$ (kN)

Find the bearing life L_{10h} using **Formula (4.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left(\frac{C_r}{P_r}\right)^3 = \frac{10^6}{60 \times 800} \times \left(\frac{64.0}{4}\right)^3$$

$\approx 85{,}000$ (hr)

(2) If a bearing unit is operated at 175 ℃, grease is degraded faster, and it cannot be used without lubrication. Supply grease at intervals specified in **Table 14.4**.

(3) If the shaft experiences axial expansion due to heat, install a fixed bearing unit on one end of the assembly and install floating bearing unit on the other side that allows the shaft to move freely through the bore of the bearing. More information is offered in **Section 9**. (see "**9 Design of shaft and base**").

Example 8 Calculating grease life

Find the grease life for pillow type unit UCP204J (bearing UC204) under the following conditions: radial load F_r is 1 kN ($F_r = 1$ kN), and rotating speed n is 800 min^{-1} ($n = 800\ \text{min}^{-1}$). Note that the radial load F_r includes load factor and belt factor. Operating temperature of the bearing should be 40 ℃.

Find the grease life L using **Formula (4.7)**.

$$\log L = 6.10 - 4.40 \times 10^{-6}\, d_m n - 2.50 \left(\frac{P_r}{C_r} - 0.05\right) - (0.021 - 1.80 \times 10^{-8}\, d_m n)\, T$$

$$= 6.10 - 4.40 \times 10^{-6} \times 12.5 \times 10^4 - 2.50 \left(\frac{1}{12.8} - 0.05\right) - (0.021 - 1.80 \times 10^{-8} \times 12.5 \times 10^4) \times 50$$

$= 4.542$

$L \approx 34{,}800$ (hr)

Example 9 Calculating life of bearing units in case of non-lubrication

Find the life of a bearing unit in the case that it is operated under the conditions shown in **Example 8**, but without lubrication.

(1) Find the rating life of bearings L_{10h} using **Formula (4.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left(\frac{C_r}{P_r}\right)^3 = \frac{10^6}{60 \times 800} \times \left(\frac{12.8}{1}\right)^3$$

$\approx 43{,}700$ (hr)

(2) Compare the grease life L shown in **Example 8** to the rating life of bearings L_h. Then, grease life L is shorter than the bearing rating life. Therefore, life of a bearing unit should be the same as the grease life L, 34,800 hours ($L = 34{,}800$ hours).

FYH

Table 5.7 (1) Radial Load/Speed Chart

Normal Duty — Unit : lbf

SHAFT SIZE	L_{10} hours	Allowable Radial Load at Various RPM — RPM (min^{-1})																					
		50	100	150	300	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	8500
1/2″ 5/8″ 3/4″ 12 mm - 20 mm	10000	927	736	643	510	430	376	341	298	271	252	237	225	215	207	200	193	188	183	179	174	171	167
	25000	683	542	474	376	317	277	252	220	200	185	174	166	158	152	147	143	138	135	132	129	126	123
	50000	542	430	376	298	252	220	200	174	158	147	138	132	126	121	117	113	110	107	104	102	100	98
	70000	485	385	336	267	225	196	179	156	142	132	124	118	112	108	104	101	98	96	93	91	89	87
	100000	430	341	298	237	200	174	158	138	126	117	110	104	100	96	93	90	87	85	83	81	79	78
7/8″ 15/16″ 1″ 25 mm	10000	1014	805	703	558	471	411	373	326	296	275	259	246	235	226	218	212	206	200	195	191		
	25000	747	593	518	411	347	303	275	240	218	203	191	181	173	167	161	156	151	147	144	141		
	50000	593	471	411	326	275	240	218	191	173	161	151	144	138	132	128	124	120	117	114	112		
	70000	530	421	367	292	246	215	195	171	155	144	135	129	123	118	114	111	107	105	102	100		
	100000	471	373	326	259	218	191	173	151	138	128	120	114	109	105	101	98	95	93	91	89		
1-1/8″ 1-3/16″ 1-1/4″ 30 mm	10000	1412	1121	979	777	655	573	520	454	413	383	361	343	328	315	304	295	286					
	25000	1040	826	721	573	483	422	383	335	304	282	266	252	241	232	224	217	211					
	50000	826	655	573	454	383	335	304	266	241	224	211	200	192	184	178	172	167					
	70000	738	586	512	406	343	299	272	238	216	200	189	179	171	165	159	154	150					
	100000	655	520	454	361	304	266	241	211	192	178	167	159	152	146	141	137	133					
1-1/4″ 1-5/16″ 1-3/8″ 1-7/16″ 35 mm	10000	1861	1477	1290	1024	864	755	686	599	544	505	475	452	432	415	401	388						
	25000	1371	1088	951	755	636	556	505	441	401	372	350	333	318	306	295	286						
	50000	1088	864	755	599	505	441	401	350	318	295	278	264	253	243	234	227						
	70000	973	772	675	535	452	394	358	313	284	264	248	236	226	217	210	203						
	100000	864	686	599	475	401	350	318	278	253	234	221	210	200	193	186	180						
1-1/2″ 1-9/16″ 40 mm	10000	2107	1672	1461	1160	978	854	776	678	616	572	538	511	489	470	454							
	25000	1553	1232	1077	854	721	630	572	500	454	421	397	377	360	346	334							
	50000	1232	978	854	678	572	500	454	397	360	334	315	299	286	275	265							
	70000	1102	874	764	606	511	447	406	355	322	299	281	267	256	246	237							
	100000	978	776	678	538	454	397	360	315	286	265	250	237	227	218	211							
1-5/8″ 1-11/16″ 1-3/4″ 45 mm	10000	2469	1960	1712	1359	1146	1001	910	795	722	670	631	599	573	551								
	25000	1819	1444	1261	1001	844	738	670	586	532	494	465	441	422	406								
	50000	1444	1146	1001	795	670	586	532	465	422	392	369	350	335	322								
	70000	1291	1025	895	710	599	523	476	415	377	350	330	313	300	288								
	100000	1146	910	795	631	532	465	422	369	335	311	293	278	266	256								
1-7/8″ 1-15/16″ 2″ 50 mm	10000	2542	2017	1762	1399	1180	1031	936	818	743	690	649	617	590									
	25000	1873	1486	1298	1031	869	759	690	603	548	508	478	454	435									
	50000	1486	1180	1031	818	690	603	548	478	435	403	380	361	345									
	70000	1329	1055	921	731	617	539	489	428	389	361	339	322	308									
	100000	1180	936	818	649	548	478	435	380	345	320	301	286	274									
2″ 2-1/8″ 2-3/16″ 55 mm	10000	3143	2494	2179	1729	1459	1274	1158	1011	919	853	803	763										
	25000	2316	1838	1606	1274	1075	939	853	745	677	629	591	562										
	50000	1838	1459	1274	1011	853	745	677	591	537	499	469	446										
	70000	1643	1304	1139	904	763	666	605	529	480	446	420	399										
	100000	1459	1158	1011	803	677	591	537	469	427	396	373	354										
2-1/4″ 2-3/8″ 2-7/16″ 60 mm	10000	3794	3012	2631	2088	1761	1539	1398	1221	1109	1030	969	921										
	25000	2796	2219	1938	1539	1298	1134	1030	900	817	759	714	678										
	50000	2219	1761	1539	1221	1030	900	817	714	649	602	567	538										
	70000	1984	1574	1375	1092	921	804	731	638	580	538	507	481										
	100000	1761	1398	1221	969	817	714	649	567	515	478	450	427										
2-1/2″ 65 mm	10000	4142	3287	2872	2279	1923	1679	1526	1333	1211	1124	1058											
	25000	3052	2422	2116	1679	1417	1237	1124	982	892	828	780											
	50000	2422	1923	1679	1333	1124	982	892	780	708	657	619											
	70000	2165	1719	1501	1192	1005	878	798	697	633	588	553											
	100000	1923	1526	1333	1058	892	780	708	619	562	522	491											
2-3/4″ 70 mm	10000	4504	3575	3123	2479	2091	1826	1659	1450	1317	1223	1150											
	25000	3319	2634	2301	1826	1540	1346	1223	1068	970	901	848											
	50000	2634	2091	1826	1450	1223	1068	970	848	770	715	673											
	70000	2355	1869	1633	1296	1093	955	867	758	688	639	601											
	100000	2091	1659	1450	1150	970	848	770	673	611	567	534											
2-15/16″ 3″ 75 mm	10000	4881	3874	3384	2686	2265	1979	1798	1571	1427	1325												
	25000	3596	2854	2493	1979	1669	1458	1325	1157	1051	976												
	50000	2854	2265	1979	1571	1325	1157	1051	919	835	775												
	70000	2551	2025	1769	1404	1184	1035	940	821	746	693												
	100000	2265	1798	1571	1247	1051	919	835	729	662	615												
3-1/8″ 80 mm	10000	5264	4178	3650	2897	2443	2135	1939	1694	1539	1429												
	25000	3879	3079	2689	2135	1800	1573	1429	1248	1134	1053												
	50000	3079	2443	2135	1694	1429	1248	1134	991	900	836												
	70000	2752	2184	1908	1514	1277	1116	1014	886	805	747												
	100000	2443	1939	1694	1345	1134	991	900	786	714	663												
3-1/4″ 85 mm	10000	6083	4828	4217	3347	2823	2466	2241	1958	1779	1651												
	25000	4482	3557	3107	2466	2080	1817	1651	1442	1310	1217												
	50000	3557	2823	2466	1958	1651	1442	1310	1145	1040	966												
	70000	3180	2524	2205	1750	1476	1289	1171	1023	930	863												
	100000	2823	2241	1958	1554	1310	1145	1040	909	826	766												
3-1/2″ 90 mm	10000	6959	5523	4825	3830	3230	2822	2564	2240	2035													
	25000	5127	4070	3555	2822	2380	2079	1889	1650	1499													
	50000	4070	3230	2822	2240	1889	1650	1499	1310	1190													
	70000	3638	2887	2522	2002	1688	1475	1340	1171	1064													
	100000	3230	2564	2240	1778	1499	1310	1190	1040	944													

1 . Shaded area A non-contact seal is used.

If the bearing with set screws is exposed
to a heavy load (Pr / Cr > 0.12), vibration,
or heavy inpact, use a tighter shaft tolerance than normal.

5 Bearing Load

Table 5.7 (2) Radial Load/Speed Chart

Medium Duty **Unit : lbf**

SHAFT SIZE	L_{10} hours	Allowable Radial Load at Various RPM																
		RPM (min^{-1})																
		50	100	150	300	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
1″ 25 mm	10000	1412	1121	979	777	655	573	520	454	413	383	361	343	328	315	304	295	286
	25000	1040	826	721	573	483	422	383	335	304	282	266	252	241	232	224	217	211
	50000	826	655	573	454	383	335	304	266	241	224	211	200	192	184	178	172	167
	70000	738	586	512	406	343	299	272	238	216	200	189	179	171	165	159	154	150
	100000	655	520	454	361	304	266	241	211	192	178	167	159	152	146	141	137	133
1-3/16″ 1-1/4″ 30 mm	10000	1861	1477	1290	1024	864	755	686	599	544	505	475	452	432	415	401	388	
	25000	1371	1088	951	755	636	556	505	441	401	372	350	333	318	306	295	286	
	50000	1088	864	755	599	505	441	401	350	318	295	278	264	253	243	234	227	
	70000	973	772	675	535	452	394	358	313	284	264	248	236	226	217	210	203	
	100000	864	686	599	475	401	350	318	278	253	234	221	210	200	193	186	180	
1-3/8″ 1-7/16″ 35 mm	10000	2107	1672	1461	1160	978	854	776	678	616	572	538	511	489	470	454		
	25000	1553	1232	1077	854	721	630	572	500	454	421	397	377	360	346	334		
	50000	1232	978	854	678	572	500	454	397	360	334	315	299	286	275	265		
	70000	1102	874	764	606	511	447	406	355	322	299	281	267	256	246	237		
	100000	978	776	678	538	454	397	360	315	286	265	250	237	227	218	211		
1-1/2″ 40 mm	10000	2469	1960	1712	1359	1146	1001	910	795	722	670	631	599	573	551			
	25000	1819	1444	1261	1001	844	738	670	586	532	494	465	441	422	406			
	50000	1444	1146	1001	795	670	586	532	465	422	392	369	350	335	322			
	70000	1291	1025	895	710	599	523	476	415	377	350	330	313	300	288			
	100000	1146	910	795	631	532	465	422	369	335	311	293	278	266	256			
1-3/4″ 45 mm	10000	2542	2017	1762	1399	1180	1031	936	818	743	690	649	617	590				
	25000	1873	1486	1298	1031	869	759	690	603	548	508	478	454	435				
	50000	1486	1180	1031	818	690	603	548	478	435	403	380	361	345				
	70000	1329	1055	921	731	617	539	489	428	389	361	339	322	308				
	100000	1180	936	818	649	548	478	435	380	345	320	301	286	274				
1-15/16″ 2″ 50 mm	10000	3143	2494	2179	1729	1459	1274	1158	1011	919	853	803	763					
	25000	2316	1838	1606	1274	1075	939	853	745	677	629	591	562					
	50000	1838	1459	1274	1011	853	745	677	591	537	499	469	446					
	70000	1643	1304	1139	904	763	666	605	529	480	446	420	399					
	100000	1459	1158	1011	803	677	591	537	469	427	396	373	354					
2-3/16″ 2-1/4″ 55 mm	10000	3794	3012	2631	2088	1761	1539	1398	1221	1109	1030	969	921					
	25000	2796	2219	1938	1539	1298	1134	1030	900	817	759	714	678					
	50000	2219	1761	1539	1221	1030	900	817	714	649	602	567	538					
	70000	1984	1574	1375	1092	921	804	731	638	580	538	507	481					
	100000	1761	1398	1221	969	817	714	649	567	515	478	450	427					
2-7/16″ 60 mm	10000	4142	3287	2872	2279	1923	1679	1526	1333	1211	1124	1058						
	25000	3052	2422	2116	1679	1417	1237	1124	982	892	828	780						
	50000	2422	1923	1679	1333	1124	982	892	780	708	657	619						
	70000	2165	1719	1501	1192	1005	878	798	697	633	588	553						
	100000	1923	1526	1333	1058	892	780	708	619	562	522	491						
2-1/2″ 65 mm	10000	4504	3575	3123	2479	2091	1826	1659	1450	1317	1223	1150						
	25000	3319	2634	2301	1826	1540	1346	1223	1068	970	901	848						
	50000	2634	2091	1826	1450	1223	1068	970	848	770	715	673						
	70000	2355	1869	1633	1296	1093	955	867	758	688	639	601						
	100000	2091	1659	1450	1150	970	848	770	673	611	567	534						
2-3/4″ 70 mm	10000	4881	3874	3384	2686	2265	1979	1798	1571	1427	1325							
	25000	3596	2854	2493	1979	1669	1458	1325	1157	1051	976							
	50000	2854	2265	1979	1571	1325	1157	1051	919	835	775							
	70000	2551	2025	1769	1404	1184	1035	940	821	746	693							
	100000	2265	1798	1571	1247	1051	919	835	729	662	615							
2-15/16″ 3″ 75 mm	10000	5264	4178	3650	2897	2443	2135	1939	1694	1539	1429							
	25000	3879	3079	2689	2135	1800	1573	1429	1248	1134	1053							
	50000	3079	2443	2135	1694	1429	1248	1134	991	900	836							
	70000	2752	2184	1908	1514	1277	1116	1014	886	805	747							
	100000	2443	1939	1694	1345	1134	991	900	786	714	663							
80 mm	10000	6083	4828	4217	3347	2823	2466	2241	1958	1779	1651							
	25000	4482	3557	3107	2466	2080	1817	1651	1442	1310	1217							
	50000	3557	2823	2466	1958	1651	1442	1310	1145	1040	966							
	70000	3180	2524	2205	1750	1476	1289	1171	1023	930	863							
	100000	2823	2241	1958	1554	1310	1145	1040	909	826	766							
3-7/16″ 85 mm	10000	6959	5523	4825	3830	3230	2822	2564	2240	2035								
	25000	5127	4070	3555	2822	2380	2079	1889	1650	1499								
	50000	4070	3230	2822	2240	1889	1650	1499	1310	1190								
	70000	3638	2887	2522	2002	1688	1475	1340	1171	1064								
	100000	3230	2564	2240	1778	1499	1310	1190	1040	944								
90 mm	10000	7893	6265	5473	4344	3664	3200	2908	2540	2308								
	25000	5816	4616	4032	3200	2699	2358	2142	1872	1700								
	50000	4616	3664	3200	2540	2142	1872	1700	1485	1350								
	70000	4126	3275	2861	2271	1915	1673	1520	1328	1206								
	100000	3664	2908	2540	2016	1700	1485	1350	1179	1071								
3-15/16″ 4″ 100 mm	10000	9631	7644	6678	5300	4470	3905	3548	3099	2816								
	25000	7096	5632	4920	3905	3294	2877	2614	2284	2075								
	50000	5632	4470	3905	3099	2614	2284	2075	1813	1647								
	70000	5035	3996	3491	2771	2337	2041	1855	1620	1472								
	100000	4470	3548	3099	2460	2075	1813	1647	1439	1307								

1 . Shaded area A non-contact seal is used.

If the bearing with set screws is exposed
to a heavy load (Pr / Cr > 0.12), vibration,
or heavy inpact, use a tighter shaft tolerance than normal.

Table 5.7 (3) Radial Load/Speed Chart

Heavy Duty **Unit : lbf**

SHAFT SIZE	L_{10} hours	Allowable Radial Load at Various RPM — RPM (min^{-1}) 50	100	150	300	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500
1″ 25 mm	10000	1535	1218	1064	845	713	622	566	494	449	417	392	372	356	343	331	320	311	303
	25000	1131	898	784	622	525	459	417	364	331	307	289	274	263	252	244	236	229	223
	50000	898	713	622	494	417	364	331	289	263	244	229	218	208	200	193	187	182	177
	70000	803	637	556	442	372	325	296	258	235	218	205	195	186	179	173	167	163	158
	100000	713	566	494	392	331	289	263	229	208	193	182	173	165	159	154	149	144	141
30 mm	10000	1933	1535	1341	1064	897	784	712	622	565	525	494	469	449	431	417	404		
	25000	1425	1131	988	784	661	578	525	458	417	387	364	346	331	318	307	297		
	50000	1131	897	784	622	525	458	417	364	331	307	289	274	262	252	244	236		
	70000	1011	802	701	556	469	410	372	325	296	274	258	245	235	226	218	211		
	100000	897	712	622	494	417	364	331	289	262	244	229	218	208	200	193	187		
35 mm	10000	2419	1920	1677	1331	1123	981	891	778	707	656	618	587	561	540	521			
	25000	1782	1414	1236	981	827	723	656	574	521	484	455	432	414	398	384			
	50000	1414	1123	981	778	656	574	521	455	414	384	361	343	328	316	305			
	70000	1264	1003	877	696	587	513	466	407	370	343	323	307	293	282	272			
	100000	1123	891	778	618	521	455	414	361	328	305	287	272	261	251	242			
1-1/2″ 40 mm	10000	2947	2339	2043	1622	1368	1195	1086	948	862	800	753	715	684	658				
	25000	2171	1724	1506	1195	1008	880	800	699	635	589	555	527	504	485				
	50000	1724	1368	1195	948	800	699	635	555	504	468	440	418	400	385				
	70000	1541	1223	1068	848	715	625	568	496	450	418	394	374	358	344				
	100000	1368	1086	948	753	635	555	504	440	400	371	349	332	317	305				
1-3/4″ 45 mm	10000	3541	2810	2455	1949	1644	1436	1304	1140	1035	961	904	859	822					
	25000	2609	2071	1809	1436	1211	1058	961	840	763	708	666	633	605					
	50000	2071	1644	1436	1140	961	840	763	666	605	562	529	502	481					
	70000	1851	1469	1283	1019	859	751	682	596	541	502	473	449	430					
	100000	1644	1304	1140	904	763	666	605	529	481	446	420	399	381					
50 mm	10000	4490	3563	3113	2471	2084	1820	1654	1445	1313	1219	1147	1089						
	25000	3308	2625	2294	1820	1535	1341	1219	1065	967	898	845	803						
	50000	2625	2084	1820	1445	1219	1065	967	845	768	713	671	637						
	70000	2347	1863	1627	1292	1089	952	865	755	686	637	599	569						
	100000	2084	1654	1445	1147	967	845	768	671	609	566	532	506						
2″ 2-3/16″ 55 mm	10000	5185	4115	3595	2853	2407	2102	1910	1669	1516	1407	1324							
	25000	3820	3032	2649	2102	1773	1549	1407	1229	1117	1037	976							
	50000	3032	2407	2102	1669	1407	1229	1117	976	887	823	774							
	70000	2710	2151	1879	1492	1258	1099	998	872	793	736	692							
	100000	2407	1910	1669	1324	1117	976	887	774	704	653	615							
2-7/16″ 60 mm	10000	5931	4707	4112	3264	2753	2405	2185	1909	1734	1610	1515							
	25000	4370	3468	3030	2405	2028	1772	1610	1406	1278	1186	1116							
	50000	3468	2753	2405	1909	1610	1406	1278	1116	1014	941	886							
	70000	3100	2461	2150	1706	1439	1257	1142	998	907	842	792							
	100000	2753	2185	1909	1515	1278	1116	1014	886	805	747	703							
2-1/2″ 65 mm	10000	6713	5328	4654	3694	3116	2722	2473	2160	1963	1822								
	25000	4946	3926	3429	2722	2296	2005	1822	1592	1446	1343								
	50000	3926	3116	2722	2160	1822	1592	1446	1263	1148	1066								
	70000	3509	2785	2433	1931	1629	1423	1293	1129	1026	953								
	100000	3116	2473	2160	1715	1446	1263	1148	1003	911	846								
2-3/4″ 70 mm	10000	7531	5977	5222	4144	3495	3054	2774	2424	2202	2044								
	25000	5549	4404	3847	3054	2576	2250	2044	1786	1622	1506								
	50000	4404	3495	3054	2424	2044	1786	1622	1417	1288	1195								
	70000	3937	3125	2730	2167	1827	1596	1450	1267	1151	1069								
	100000	3495	2774	2424	1924	1622	1417	1288	1125	1022	949								
2-15/16″ 3″ 75 mm	10000	8183	6494	5673	4503	3798	3318	3014	2633	2393	2221								
	25000	6029	4785	4180	3318	2798	2445	2221	1940	1763	1637								
	50000	4785	3798	3318	2633	2221	1940	1763	1540	1399	1299								
	70000	4277	3395	2966	2354	1985	1734	1576	1377	1251	1161								
	100000	3798	3014	2633	2090	1763	1540	1399	1222	1111	1031								

SHAFT SIZE	L_{10} hours	Allowable Radial Load at Various RPM — RPM (min^{-1}) 50	100	150	300	500	750	1000	1500	2000
80 mm	10000	8907	7069	6176	4902	4134	3611	3281	2866	2604
	25000	6562	5209	4550	3611	3046	2661	2418	2112	1919
	50000	5209	4134	3611	2866	2418	2112	1919	1676	1523
	70000	4656	3695	3228	2562	2161	1888	1715	1498	1361
	100000	4134	3281	2866	2275	1919	1676	1523	1330	1209
85 mm	10000	9631	7644	6678	5300	4470	3905	3548	3099	2816
	25000	7096	5632	4920	3905	3294	2877	2614	2284	2075
	50000	5632	4470	3905	3099	2614	2284	2075	1813	1647
	70000	5035	3996	3491	2771	2337	2041	1855	1620	1472
	100000	4470	3548	3099	2460	2075	1813	1647	1439	1307
3-1/2″ 90 mm	10000	10355	8219	7180	5699	4806	4199	3815	3333	3028
	25000	7630	6056	5290	4199	3541	3094	2811	2455	2231
	50000	6056	4806	4199	3333	2811	2455	2231	1949	1771
	70000	5413	4296	3753	2979	2513	2195	1994	1742	1583
	100000	4806	3815	3333	2645	2231	1949	1771	1547	1405
95 mm	10000	11079	8793	7682	6097	5142	4492	4082	3566	3240
	25000	8163	6479	5660	4492	3789	3310	3007	2627	2387
	50000	6479	5142	4492	3566	3007	2627	2387	2085	1894
	70000	5792	4597	4016	3187	2688	2348	2134	1864	1693
	100000	5142	4082	3566	2830	2387	2085	1894	1655	1504
3-15/16″ 4″ 100 mm	10000	12527	9943	8686	6894	5815	5080	4615	4032	
	25000	9230	7326	6400	5080	4284	3743	3400	2971	
	50000	7326	5815	5080	4032	3400	2971	2699	2358	
	70000	6549	5198	4541	3604	3040	2655	2413	2108	
	100000	5815	4615	4032	3200	2699	2358	2142	1871	
105 mm	10000	13324	10575	9238	7332	6184	5403	4909	4288	
	25000	9817	7792	6807	5403	4557	3981	3617	3159	
	50000	7792	6184	5403	4288	3617	3159	2871	2508	
	70000	6965	5528	4829	3833	3233	2824	2566	2242	
	100000	6184	4909	4288	3403	2871	2508	2278	1990	
110 mm	10000	14844	11782	10293	8169	6890	6019	5469	4777	
	25000	10937	8681	7584	6019	5077	4435	4029	3520	
	50000	8681	6890	6019	4777	4029	3520	3198	2794	
	70000	7760	6159	5381	4271	3602	3147	2859	2497	
	100000	6890	5469	4777	3792	3198	2794	2538	2217	
120 mm	10000	14989	11897	10393	8249	6957	6078	5522	4824	
	25000	11044	8766	7658	6078	5126	4478	4069	3554	
	50000	8766	6957	6078	4824	4069	3554	3229	2821	
	70000	7836	6219	5433	4312	3637	3177	2887	2522	
	100000	6957	5522	4824	3829	3229	2821	2563	2239	
130 mm	10000	16582	13161	11498	9126	7697	6724	6109	5337	
	25000	12218	9697	8471	6724	5671	4954	4501	3932	
	50000	9697	7697	6724	5337	4501	3932	3573	3121	
	70000	8669	6880	6010	4770	4024	3515	3194	2790	
	100000	7697	6109	5337	4236	3573	3121	2836	2477	
140 mm	10000	18320	14541	12702	10082	8503	7428	6749		
	25000	13498	10714	9359	7428	6265	5473	4973		
	50000	10714	8503	7428	5896	4973	4344	3947		
	70000	9577	7601	6640	5270	4445	3883	3528		
	100000	8503	6749	5896	4680	3947	3448	3133		

1 . Shaded area A non-contact seal is used.

If the bearing with set screws is exposed to a heavy load (Pr / Cr > 0.12), vibration, or heavy inpact, use a tighter shaft tolerance than normal.

Ball Bearing Life Calculations

The relationship between the basic rating life, the basic dynamic load rating, and the dynamic equivalent load of the ball bearing is indicated in Formula 1.
If the ball bearing unit is being used at a fixed rotating speed, the life is indicated as time. This is shown in Formula 2.

$$1.\quad L_{10} = \left(\frac{Cr}{Pr}\right)^3$$

$$2.\quad L_{10_h} = \frac{10^6 L_{10}}{60n} = \frac{10^6}{60n} \cdot \left(\frac{Cr}{Pr}\right)^3$$

L_{10} : Basic Rating Life 10^6rotations
L_{10_h} : Rated Life (hr)
Cr : Basic Dynamic Load Rating (kN)
Pr : Dynamic equivalent Load (kN)
n : Speed (min^{-1})

SIZE	Basic Loads (lbf) Dynamic Load (C_r)	Static Load (C_{0r})
UC201	2880	1496
UC202	2880	1496
UC203	2880	1496
UC204	2880	1496
UC205	3150	1766
UC206	4388	2543
UC207	5783	3465
UC208	6548	4005
UC209	7673	4793
UC210	7898	5243
UC211	9765	6615
UC212	11790	8145
UC213	12870	9023
UC214	13995	9923
UC215	15165	10868
UC216	16358	11925
UC217	18900	13928
UC218	21623	16088

SIZE	Basic Loads (lbf) Dynamic Load (C_r)	Static Load (C_{0r})
UC305	4770	2453
UC306	6008	3375
UC307	7515	4343
UC308	9158	5400
UC309	11003	6638
UC310	13950	8618
UC311	16110	10125
UC312	18428	11745
UC313	20858	13478
UC314	23400	15345
UC315	25425	17370
UC316	27675	19508
UC317	29925	21780
UC318	32175	24075
UC319	34425	26775
UC320	38925	31725
UC321	41400	34425
UC322	46125	40500
UC324	46575	41625
UC326	51525	48150
UC328	56925	55350

SIZE	Basic Loads (lbf) Dynamic Load (C_r)	Static Load (C_{0r})
UCX05	4388	2543
UCX06	5783	3465
UCX07	6548	4005
UCX08	7673	4793
UCX09	7898	5243
UCX10	9765	6615
UCX11	11790	8145
UCX12	12870	9023
UCX13	13995	9923
UCX14	15165	10868
UCX15	16358	11925
UCX16	18900	13928
UCX17	21623	16088
UCX18	24525	18428
UCX20	29925	23625