Bearing Selection

Dynamic Loading

Selection of SRB split roller bearings must take into account the effects of both radial and axial loads. These loads must be considered independently of each other.

Radial Load Considerations

The basic rating life of a bearing can be derived from the formulae laid down in ISO281:1990

$$L_{10} = (C/P)^{10/3} \ (10^6 \text{ Revolutions}) \quad \text{– (i)}$$

In the majority of cases where the speed remains constant then the life can be expressed in hours from the formula

$$L_{10}h = \frac{(10^6) \times L_{10}}{60 \times n} \quad \text{– (ii)}$$

Substituting – (i)

$$L_{10}h = \frac{(10^6) \times \left(\frac{C}{P}\right)^{10/3}}{60 \times n} \quad \text{– (ii)}$$

L_{10} = **Basic Rating Life (90% reliability), 10^6 Revolutions**

$L_{10}h$ = **Basic Rating Life (90% Reliability), Hours**

C = **Bearing Dynamic Capacity, kN**

n = **Speed, min-1**

P = **Equivalent Bearing Load**

This calculation assumes for the load components considered for an individual bearing, that the shaft system is a beam resting on rigid, moment free supports. Elastic deformations in the bearing, housing or machine structure are not taken into account.

Equivalent Load "P"

As previously stated radial and axial loads must be considered separately for split roller bearings. For the calculation of theoretical life only radial loads are considered.

Fr = Radial Loads

The value of Fr is that calculated from standard mechanical formulae, the impact of additional forces resulting from external influences must also be considered.

Fz = Factor

Load Condition	Factor Fz
Steady	1.0 to 1.3
Light Shock or Out of Balance	1.3 to 2.0
Heavy Shock or Vibration	2.0 to 3.0

Under the influence of the above conditions

$$P = F_r \times F_z$$

The required theoretical bearing life is based upon a number of factors, including reliability, accessibility and service considerations. Generally life values should be as follows:

Guide to Life Values	
Machine Used Intermittently	500 to 2,000 hours
Occasional Use	5,000 to 10,000 hours
Normal Operation	20,000 to 50,000 hours
Continuous Operation	75,000 to 100,000 hours
High Reliability	> 100,000 hours

Adjusted Life Calculation

The L10 fatigue life calculation is based upon the rating life of a large number of identical bearings expressed as a number of revolutions operating at a constant speed. This rating life is reached or exceeded by 90% of these before the first evidence of fatigue appears.

The above definition applies to bearings operating under optimum conditions. Variations in operating conditions will lead to changes in the life of these bearings.

ISO281 allows for an adjusted life calculation:

Lhna = a_1 x a_2 x a_3 x L_{10}h

Where

Lhna = Adjusted Life

L_{10}h = Rating Life in Hours

a_1 = Life adjustment factor, failure probability other than 10%

a_2 = Life adjustment factor, material properties

a_3 = Life adjustment factor, operating conditions

a_1 Factor

In cases where a failure rate other than 10% is required, then an a_1 factor as in the table below, should be applied.

Table A1

	Adjustment Factor					
Failure Probability %	10	5	4	3	2	1
Factor a_1	1.00	0.62	0.53	0.44	0.33	0.21

a_2 Factor

This factor takes into account the material properties.

a_3 Factor

The a_3 factor considers all operational parameters that influence fatigue life. The most obvious of these is lubrication. The highest life values are achieved where a state of hydrodynamic lubrication exists, in this state no metal to metal contact occurs.

Decreasing effectiveness of lubricant due to decreasing film thickness or effects of contamination will reduce the a_3 factor.

Due to the interrelationships between materials adjustment factor a_2 and operating adjustment factor a_3, a common factor a_{23} is frequently used.

a_{23} Factor

$a_{23} = a_2 + a_3$

The a_{23} factor can be taken from fig 1:

a_{23} Life Adjustment Factor

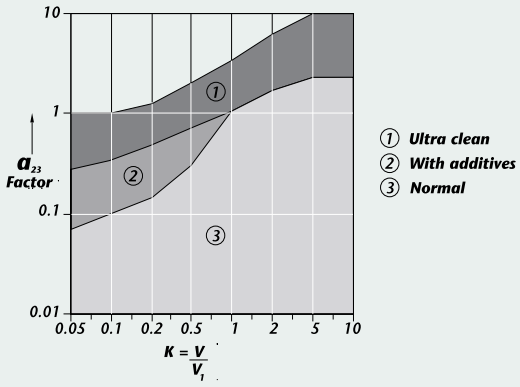
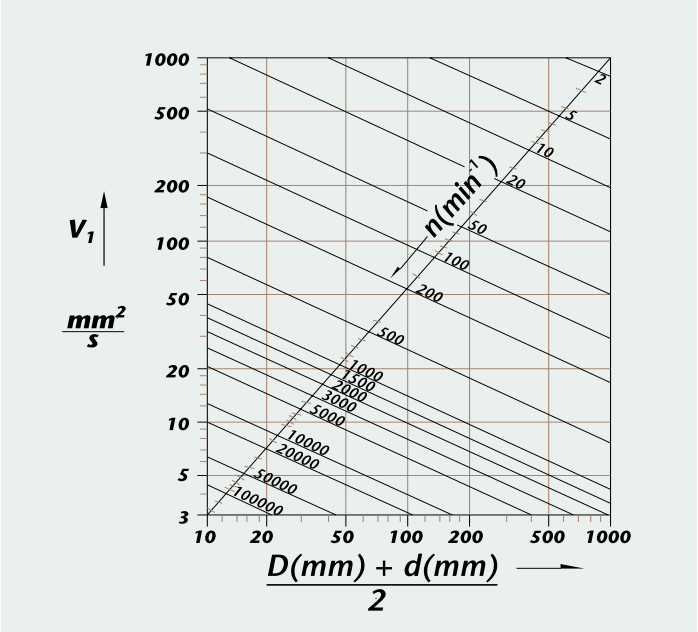


Fig1

V_1 = Rated Viscosity (Depends on bearing size and operating speed)

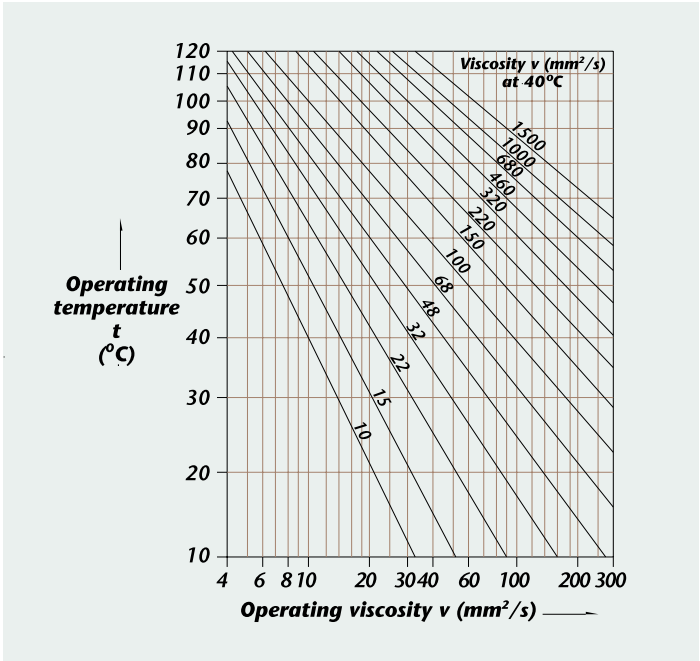
V = Operating Viscosity (Depends on original viscosity and operating temperature)

Values for V and V_1 are obtained from the following graphs:



Where D = Bearing outside diameter
d = Bearing Bore
n – Shaft speed (RPM)

V_1 is then read off the vertical axis.



Using the operating temperature and nominal lubricant viscosity, the value for operating viscosity, V, is read off the horizontal axis.

Static Loading

In situations where bearings rotate slowly (<10 rpm), oscillate slowly, are stationary for prolonged periods, or subject to high shock loads, it is important to check that no permanent deformations occur between rolling elements and raceways at peak load.

The basic static load rating is defined in ISO 76:1987 and refers to the contact stress at the centre of the most heavily loaded rolling element/raceway contact area. For roller bearings this value is 4000 Mpa. This will result in a permanent deformation of 0.0001 of the roller diameter.

The required static load rating can be determined from:

Co = Fs. Po

Co = Basic Static Load Rating
Po = Equivalent Static Load
Fs = Static Safety Factor

Guidelines for the Static Safety Factor Fs can be found in the table below:

Nature of Duty	Requirements for Duty		
	Low	Medium	High
Smooth no Vibration	1.0	1.5	3.0
Normal	1.0	1.5	3.5
Heavy	>2.5	>3.0	>4.0

Bearing Ratings

Light Series

Shaft (d)		Bearings Ratings			
mm	inch	Dynamic C_r (kN / lb)	Static C_{or} (kN / lb)	Axial C_a (kN / lb)	Max RPM
35 40	1 3/16 1 1/2	65 14613	68 15287	3.20 719.38	5400
45 50	1 11/16 2	83 18659	87 19558	3.60 809.30	4630
60 65	2 3/16 2 1/2	103 23155	115 25853	5.40 1213.95	3940
70 75	2 11/16 3	138 31024	161 36194	7.60 1708.53	3310
80 90	3 3/16 3 1/2	187 42039	231 51931	12.40 2787.59	2790
100 105	3 11/16 4	288 64745	366 82280	16.00 3596.90	2340
110 115	4 3/16 4 1/2	316 71040	427 95993	18.60 4181.39	1970
120 130	4 11/16 5	363 81606	496 111505	22.20 4990.69	1740
135 140	5 3/16 5 1/2	422 94869	585 131513	25.80 5799.99	1570
150 155	5 11/16 6	459 103187	664 149273	29.40 6609.30	1450
160	6 7/16 6 1/2	583 131064	792 178049	33.00 7419	1320
170 180	6 11/16 7	524 117800	828 186142	36.40 8183	1220
190 200	7 1/4 8	614 138033	990 222561	41.00 9217	1070
220 230	8 1/2 9	659 148149	1062 238747	49.00 11016	930
240 250	9 1/2 10	696 156467	1182 265724	57.80 12994	820
260 280	10 1/2 11	794 178498	1376 309337	66.80 15017	730
300 305	11 1/2 12	929 208848	1665 374307	78.20 17580	650
320 330	12 1/2 13	920 206824	1674 376330	89.00 20008	590
340 350	14	967 217390	1824 410052	99.60 22391	540
360 380	15	1011 227282	1975 443998	110.40 24819	500
400	16	1054 236949	2125 477719	115.60 25988	460
420	17	1095 246166	2275 511440	121.00 27202	430
440 460	18	1134 254933	2427 545611	127.20 28596	410
480	19	1291 290228	2800 629465	132.60 29810	380
500	20	1336 300345	2974 668582	137.80 30979	360
530	21	1377 309562	3150 708148	140.60 31608	340
560	22	1419 319004	3324 747265	142.40 32013	330
580	23	1591 357671	3759 845057	144.00 32372	310
600	24	1638 368237	3956 889344	146.80 33002	300

Medium Series

Shaft (d)		Bearings Ratings			
mm	inch	Dynamic C_r (kN / lb)	Static C_{or} (kN / lb)	Axial C_a (kN / lb)	Max RPM
45 50	1 11/16 2	121 27202	127 28551	6.20 1394	4350
55 65	2 3/16 2 1/2	168 37768	190 42714	8.80 1978	3680
70 75	2 11/16 3	258 58001	300 67443	10.60 2383	3080
80 90	3 3/16 3 1/2	297 66768	353 79358	17.80 4002	2520
100 105	3 11/16 4	388 87226	491 110381	25.00 5620	2130
110 115	4 3/16 4 1/2	454 102063	592 133087	31.20 7014	1820
120 130	4 11/16 5	525 118025	700 157366	38.20 8588	1600
135 140	5 3/16 5 1/2	600 134885	817 183669	45.40 10206	1450
150 155	5 11/16 6	730 164111	1034 232453	52.40 11780	1320
160 170	6 7/16 6 1/2	842 189289	1175 264151	61.40 13803	1200
180	6 11/16 7	927 208398	1357 305066	71.20 16006	1120
190 200	7 1/4 8	1013 227732	1516 340810	80.00 17985	960
220 230	8 1/2 9	1138 255833	1668 374981	89.80 20188	850
240 260	9 1/2 10	1240 278763	1882 423091	98.80 22211	750
270 280	10 1/2 11	1476 331818	2357 529875	113.80 25583	670
300 305	11 1/2 12	1569 352725	2607 586077	129.00 29000	610
320 330	12 1/2 13	1723 387346	2922 656892	144.20 32417	550
340 360	14	1989 447145	3403 765025	159.20 35790	500
380	15	1800 404656	3202 719838	174.40 39207	460
400	16	2105 473223	3793 852701	188.40 42354	430
420	17	2324 522456	4164 936105	202.00 45411	400
440 460	18	2215 497952	4183 940376	216.00 48559	380
480	19	2445 549658	4594 1032773	230.00 51706	360
500	20	2320 521557	4571 1027602	244.00 54853	340
530	21	2556 574612	5028 1130340	258.00 58001	330
560	22	2683 603163	5436 1222062	272.00 61148	310
580	23	2740 615977	5601 1259155	286.00 64295	300
600	24	2770 622721	5637 1267248	300.00 67443	290

Heavy Series

Shaft (d)		Bearings Ratings			
mm	inch	Dynamic C_r (kN / lb)	Static C_{or} (kN / lb)	Axial C_a (kN / lb)	Max RPM
100 105	3 11/16 4	653 146800	783 176025	31.20 7014	1820
110 120	4 3/16 4 1/2	656 147475	801 180072	39.10 8790	1640
125 130	4 15/16 5	753 169281	974 218964	49.00 11016	1500
135 140	5 3/16 5 1/2	827 185917	1084 243693	58.80 13219	1340
150 155	5 11/16 6	1037 233127	1325 297872	69.40 15602	1220
160 170	6 7/16 6 11/16	1015 228181	1326 298097	79.20 17805	1110
175 180	6 3/4 7	1275 286631	1767 397238	89.00 20008	1030
190 200	7 1/4 8	1423 319903	1958 440176	99.60 22391	880
220 230	8 1/2 9	1665 374307	2455 551906	109.40 24594	760
240 260	9 1/2 10	1694 380826	2519 566294	130.80 29405	700
280	11	1936 435230	3115 700280	153.00 34396	620
300	12	2114 475246	3194 718040	174.40 39207	560
320	13	2718 611031	4093 920143	198.80 44692	500
340 360	14	2686 603837	4421 993881	213.60 48019	460
380 400	15 16	3195 718265	5238 1177550	250.80 56382	420
420 440	17	3187 716466	5813 1306815	275.80 62002	360
460	18	3501 787056	6091 1369312	302.40 67982	340
500 530	20 21	4324 972074	7603 1709223	347.00 78009	310
560	22	4448 999950	8781 1974048	382.60 86012	280
580 600	23 24	4443 998826	8918 2004847	400 89924	270

Axial load ratings (C_a) assume the use of EP additives or oil lubrication, otherwise use 50% of values.

Higher loads and speeds may be permissible. Please contact SRB Technical Services.