This data sheet interacts with

PRT2 Catalogue

54 - 56

HepcoMotion®

No. 3 Load Life Information

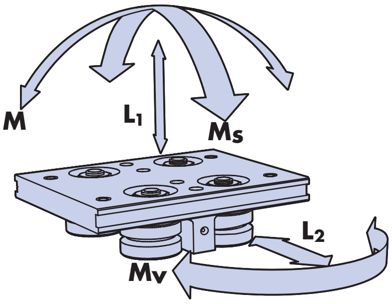
The load capacity and life expectancy of HepcoMotion ring slides, segments and track systems is determined by many factors including the ring size, the type and number of bearings, the presence of lubrication, the magnitude and direction of loads, the speed and the distance travelled.

It is usual to run systems at much less than the maximum load to prolong life, which can be calculated using the data and formulae in this datasheet. For calculation purposes, systems fall into two categories, those where a carriage runs on a ring slide, segment or track system and those where a ring slide is captivated and rotates in a number of bearings (or the similar arrangement where the ring slide is stationary and the bearings and load rotate).

Where possible, systems should be oiled using Hepco lubricators 📖 37 of the PRT2 catalogue and/or the bleed lubrication system 📖 52. This will greatly extend system life.

Systems with carriages

When calculating the life, first the load on each carriage should be resolved into the direct load components L_1 and L_2 and moment load components M, M_V and M_S.



Carriage Load Capacities

Capacities are shown for both 'dry' and 'lubricated' conditions - this refers to the bearing and slide 'V' contact, since all bearings are lubricated internally for life.

Values are based on shock-free duty.

Carriage Part Number	Dry System (Twin and DR Type Bearings)					Lubricated System (Twin Type Bearings)					Lubricated System (DR Type Bearings)				
	$L_{1(max)}$	$L_{2(max)}$	$M_{S(max)}$	$M_{V(max)}$	$M_{(max)}$	$L_{1(max)}$	$L_{2(max)}$	$M_{S(max)}$	$M_{V(max)}$	$M_{(max)}$	$L_{1(max)}$	$L_{2(max)}$	$M_{S(max)}$	$M_{V(max)}$	$M_{(max)}$
	N	N	Nm	Nm	Nm	N	N	Nm	Nm	Nm	N	N	Nm	Nm	Nm
FCC 12 93	90	90	0.5	1	1	240	240	1.3	2.7	2.7	Not Available				
FCC 12 127	90	90	0.5	1	1	240	240	1.3	2.6	2.6	Not Available				
FCC 20 143	180	180	1.6	2.5	2.5	500	400	4.5	5.5	7	760	1200	7	16	10
FCC 20 210	180	180	1.6	2.7	2.7	500	400	4.5	6	7.5	760	1200	7	18	11
FCC 25 159	400	400	4.5	8.5	8.5	1280	1200	14	25	27	1600	3000	18	64	33
FCC 25 255	400	400	4.5	8	8	1280	1200	14	23	25	1600	3000	18	60	31
FCC 25 351	400	400	4.5	8.5	8.5	1280	1200	14	24	27	1600	3000	18	63	33
BCP 25	400	400	4.5	15	15	1280[*1]	1200[*1]	14[*1]	45[*1]	45[*1]	1600[*1]	3000[*1]	18[*1]	110[*1]	60[*1]
FCC 44 468	800	800	16	28	28	3200	2800	64	95	110	3600	6000	73	210	120
FCC 44 612	800	800	16	29	29	3200	2800	64	100	115	3600	6000	73	220	130
BCP 44	800	800	16	40	40	3200[*1]	2800[*1]	64[*1]	140[*1]	160[*1]	3600[*1]	6000[*1]	73[*1]	300[*1]	180[*1]
FCC 76 799	1800	1800	64	85	85	7200	6400	250	300	340	10000	10000	360	470	470
FCC 76 1033	1800	1800	64	105	105	7200	6400	250	360	410	10000	10000	360	570	570
FCC 76 1267	1800	1800	64	120	120	7200	6400	250	420	480	10000	10000	360	670	670
FCC 76 1501	1800	1800	64	140	140	7200	6400	250	480	550	10000	10000	360	770	770
BCP 76	1800	1800	64	115	115	7200[*1]	6400[*1]	250[*1]	415[*1]	460[*1]	10000[*1]	10000[*1]	360[*1]	650[*1]	650[*1]

The L_2 & M_V load capacities for carriages using floating bearings 📖 36 of the PRT2 catalogue are the same as is shown above for DR bearings. The L_1 & M_S load capacities for carriages using floating bearings are zero (they are free to float in these directions). Please note that bogie carriages (BCP) are not available with floating bearings.

No. 3 Load Life Information

To determine life, calculate the load factor L_F using equation [1] below, then use equation [3] or [4] to determine life for the system.

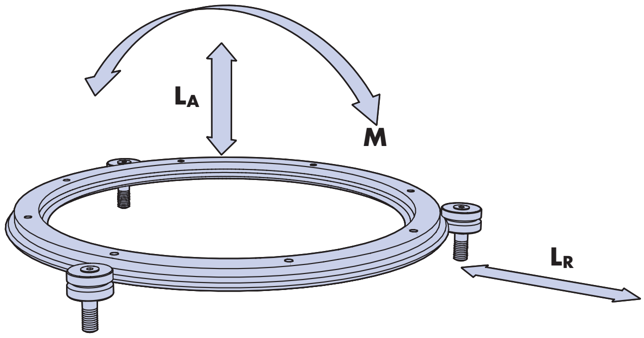
$$[1] \quad L_F = \frac{L_1}{L_{1(max)}} + \frac{L_2}{L_{2(max)}} + \frac{M_S}{M_{S(max)}} + \frac{M_V}{M_{V(max)}} + \frac{M}{M_{(max)}} \leq 1 \text{ or } 0.8 \text{ for stainless steel}$$

Notes:

1. In heavily loaded bogie type carriages, the bogie swivel bearings can affect life. Applications for bogie carriages in which L_F is more than 0.5, calculated using the *1 load figures from the table see page 1, should be referred to Hepco to confirm suitability.
2. When calculating L_2 and M_S loadings, the centrifugal force must be included which acts radially outwards from the centre of mass (COM) of the moving object. Its magnitude is $F = DV^2/R$, where V is the velocity of the COM in m/s, R is the distance of the COM from the ring axis in metres and D is the mass in kg. F is in N (newtons).

Systems with Ring Slides in Bearings

It is usual to space bearings equally around the ring[*1]. When calculating the life, the load should be resolved into the direct load components L_A and L_R and the moment load component M, as shown in the diagram opposite.



System Load Capacities

Capacities are shown for both 'dry' and 'lubricated' conditions - this refers to the bearing and slide 'V' contact, since all bearings are lubricated internally for life. Values are based on shock-free duty.

Bearing Part Numbers	Used with Ring Slides	Number of equally spaced bearings	Dry System (Twin and DR Type Bearings)			Lubricated System (Twin Type Bearings)			Lubricated System (DR Type Bearings)		
			$L_{A(max)}$	$L_{R(max)}$	$M_{(max)}$	$L_{A(max)}$	$L_{R(max)}$	$M_{(max)}$	$L_{A(max)}$	$L_{R(max)}$	$M_{(max)}$
			N	N	Nm	N	N	Nm	N	N	Nm
...J13...		3	67	38	16 x Øc[*6]	180	102	43 x Øc[*6]	Not Available		
	R12	4	83	45	19 x Øc[*6]	220	120	52 x Øc[*6]	Not Available		
		Each additional 1	10	6	2 x Øc[*6]	43	30	9 x Øc[*6]	Not Available		
...J18...	R20	3	135	76	32 x Øc[*6]	375	170	90 x Øc[*6]	570	510	135 x Øc[*6]
	REV	4	165	90	39 x Øc[*6]	465	200	108 x Øc[*6]	700	600	165 x Øc[*6]
	RIV	Each additional 1	21	13	4 x Øc[*6]	90	50	18 x Øc[*6]	135	150	28 x Øc[*6]
...J25...	R25	3	300	170	72 x Øc[*6]	960	510	230 x Øc[*6]	1200	1280	285 x Øc[*6]
	RES	4	370	200	87 x Øc[*6]	1190	600	278 x Øc[*6]	1480	1500	340 x Øc[*6]
	RIS	Each additional 1	48	30	9 x Øc[*6]	230	150	48 x Øc[*6]	285	375	60 x Øc[*6]
...J34...	R44	3	600	340	140 x Øc[*6]	2400	1200	570 x Øc[*6]	2700	2550	640 x Øc[*6]
	REM	4	740	400	170 x Øc[*6]	2950	1400	690 x Øc[*6]	3340	3000	780 x Øc[*6]
	RIM	Each additional 1	96	60	19 x Øc[*6]	570	350	120 x Øc[*6]	640	750	135 x Øc[*6]
...J54...	R76	3	1350	765	320 x Øc[*6]	5400	2740	1290 x Øc[*6]	7500	4250	1800 x Øc[*6]
	REL	4	1670	900	390 x Øc[*6]	6650	3200	1560 x Øc[*6]	9300	5000	2170 x Øc[*6]
	RIL	Each additional 1	210	130	44 x Øc[*6]	1290	800	270 x Øc[*6]	1800	1250	375 x Øc[*6]

The L_R load capacities for systems using floating bearings 📖 36 of the PRT2 catalogue are the same as is shown above for DR bearings. The L_A & M load capacities for systems using floating bearings are zero (they are free to float in these directions).

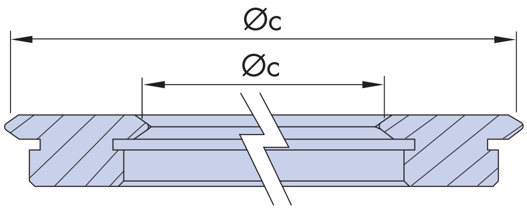
To determine the life of this system, first obtain a value for the load factor L_F by entering the values for L_A, L_R and M in respect of the proposed duty into equation [2] below, together with the maximum load capacities from the table above.

$$[2] \quad L_F = \frac{L_A}{L_{A(max)}} + \frac{L_R}{L_{R(max)}} + \frac{M}{M_{(max)}} \leq 1 \text{ or } 0.8 \text{ for stainless steel}$$

The life is then determined using equations [3] or [4].

Notes:

3. In some applications where the bearings rotate with the load, it may be beneficial to distribute the bearings unequally around the ring. Contact Hepco for application advice.
4. SPEED OF OPERATION. Hepco ring slides, segments and track systems are rated for speeds of 1m/s without lubrication or 5m/s when lubricated, but take care to allow for intertial loads. Greater speeds may be tolerated at reduced loads. Contact Hepco for details.
5. SHORT STROKE OPERATION. If the stroke length is less than five times the bearing outside diameter, then calculate the life as if the stroke is five times the bearing outside diameter.
6. Øc is ring slide contact diameter in metres (the diameter of the circle through the mid position of the contact points between the bearings and the ring, see below).



Ring contact diameter Øc (m)		
Ring part number	**External Vee**	**Internal Vee**
R12 93	0.10325	0.08275
R12 127	0.13725	0.11675
R20 143	0.1605	0.1255
R20 210	0.2275	0.1925
R25 159	0.1815	0.1365
R25 255	0.2775	0.2325
R25 351	0.3735	0.3285
R44 468	0.5085	0.4275
R44 612	0.6525	0.5715
R76 799	0.8695	0.7285
R76 1033	1.1035	0.9625
R76 1267	1.3375	1.1965
R76 1501	1.5715	1.4305

Ring contact diameter Øc (m)	
Ring part number	**External Vee**
REV 156	0.154
REV 223	0.2215
RES 184	0.1815
RES 280	0.2775
RES 376	0.3735
REM 505	0.502
REM 655	0.652
REL 874	0.8683

Ring contact diameter Øc (m)	
Ring part number	**Internal Vee**
RIV 161	0.1316
RIV 228	0.1988
RIS 182	0.1425
RIS 278	0.2385
RIS 374	0.3345
RIM 482	0.428
RIM 627	0.573
RIL 820	0.7397

Ring contact diameter Øc (m)	
Ring part number	**External Vee**
RD25 159	0.1815
RD25 255	0.2775
RD25 351	0.3735
RD44 468	0.5085

Calculating System Life

With L_F determined for either a 4 bearing carriage, or for a ring system 📖 2, equations [1]&[2], the life in km can be calculated using one of the two equations below. In these equations, the Basic Life is taken from the table on the right in respect of the bearings and the lubrication condition applicable.

For dry systems use equation [3]:

$$[3] \quad \text{System life (km)} = \frac{B_L}{(0.03 + 0.97L_F)^2}$$

For lubricated systems use equation [4]:

$$[4] \quad \text{System life (km)} = \frac{B_L}{(0.03 + 0.97L_F)^3}$$

Bearings	Included in		Basic Life Dry	Basic Life Lubricated
	FCC	BCP		
...J13...	FCC 12 ...	-	40	40
SS...J13...	CR FCC 12 ...	-	30	30
...J18...	FCC 20 ...	-	50	60
SS...J18...	CR FCC 20 ...	-	35	45
...J18DR...	FCC 20 ... DR	-	50	60
SS...J18DR...	CR FCC 20 ... DR	-	35	45
...J25...	FCC 25 ...	BCP 25	70	40
SS...J25...	CR FCC 25 ...	-	40	25
...J25DR...	FCC 25 ... DR	BCP 25 DR	70	45
SS...J25DR...	CR FCC 25 ... DR	-	40	35
...J34...	FCC 44 ...	BCP 44	100	70
SS...J34...	CR FCC 44 ...	-	60	50
...J34DR...	FCC 44 ... DR	BCP 44 DR	100	160
SS...J34DR...	CR FCC 44 ... DR	-	60	120
...J54...	FCC 76 ...	BCP 76	150	150
SS...J54...	CR FCC 76 ...	-	100	110
...J54DR...	FCC 76 ... DR	BCP 76 DR	150	280
SS...J54DR...	CR FCC 76 ... DR	-	100	220

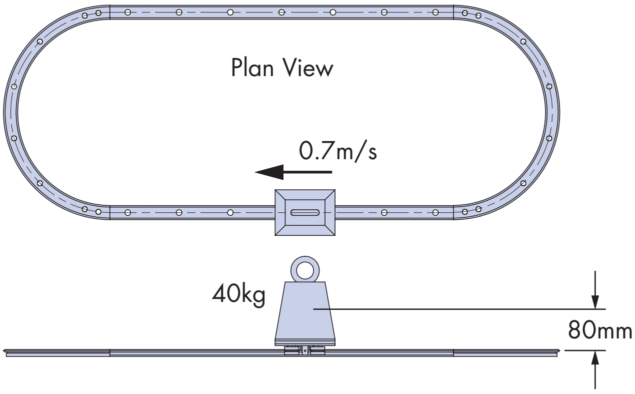
The above data assumes that steel bearings run on steel rings, and that stainless steel bearings run on stainless steel rings.

No. 3 Load Life Information

Example 1

A track system consists of: 1 x TR44 468 R180C; 1 x TNM44 B870 2 x AK; 1 x TR44 468 R180C; 1 x TNM44 B870 2 x AK; 1 x FCC 44 468 LB.

The carriage carries a weight such that the mass of the load and the carriage together is a total of 40kg whose centre of mass is over the middle of the carriage. The centre of the mass is 80mm above the slide V's. The speed of operation is 0.7m/s, and the fixed centre carriage is fitted with lubricators.



The load factor can be calculated using equation [1].

$$L_F = \frac{L_1}{L_{1(max)}} + \frac{L_2}{L_{2(max)}} + \frac{M_S}{M_{S(max)}} + \frac{M_V}{M_{V(max)}} + \frac{M}{M_{(max)}}$$

L_1 = 40kg x 9.81 m/s^2 (g) = 392.4N

L_2 = (centrifugal force see note 2 page 2) = DV^2/R

L_2 = 40kg x (0.7m/s)^2 ÷ 0.234m = 83.7N

M_S = L2 x 0.08m = 83.7 x 0.08m = 6.7Nm

M_V = M = 0

The values for $L_{1(max)}$, $L_{2(max)}$ and $M_{s(max)}$ can be taken directly from the table on 📖 1;

For a FCC 44 468 LB

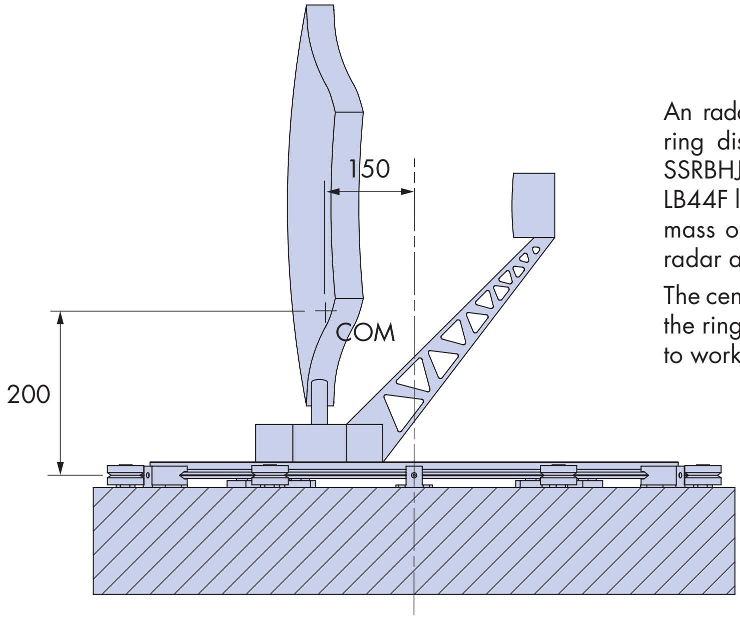
$L_{1(max)}$ = 3200N
$L_{2(max)}$ = 2800N
$M_{s(max)}$ = 64Nm

$$L_F = \frac{392.4}{3200} + \frac{83.7}{2800} + \frac{6.7}{64} = 0.2572$$

The basic life for this system (FCC 44 468 LB includes ...J34.. bearings and is lubricated) is taken for the table on 📖 3 - this is 70km. The system life a calculated using equation [4].

$$\text{System life (km)} = \frac{B_L}{(0.03 + 0.97L_F)^3} = \frac{70}{(0.03 + 0.97\text{x } 0.2572)^3} = 3206 \text{ km}$$

Example 2



An radar antenna is mounted on a HepcoMotion SSRD44 468 L P ring disc, which rotates in 2 off SSRBHJ34CDRNSCHK & 4 off SSRBHJ34EDRNSCHK bearings. The system is lubricated with 6 off LB44F lubricators. The radar antenna rotates once a second and the mass of the rotating assembly (which includes the ring, base and radar antenna) is 15kg.

The centre of mass (COM) of the assembly is 150mm from the axis of the ring disc and 200mm above the ring V's. The system is required to work on average 36 hours per week.

The load factor can be calculated using equation 2.

$$L_F = \frac{L_A}{L_{A(max)}} + \frac{L_R}{L_{R(max)}} + \frac{M}{M_{(max)}}$$

L_A = 15kg x 9.81m/s^2 (g) = 147.15N
Speed of the centre of mass: 1 rev/sec = 2 x π x 0.15m x 1 = 0.942m/s
$L_R = DV^2/R$ = 15kg x (0.942m/s)^2 ÷ 0.15m = 88.826N
M = L_R x h + L_A x R= 88.826N x 0.2m + 147.15N x 0.15m = 39.84Nm

The values for $L_{A(max)}$, $L_{R(max)}$ & $M_{(max)}$ can be calculated for the data in table on 📖 2.

$L_{A(max)}$ = 3340N + 2 x 640N = 4620N
$L_{R(max)}$ = 3000N + 2 x 750N = 4500N
$M_{(max)}$ = (780 + 2 x 135) x 0.5085m (Øc from page 3) = 533.925Nm

$$L_F = \frac{147.15}{4620} + \frac{88.826}{4500} + \frac{39.84}{533.925} = 0.126$$

The basic life for this system SSBHJR34DR.. lubricated bearings can be taken for the table on 📖 3 - this is 120km. The system life a calculated using equation [4].

$$\text{System life (km)} = \frac{B_L}{(0.03 + 0.97L_F)^3} = \frac{120}{(0.03 + 0.97\text{x } 0.126)^3} = 33890 \text{ km}$$

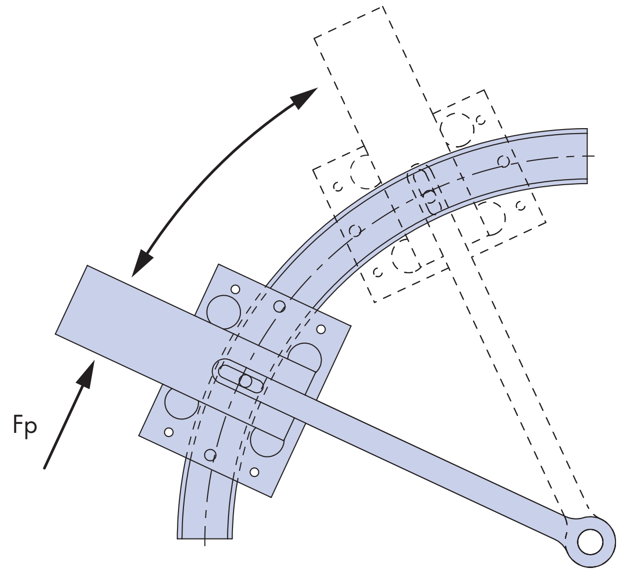
To determine the life of the system in years; 1 revolution = 0.5085m x π = 1.5975m. Each week the system runs for 3600rev/hour x 36 hours = 207km. System life = 33890 ÷ 207 = 163.7 weeks = 3.15 years.

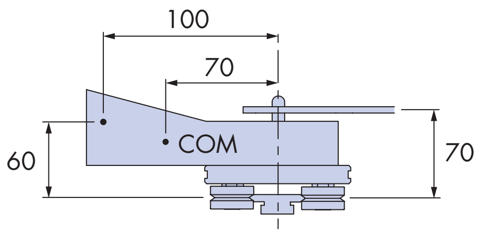
Example 3

A feeding mechanism incorporates an R44 612 R90 double edge ring segment and FCC 44 612 LB DR CHK fixed centre carriage. This mechanism has a paddle which pushes components onto a conveyor via a curved path. The pusher is powered by a rotary actuator which engages on a pin on the centre of the carriage plate, 70mm above the centre line of the V's. The mass of the carriage assembly is 15kg and the centre of mass is 70mm from the centre of the carriage.

When the mechanism is pushing products onto the conveyor, the pushing force Fp is 300N which acts 100mm from the centre of the carriage and at a height of 60mm from the centre of the V's. The length of travel is 150mm and the system is lubricated by the lubricators fitted to the fixed centre carriage.

The application is slow speed and low acceleration, so the centrifugal and inertia forces can be ignored for the calculations.





The load factor can be calculated using equation [1].

$$L_F = \frac{L_1}{L_{1(max)}} + \frac{L_2}{L_{2(max)}} + \frac{M_S}{M_{S(max)}} + \frac{M_V}{M_{V(max)}} + \frac{M}{M_{(max)}}$$

L_1 = 15kg x 9.81 m/s^2 (g) = 147.15N
L_2 = 0
The reaction force on the carriage pin = F_p x mechanical advantage
= F_p x paddle force radius ÷ carriage reaction force radius
= F_p x [(306mm + 100mm) ÷ 306mm] = 300N x 1.327 = 398N
M = 398N x 0.07m - 300N x 0.06m = 9.86Nm
M_V = 300N x 0.1m = 30Nm
M_S = 147.15N x 0.07m = 10.3Nm

The values for $L_{1(max)}$, $M_{s(max)}$, $M_{v(max)}$ and $M_{(max)}$ can be taken directly from the table on 📖 1;
For a FCC 44 612 LB DR

$L_{1(max)}$ = 3600N　　$M_{s(max)}$ = 73Nm
$M_{v(max)}$ = 220Nm　　$M_{(max)}$ = 130 Nm

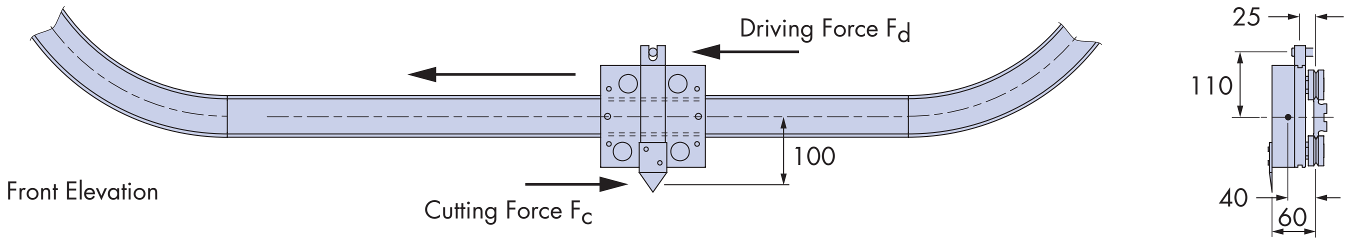
$$L_F = \frac{147.15}{3600} + \frac{9.86}{130} + \frac{30}{220} + \frac{10.3}{73} = 0.3942$$

The basic life for this system (FCC 44 612 LB DR includes ...J34DR.. bearings and is lubricated) is taken for the table on 📖 3 - this is 160km. The system life a calculated using equation [4].

$$\text{System life (km)} = \frac{B_L}{(0.03 + 0.97L_F)^3} = \frac{160}{(0.03 + 0.97x\,0.3942)^3} = 2282 \text{ km}$$

The linear travel of this application is 150mm which is less than 5 times the bearing outside diameter (5 x ø34 = 170mm, see note 3, on 📖 3). The system life should therefore be based on 170mm per stroke; 2281km ÷ 170mm ≈ 13.4 million strokes

Example 4



A textile cutting machine uses a HepcoMotion double edge track system consisting of 1 x TR76 799 R180 C; 1 x TNL 76 B2040 - 2 x AK; 1 x TR76 799 R180 C; 1 x TNL76 B2040 - 2 x AK and 1 x FCC 76 799 LB. The fixed centre carriage carries a knife which experiences a resistance force of 250N at a distance of 100mm from the carriage centre, and the blade is offset by 60mm from the centreline of the V's. The carriage is driven by a timing belt which engages a pin in a yoke on the side of the carriage. The line of force is offset by 110mm from the carriage centre. The carriage and knife assembly weighs 20kg and travels at 1m/s. The knife only cuts while the carriage is on the lower of the two straight slide of the track system.

The load factor can be calculated using equation 1.

$$L_F = \frac{L_1}{L_{1(max)}} + \frac{L_2}{L_{2(max)}} + \frac{M_S}{M_{S(max)}} + \frac{M_V}{M_{V(max)}} + \frac{M}{M_{(max)}}$$

$L_1 = 0$
$L_2 = 20kg \times 9.81m/s^2\ (g) = 196.2N$
The friction within the system is negligible therefore, the drive force (F_d) will equal the cutting force (F_c); both equal 250N
$M = Fc \times 0.06m - Fd \times 0.025m = 250 \times 0.06 - 250 \times 0.025 = 8.75Nm$
$M_V = Fc \times 0.1m + Fd \times 0.11m = 250 \times 0.1 + 250 \times 0.11 = 52.5Nm$
$M_S = 196.2 \times 0.04 = 7.848Nm$

The values for $L_{2(max)}$, $M_{s(max)}$, $M_{v(max)}$ and $M_{(max)}$ can be taken directly from the table on 📖 1;
For a FCC 76 799 LB

$L_{2(max)} = 6400N$ $M_{s(max)} = 250Nm$
$M_{v(max)} = 300Nm$ $M_{(max)} = 340Nm$

$$L_F = \frac{196.2}{6400} + \frac{7.848}{250} + \frac{52.5}{300} + \frac{8.75}{340} = 0.2628$$

The basic life for this system (FCC 76 799 LB includes ...J54... bearings and is lubricated) is taken for the table on 📖 3 - this is 150km. The system life a calculated using equation [4].

$$\text{System life (km)} = \frac{B_L}{(0.03 + 0.97L_F)^3} = \frac{150}{(0.03 + 0.97 \times 0.2628)^3} = 6486 \text{ km}$$

On the double edge ring segments of the track system there is no cutting force and the driving force will be small, but there will be a centrifugal force = $DV^2/R = 20kg \times 1^2 / 0.3995 = 50.06N$ plus the weight of the carriage. On the top straight slide there is only the carriage weight acting. The worst case loading anywhere in the system other than on the lower straight slide occurs on the bottom of the ring segments of the track where the various load components are as follows:

$L_1 = 0$ $L_2 = 20kg \times 9.81m/s^2 + 50.06N = 246.26N$ $M = 0$
$M_V = 0$ $M_S = 246.26N \times 0.04m = 9.85Nm$

These figures can be entered into equation [1], giving a LF figure of 0.078, applying this to equation [4], provides a System life of 127590km. The life calculations show that the expected life on the section where the cutting takes place is 20 times shorter than the return section of the track, therefore the wear on the return section can be ignored for the purposes of this life prediction.

On this basis the system life can be converted in system revolution as follows;

$6486km \div 2040mm \approx 3.1$ million circuits of the track system.

Notes

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