Advertisement

Engineering circular systems

Curved guide wheel systems move payloads through bends. Proper sizing boosts performance, simplifies assembly, and (with proper lubrication) extends life.

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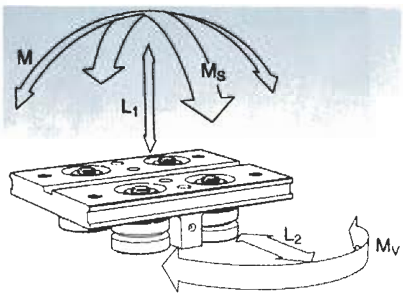
Lubrication, loads, direction, speed, and distance determine which guide component — specified in terms of size and number of bearing assemblies as well as ring size — is best for a given system load capacity and life. For longer life, systems should be designed for loads higher than those to be carried during normal operation.

For HepcoMotion's PRT Precision Ring and Track systems from Bishop-Wisecarver, we calculate system life in three steps:

❶ Resolve loading on system into direct and moment load components
❷ Obtain the system load factor L_F
❸ Apply the load factor to the appropriate nomagram to determine system life.

Load components affecting a carriage traveling on curved track are different than for rings rotating around fixed bearings — so different load factor equations are required to determine system life.

On curved track



Loading must be resolved into direct load components, and moment roll, pitch, and yaw.

Carriage capacity and life on rings, curved track

When calculating life for a curved track system, loading on the system must be resolved into direct load components L_1 (axial loads parallel to bearing shaft) and L_2 (radial loads perpendicular to bearing shaft), and three moment load components: M_S (roll), M (pitch), and M_V (yaw). Centrifugal force affects L_2 and M_S, because it moves in a radial direction, a force spiraling away from the moving-object center of mass (*COM*).

COM force is calculated $F = DV^2/R$, where V is COM velocity (in m/sec), R its distance from the ring axis (in m), and D its mass. F is in Newtons. Next, we obtain main load factor L_F with respect to duty cycle:

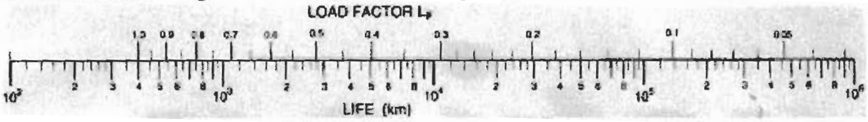
$$L_F = \frac{M}{M_{max}} + \frac{M_V}{M_{V\,max}} + \frac{M_S}{M_{S\,max}} \ldots$$

$$\ldots + \frac{L_1}{L_{1\,max}} + \frac{L_2}{L_{2\,max}}$$

where maximum load capacities are obtained from the system manufacturer. Then, the direct and mo-

Bearing Assembly Size	Used with Ring Part Number	Number of Bearing Assemblies Equally Spaced	Maximum Lubricated Load Capacity			Maximum Unlubricated Load Capacity		
			L_1 (N)	L_2 (N)	M (Nm)	L_1 (N)	L_2 (N)	M (Nm)
[illegible]	R12-93 R12-127	3	[illegible]	52	[illegible]	[illegible]	34	[illegible]
		4	113	[illegible]	[illegible]	75	40	[illegible]
		Each Additional 1	25	15	[illegible]	5	3	[illegible]
[illegible]	R25-159 R25-255 R25-351	3	[illegible]	350	[illegible]	[illegible]	125	[illegible]
		4	750	400	[illegible]	[illegible]	[illegible]	[illegible]
		Each Additional 1	[illegible]	100	[illegible]	18	12	[illegible]

Load/life nomogram for lubricated systems



ment loads of the track components and type of carriage must also be identified.

Capacity and life for rotating ring systems

In applications where a ring rotates around fixed bearings, assemblies should be equally spaced around the ring. (Where bearing assemblies rotate *with* load, assemblies can be spaced unequally.) Loading must be resolved into the two direct-load components (axial loads parallel to the ring axis L_A and radial loads perpendicular to it L_R) and the roll moment load component M.

As with carriages on curved track, centrifugal force affects factors L_R and M. Here, the main load factor L_F is:

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

Assume we have one 360° ring with a 25-mm cross-section (and 351-mm diameter) that rotates along six RLJ-25 fixed bearing assemblies. Also assume that the ring rotates once per second, has five lubricators, and that:

• Rotating assembly (ring, platform, payload) is 8 kg • COM is 100 mm from the ring axis, and 150 mm above the ring Vs • Duty cycle is 36 hours per week. Axial, radial, and moment loads are then resolved:

Axial load: L_A = 8 kg × 9.81 m/sec^2(g) = 78.5 N

Center of mass speed: 1 rev/sec = 2 × π × 0.10 m × 1 = 0.63 m/sec

Radial load: $L_R = DV^2/R$ = 8 kg × (0.63 m/sec)^2 ÷ 0.10 m = 31.8 N

Moment load: $M = L_R$ × h = *31.8 N* × *0.15 m* = 4.77 Nm

From Table 1: $M_{\max}$ = *(187 + 2 × 37)* × *Øc* = *261* × *(0.351 + 0.020)* = 96.8 Nm

$L_{A\max}$ = *750* + *2* × *150* = 1,050 N

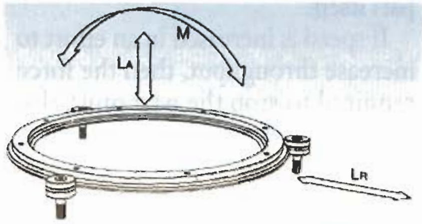
$L_{R\max}$ = *400* + *2* × *100* = 600 N.

Load capacity tables give corresponding direct and moment loads.

To obtain linear life, a 0.177 life factor value (calculated with the above equation) is entered into a load/life nomogram (shown above) for lubricated systems. The factor 0.177 corresponds to 39,000 km on the nomagram, which predicts system life in kilometers traveled.

For more information, visit bwc.com.

On rotating ring



Loading must be resolved into the two direct-load components and a roll moment component.

About carriage types

There are two common carriage types for ring or curved-track guide wheel systems. Properly specified, they can move bidirectionally. Fixed-center carriages are typical for track systems of common bend radii without *S* bends, ring slide tracks, and segment tracks. Bogie carriages accommodate *S* bends and varying radii and (because of wide bearing spacing) they improve stability. A bogie carriage swivels on a self-lubricating axial/radial bearing with adjustable preload, for traversing straight and curved track joints without the clearance seen in fixed-center carriages.

Fixed-center carriage geometry enables traversal from straight to curve track section, allowing each pair of bearings to follow slides independently. Where bearing assemblies traverse straight and curved track joints, there's a small amount of play — but it usually doesn't affect system operation.