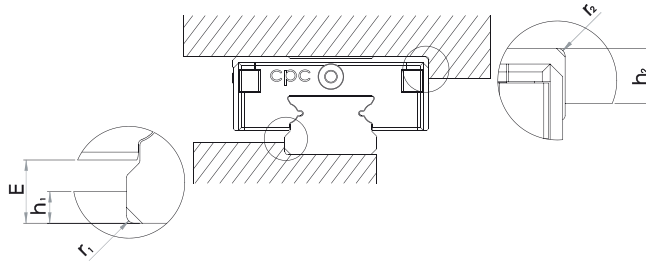# Installation Instructions

Height and Chamfer of Reference Edge

To avoid interference, the corner of the reference edge should have a chamfer. If not, please refer to the following table for the height of the reference edge corner and the height of the reference edge.

Height and chamfer of the reference surface

Size	h2	r2max	r1max	SS		ZUE	
				h1	E	h1	E
3M	1.5	0.3	0.1	0.8	1	-	-
5M	1.9	0.3	0.2	1.1	1.3	0.7	1.0
7M	2.8	0.3	0.2	1.2	1.4	-	-
9M	3	0.3	0.2	1.8	2.1	1.1	1.5
12M	4	0.5	0.3	2.6	2.9	1.7	2.1
15M	4.5	0.5	0.3	3.6	3.9	2.4	2.9

Size	h2	r2max	r1max	SS		ZUE	
				h1	E	h1	E
2WL	1.5	0.3	0.1	0.6	0.8	0.4	0.6
3W	1.7	0.3	0.1	0.4	0.6	-	-
5W	2	0.3	0.2	1.2	1.4	-	-
7W	2.8	0.3	0.2	1.7	1.9	1.1	1.4
9W	3	0.3	0.2	3	3.3	2.2	2.6
12W	4	0.5	0.3	3.5	3.7	2.4	2.8
15W	4.5	0.5	0.3	3.5	3.7	2.4	2.8

Screw tightening torque (Nm)

Screw grade 12.9 Alloy Steel Screw	Steel	Cast Iron	Non Iron Metal
M2	0.6	0.4	0.3
M2.5/M2.6	1.2	0.8	0.6
M3	1.8	1.3	1
M4	4	2.5	2

SO 3506-1 A2-70 Stainless Screw	Cast Iron
M1.6	0.15
M2	0.3
M2.5/M2.6	0.6
M3	1.1
M4	2.5

The mounting surface

The mounting surface should be ground or fine milled to reach a surface roughness of Ra1.6 µm.
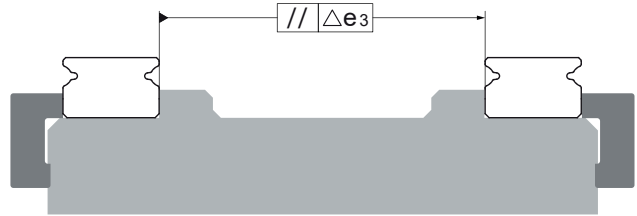
Geometric and Positional Accuracy of the Mounting Surface

Inaccurate mounting surfaces will affect the operational accuracy of the linear guide when the mounting surface height differential is greater than the values calculated by formulas (15), (16), and (17). The rating lifetime will also be shortened.

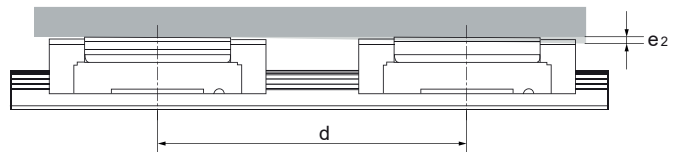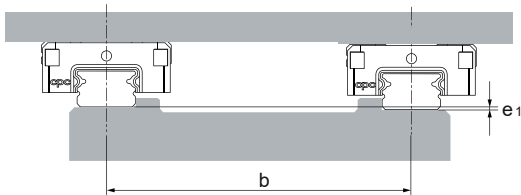$$e1 \text{ (mm)} = b \text{ (mm)} \cdot f1 \cdot 10^{-4} \quad \underline{\quad}(15)$$

$$e2 \text{ (mm)} = d \text{ (mm)} \cdot f2 \cdot 10^{-4} \quad \underline{\quad}(16)$$

$$e3 \text{ (mm)} = f3 \cdot 10^{-3} \quad \underline{\quad}(17)$$

Reference Edge

Rail: Both sides of the track rail can serve as the reference edge without any special marking. Block: Reference edge is opposite to the groove marking side.
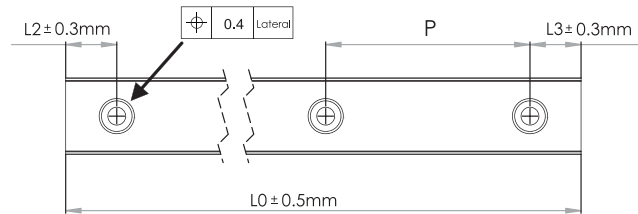
Size	V0/VS			V1		
	f1	f2	f3	f1	f2	f3
3MN	4	9	2	3	9	1
5MN	4	8	2	2	8	2
7MN	5	11	4	3	10	3
9MN	5	11	6	4	10	4
12MN	6	13	8	4	12	6
15MN	7	11	12	5	10	8
3ML	4	5	2	3	5	1
5ML	3	5	2	2	5	1
7ML	4	6	4	3	6	3
9ML	5	7	5	3	7	4
12ML	5	8	8	3	7	5
15ML	7	8	11	4	8	7

Size	2V0/VS			V1		
	f1	f2	f3	f1	f2	f3
2WL	4	5	2	3	5	1
3WN	2	5	2	4	3	1
5WN	2	5	2	1	3	1
7WN	2	6	4	2	4	3
9WN	2	7	6	2	5	4
12WN	3	8	8	2	5	5
15WN	2	9	11	1	6	7
3WL	2	3	1	1	2	1
5WL	2	3	2	1	2	1
7WL	2	4	4	1	3	3
9WL	2	5	5	2	3	3
12WL	2	5	7	2	3	5
15WL	2	5	10	1	4	7

Length of Rail

Butt-jointing is required when lengths exceed Lmax. For more detailed information, please contact Rollco technical support.

Standard Type

Size	Standard length of one rail	Pitch	L2, L3 min.	L2, L3 max.	L0 max.
3M	30 / 40 / 50	10	3	5	300
5M	40 / 55 / 70 / 85 / 100	15	3	10	1000
7M	Cut to length	15	3	10	1000
9M	Cut to length	20	4	20	1000
12M	Cut to length	25	4	20	1000
15M	Cut to length	40	4	35	1000

Wide Type

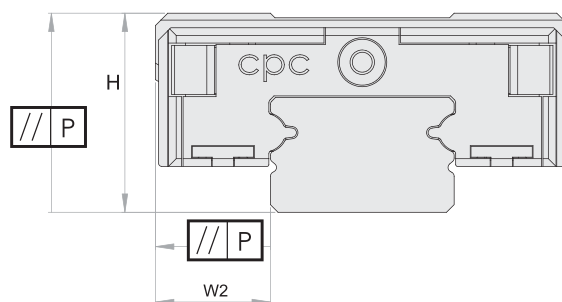| Size	Standard length of one rail	Pitch	L2, L3 min.	L2, L3 max.	L0 max.
2W	30 / 40 / 50	10	3	5	300
3W	40 / 55 / 70	15	3	10	1000
5W	Cut to length	20	4	15	1000
7W	Cut to length	30	3	25	1000
9W	Cut to length	30	4	25	1000
12W	Cut to length	40	4	35	1000
15W	Cut to length	40	4	35	1000

Precision

Accuracy

MR miniature linear guide series have three accuracy grades (P,H,N) for your choice.

Accuracy grades (μm)

		Precision P	High H	Normal N
Admissible height H dimension Tolerance	H	± 10	± 20	± 40
Height variation for different runner blocks on the same rail position	ΔH	7	15	25
Admissible width W dimension tolerance	W2	± 15	± 25	± 40
Width variation for different runner blocks on the same rail position	ΔW2	10	20	30

Speed

The maximum speed for the standard MR-SS type is:
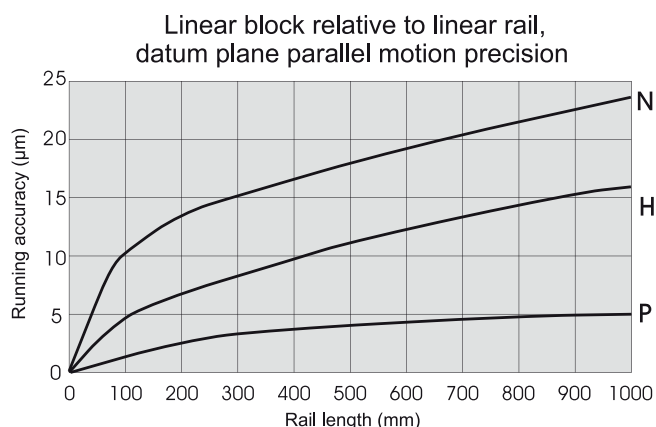**Vmax = 3 m/s**

Maximum acceleration:
αmax = 250 m/s²

(If preload is at V0, capability of reaching 40m/s²)

The maximum speed for the standard MR-ZUE type is:
Vmax = 5 m/s

Maximum acceleration **αmax = 300 m/s²**
(If preload is at V0, capable of reaching 60m/s²)

Linear block relative to linear rail,
datum plane parallel motion precision

Preload

The MR Miniature Linear Guide series has three degrees of preload capacity: V0, VS and V1 (as described in the preload table below). Appropriate preload levels can enhance the stiffness, precision, and torsion resistance performance of the linear guide. But an inappropriate application thereof can also negatively affect the product life and its motional resistance levels.

Preload type	Model code	Clearance (μm)						Application
		3	5	7	9	12	15	
Clearance	V0	+3 – 0	+3 – 0	+4 – 0	+4 – 0	+5 – 0	+6 – 0	Very smooth
Standard	VS	+1 – 0	+1 – 0	+2 – 0	+2 – 0	+2 – 0	+3 – 0	Smooth and high precision
Light preload	V1	0 – -0.5	0 – -1	0 – -3	0 – -4	0 – -5	0 – -6	High rigidity Minimizes vibration High precision Load balance

Operating Temperature

The MR Miniature Linear Guide can operate in a range of temperatures from -40°C~ + 80°C. For short term operation, it can reach up to +100°C.

Lubrication

Function

When operating the linear guide under sufficient lubrication conditions, a one-micron layer of oil forms at the contact zone, separating the loaded rolling components and the raceway.

Sufficient lubrication will:

- Reduce friction
- Reduce wear
- Reduce corrosion
  Dissipate heat and increase service life

Lubrication Caution

- ZUE Lubrication Storage block

  1. The block already contains lubricants which can be directly installed on the machine, without the need for additional washing.

  2. When first washing the blocks, please do not soak them in the lubricant before both the detergent and cleaning naphtha within are totally dry. The block is ready for installation only after the lubrication storage is full of the lubricant.

- The linear guide must be lubricated for protection before first time use. Contaminants of any kind, weather liquid or solid, should be avoided.
- The runner block should be moved back and forth during lubrication.
- The lubricant can be added either manually or automatically directly onto the rail raceway.
- The lubricant can be injected into the lubrication holes on either end of the runner block.
- A thin layer of observable lubricant should be maintained on the surface of the rail .
- Re-lubrication must be completed before contamination or discoloration of the lubricant occurs.
- Please notify us if product is intended for use in acidic, alkaline, or clean room applications.
- Please contact Rollco technical department for lubrication assistance if the runner block is intended for use in a wall mount configuration.
- The re-lubrication interval must be shortened if the travel stroke is < 2 or > 15 times the length of the steel body of the runner block.

Grease Lubrication

When grease lubrication is applied, we recommend synthetic oil-based lithium soap grease with a viscosity between ISO VG32-100.

Oil Lubrication

For oil lubrication, we recommend synthetic oils CLP, CGLP (based on DIN 51517) or HLP (based on DIN 51524) with a viscosity range of between ISO VG32-100 and a working temperature range between 0°C~+70°C. We recommend ISO VG10 for use in lower temperature environments.

Re-lubrication

- Re-lubrication shall be applied before the lubricant in the block is contaminated or changes color.
- The amount of the lubricant applied should be 1/2 of the first lubrication. When applying lubricant, this should be done until it seeps out from the device.
- Re-lubrication shall be applied under steady operating temperature, with the runner block moved back and forth throughout for optimum distribution.
- If the stroke is smaller than twice or greater than 15 times the steel body length of the block, the re-lubrication interval shall be shortened.

Model code	First lubrication (cm³)	Model code	First lubrication (cm³)
-	-	2 WL	0.03
3 MN	0.02	3 WN	0.03
3 ML	0.03	3 WL	0.04
5 MN	0.03	5 WN	0.04
5 ML	0.04	5 WL	0.05
7 MN	0.12	7 WN	0.19
7 ML	0.16	7 WL	0.23
9 MN	0.23	9 WN	0.30
9 ML	0.30	9 WL	0.38
12 MN	0.41	12 WN	0.52
12 ML	0.51	12 WL	0.66
15 MN	0.78	15 WN	0.87
15 ML	1.05	15 WL	1.11

Re-lubrication Interval

The re-lubrication interval depends on individual use, as the speed, load, stroke length and operating environment are all factors. Careful observation of rails and blocks is the basis to determine the optimal re-lubrication interval; as a rule of thumb, re-lubricate at least once per year. Do not apply water-based coolant liquid on the linear rails or slide. Inject lubricant through injection holes on both ends of the runner block with the recommended cpc brand injector.

Lubrication Grease

00   For general applications
01   For low-friction, low-noise applications
02   For clean room applications
03   For clean room and vacuum environment applications
04   For high-speed applications
05   For micro-oscillation applications

Lubrication Oil

11   For general applications, ISO V32-68

Lubricant amount: 10ml

Friction

The MR Miniature Linear Guide Series has low-friction characteristics with a stable and minor starting friction.

Sealing Design

The MR Miniature Linear Guide Series are enclosed by end seals on both ends of the runner block. Optional side seals can also create an all-around sealing system.

MR size	Friction of end seal under lubrication		Friction
	M	W	
2	0.08	0.2	
3	0.08	0.2	$F_{rn} = \mu \cdot F$ _____(1)
5	0.08	0.2	F Load (N)
7	0.1	0.4	F_{rn} Friction (N)
9	0.1	0.8	
12	0.4	1.0	The MR Miniature Linear Guide Series friction factor is app $\mu = 0.002\!\sim\!0.003$
15	1.0	1.0	

Friction Factors

- Sealing system.
- Collision between the balls during operation.
- Collision between the balls and the return path.
- Number of balls in the gothic arch load zone.
- Resistance from lubricant to ball pressure.
- Resistance caused by contaminants.

Load Capacity and Rating Life

Static Load Rating C_0

Measuring the static load of the travel force along the acting direction, the maximum stress between the rolling balls and raceway is as follows:

If the curvature radius is lower or equal to 0.52: 4200 MP
If the curvature radius is equal or higher to 0.6: 4600 MP

Note: Under maximum stress levels, a permanent deformation will be generated at the contact point. This corresponds roughly to about 0.0001 times the rolling element diameter. (The above is according to ISO 14728-2)

Static load safety factor calculation		
Operation condition	S_0	$S_0 = C_0 / P_0$ _____(11)
Normal operation	1 – 2	$S_0 = M_0 / M$ _____(12)
Load with vibration or impact	2 – 3	$P_0 = F_{max}$ _____(13)
High accuracy and smooth running	≥ 3	$M_0 = M_{max}$ _____(14)

Static Load P_0 and Moment M_0

The permissible static and applied static load of the MR Miniature Linear Guide Series is limited by:

- The static load of the linear guide.
- The permissible load of fixed screws.
- The permissible load for the connected parts of the mechanism.
- The static load safety factor required for the application.

The equivalent static load and static torque are the largest load and torque, please consult with formulas (13) and (14).

Static Load Safety Factor S_0

In order for the linear bearing to permanently withstand potential deformation while delivering a guaranteed accuracy and reliable motion, the static load safety factor should be calculated with formulas (11) and (12).

S_0 static load safety factor
C_0 basic static load in acting direction N
P_0 equivalent static load in acting direction N
M_0 basic static moment in acting direction Nm
M equivalent static moment in acting direction Nm

Dynamic Load Rating C_{100B}

For constant sized and directional loads, when the linear bearing is under such a load, the rating life of a linear guide can reach a theoretical travel distance of 100km. (The above is according to ISO 14728-1.)

Rating life calculation		

$C_{50B} = 1.26 \cdot C_{100B}$ ____(2)	L = rating life for 100,000 meter travel distance	(m)
$C_{100B} = 0.79 \cdot C_{50B}$ ____(3)	L_h = rating life in hours	(h)
	C_{100B} = dynamic load rating	(N)
$L = \left(\dfrac{C_{100B}}{P}\right)^3 \cdot 10^5$ ____(4)	P = equivalent load	(N)
	s = length of stroke	(m)
$L_h = \left(\dfrac{L}{2 \cdot s \cdot n \cdot 60}\right) = \left(\dfrac{L}{v_m \cdot 60}\right)$ ____(5)	n = stroke repetition	(min^{-1})
	v_m = average speed	(m/min)

Rating Life L

90% survival rate for an individual linear guide or a batch of identical linear guides in standard product material and operation conditions is calculated as above (according to ISO 14728-1 standards). When using the 50km travel standard, the dynamic load rating will exceed the ISO 14728-1 standard value by 20% or more. Formula (2) describes the relationship between the two load ratings.

Calculation of Rating Life

Formulas (4) and (5) can be used when the equivalent dynamic load and the average speeds are constant.

Equivalent Dynamic Load and Speed

If the load and speed are not constant, it is important to take into account the actual load and speed as both will influence life expectancy.

Equivalent Dynamic Load

If there is a change in load only, the equivalent dynamic load can be calculated according to formula (6).

Equivalent Speed

If there is a change in speed only, the equivalent speed can be calculated according to formula (7). If there are changes in both load and speed, the equivalent dynamic load can be calculated according to formula (8).

Equivalent load capacities and speed calculation

$$P = \sqrt[3]{\frac{q_1 \cdot F_1{}^3 + q_2 \cdot F_2{}^3 + \cdots + q_n \cdot F_n{}^3}{100}} \qquad (6)$$

$$\bar{v} = \frac{q_1 \cdot v_1 + q_2 \cdot v_2 + \cdots + q_n \cdot v_n}{100} \qquad (7)$$

$$P = \sqrt[3]{\frac{q_1 \cdot v_1 \cdot F_1{}^3 + q_2 \cdot v_2 \cdot F_2{}^3 + \cdots + q_n \cdot v_n \cdot F_n{}^3}{100\, \bar{v}}} \qquad (8)$$

$$P = |F_X| + |F_Y| \qquad (9)$$

$$P = |F| + |M| \cdot \frac{C_0}{M_0} \qquad (10)$$

P	=	Equivalent dynamic load	(N)
q	=	Percentage of stroke	(%)
F_1	=	Discrete load steps	(N)
$\bar{v}$	=	Average speed	(m/min)
v	=	Discrete speed steps	(m/min)
F	=	External dynamic load	N
F_Y	=	External dynamic load, vertical	N
F_X	=	External dynamic load, horizontal	N
C_0	=	Static load rating	N
M	=	Static moment	Nm
M_0	=	Static moment in direction of action	Nm

Combined Equivalent Dynamic Load

If the linear guide bears the load from arbitrary angels so that the acting force does not conform to horizontal and vertical directions, its equivalent dynamic load is calculated as shown on formula (9).

Under the Condition with the Moment

If the linear guide bears the load and the moment simultaneously, its equivalent dynamic load is calculated with formula (10). According to ISO 14728-1, when equivalent dynamic load tolerance rates below   0.5C, P   C0m, a realiable product life value can be calculated.

Single Block Bearing the Moment

For a given structure, if the block needs to bear torque moments from Mp and My directions, the maximum moment that the block can withstand while still maintain smooth running conditions measures at about 0.3-0.1 times the static moment rating. The higher the preload, the higher the loading value and vice versa.

In the case of any design questions, please contact Rollco.
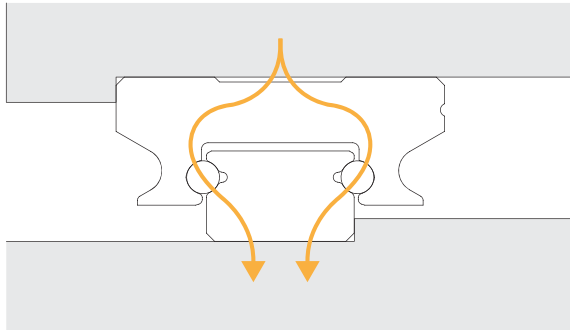
Line Chart
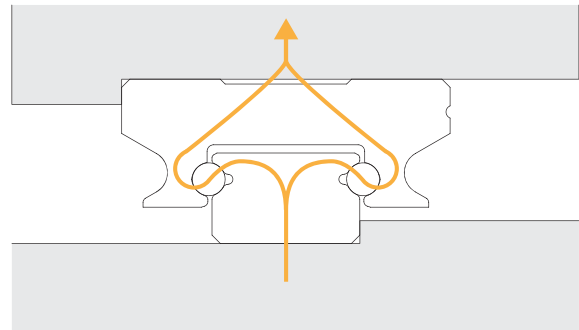
Under pressure

Figure A
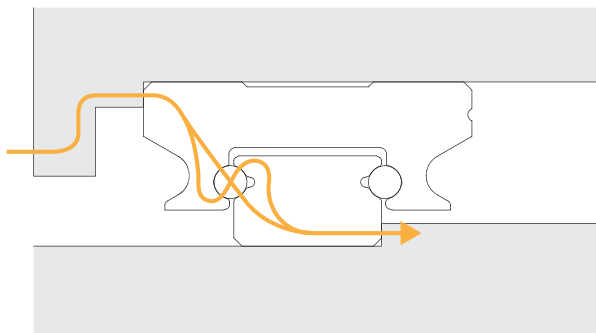
Pull up

Figure B

Lateral force 1

Figure C
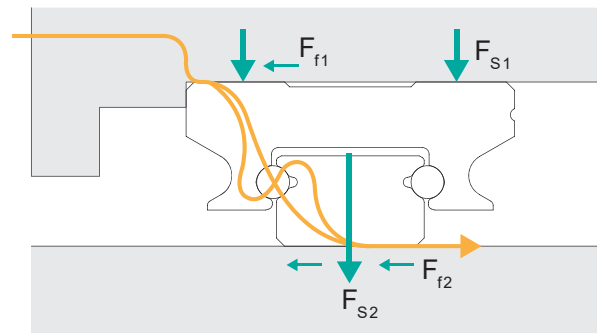
Lateral force 1

Figure D

F_{S1} 、 F_{S2} :screw fixation
F_{f1} 、 F_{f2} :frictional resistance
$F_f = F_S \bullet \mu_0$

As can be seen from the three diagrams in Figure A to Figure D, when subjected to upward, downward and lateral loads, the force flow will be distributed to the two ball transfer.
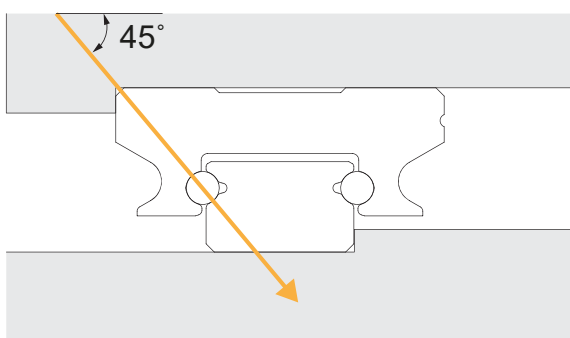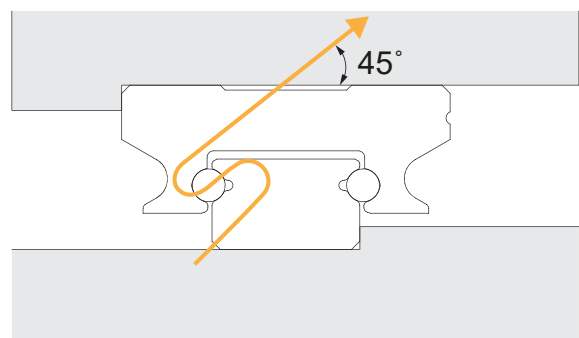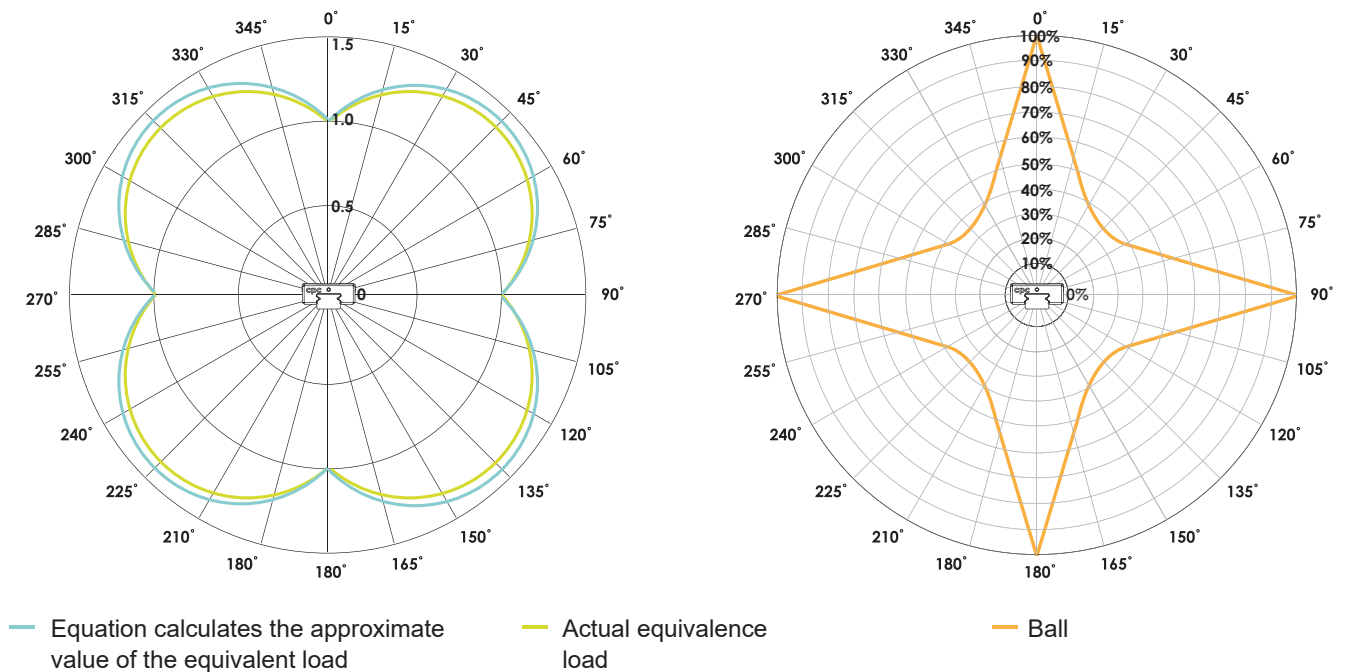

Figure E

Figure F

As shown in the two diagrams in Figures E and F, the load acting on the 45-degree angle has the greatest effect on the system's life because the transfer of force is limited to a single row of balls.

When the load is applied horizontally or vertically (0°, 90°, 180° , 270°), the equivalent load of the slide is equal to the actual load. When the load angle is 45, its equivalent load is approximately 1.414 times that of the main direction.

When the same load is at different angles, the comparison of equation and the actual equivalence load is as shown in the following figure.

Therefore, in order to increase the service life of the linear system, it should be installed in the appropriate direction to bear the load. Otherwise, the service life will be greatly reduced, as shown in the figure below. Since the relationship between life and load is as the power of formula (8), when the acceptance angle is 45°, the service life will be significantly reduced.

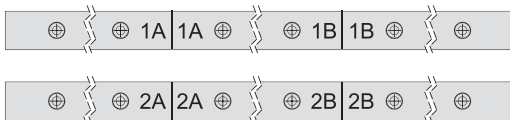The following is the life L comparison chart (in %) for different angles under the same load.

— Equation calculates the approximate value of the equivalent load

— Actual equivalence load

— Ball

Customization Requirements

The meaning of suffix characters:

J = Slide rail connection

G = Customer designated lubricant

I = With Inspection report

R = Special process for rail

B = Special processing for block

S = Special straightness requirements for rail

C3 = Cap M3

C4 = Cap M4

J: Slide rail connection

When the required length of rail exceeds the standard rail length, a butt-joint can be specified. The rail butt-joint indication is marked as illustrated below.

G: Customer designated lubricant

According to application environment.

GN: No lubricant

GC: Low dust generation

Suitable for clean room environments.

I: With Inspection report

Please contact technical support.

R: Special process for rail

For special process requirements, please contact Rollco technical support.

B: Special processing for block

For special process requirements, please contact technical support.

S: Special straightness requirements for rail

The straightness of the linear guide rail is specially calibrated by precision fine grinding.

C3: CapM3

Applies to MR9M, MR12M, MR15M, MR7W & MR9W rails.

C4: CapM4

Applies to MR12W, MR15W rails.