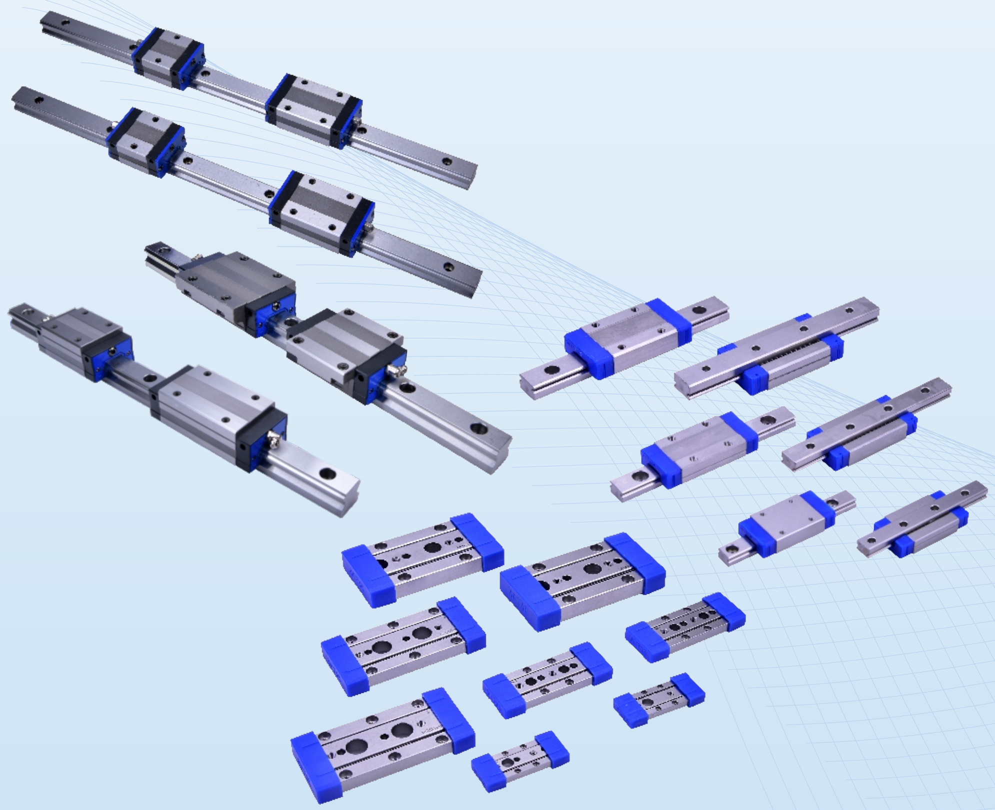
AirTAC INTERNATIONAL GROUP

BIBUS AirTAC

Lineaire Geleidingen (2022A)

- LSH Series Standard Linear Guide
- LSD Series Low Profile Type Linear Guide
- LRM Series Miniature Linear Guide
- LGC Series Crossed Roller Way



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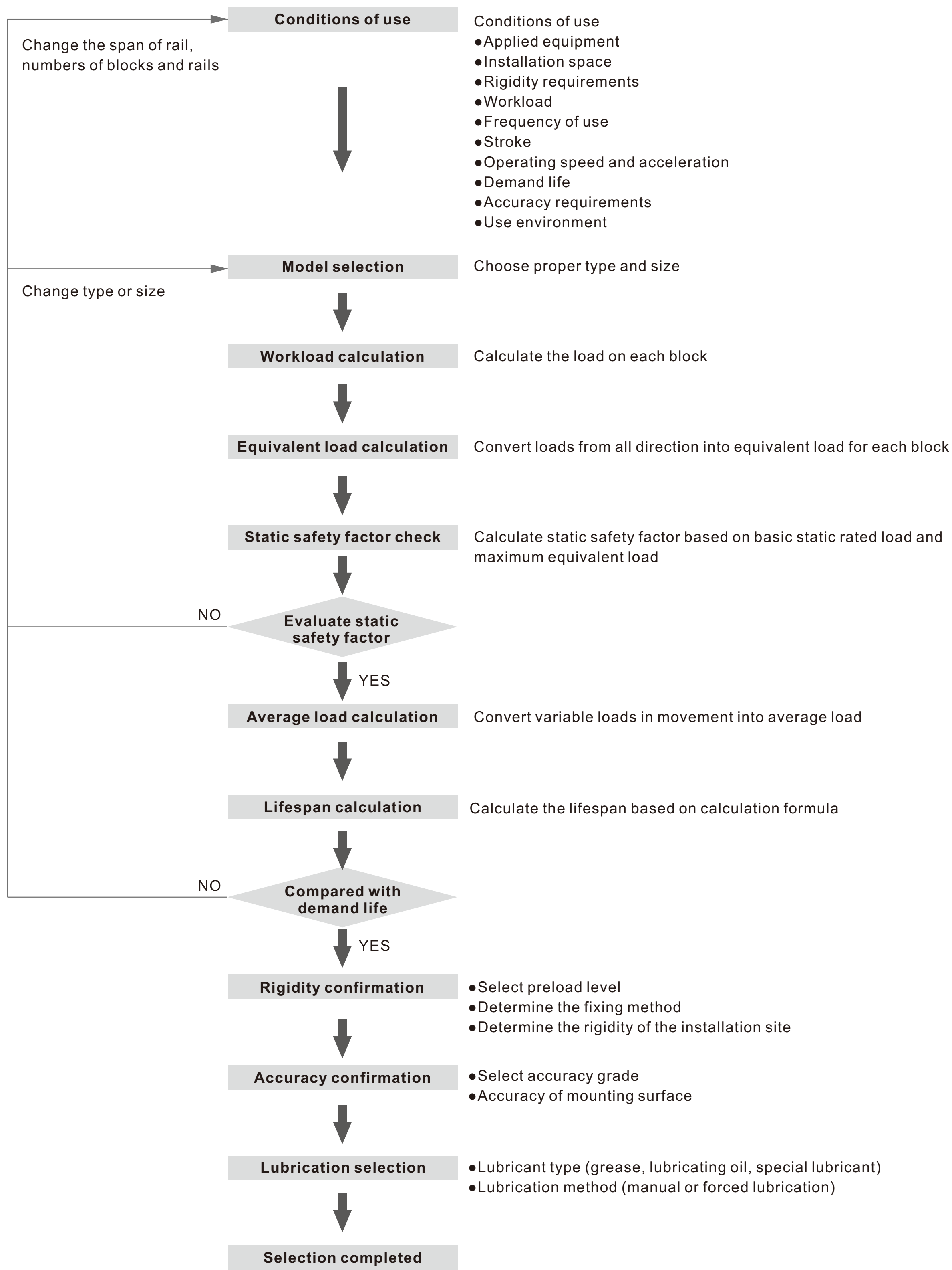
Linear Guide Selection

How to select Linear Guide



Linear Guide Selection

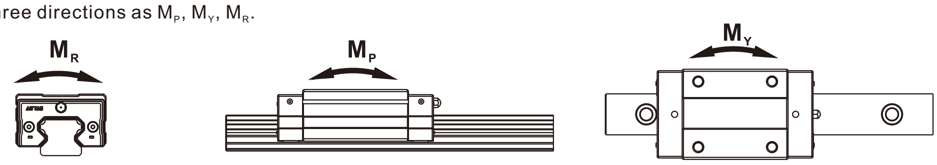
Load Capacity and Rating Life

1.Basic static load rating (C_0)

When a linear guide absorbs a large force or impact in a static or low-speed movement, it will cause permanent deformation either on rollers and groove. When sum of deformation on groove and rollers exceeds a certain limit, it will affect the smoothness of its linear movement.
Basic static load rating is defined as the magnitude of a given stress applied at where the stress is the biggest caused the sum of permanent deformation on groove and roller is 1/10000 of the diameter of the rollers.

2. Allowable static moment(M_0)

When torque is applied on a linear guide, rollers in the both ends of block will endure the major stress force.
Allowable static moment is defined as a given moment applied and raised stress force on linear guide which will cause sum of permanent deformation on groove and roller is 1/10000 of the diameter of the rollers.
Static moment is defined in three directions as M_P, M_Y, M_R.



3.Static safety factor(f_s)

During vibration, impact or sudden start and stop, the inertia force or torque will raise huge loads on linear guide. For this kind of situation, it is necessary to put static safety factor into consideration. Static safety factor is a ratio of the basic statics load rating to the calculated working load as shown in following formula. The reference of static safety factor for different conditions is shown in following table:

Use machinery	Load condition	f_s
General industrial machinery	General load conditions	1.0~1.3
	When there is vibration or shock	2.0~3.0
Machine tool	General load conditions	1.0~1.5
	When there is vibration or shock	2.5~7.0

$f_s = \frac{C_0}{P}$ or $f_s = \frac{M_0}{M}$

f_s: Static safety factor
C_0: Basic static load rating (N)
M_0: Allowable static moment (N·m)
P: Calculation load (N)
M: Calculation moment (N·m)

4.Basic dynamic load rating(C)

Basic Dynamic Load rating is defined as the maximum allowable load and can be applied on the same specification of linear guides. This will result in a nominal life of 50 KM operation for linear guide.

5.Life calculation

●**Life**

When a linear guide is with bearings loaded during operation, the groove and rollers will constantly endure stress force. Once reaching fatigue, the surface will peel off and damage. The life of a given linear guide is defined as the moving distance of a linear guide in which peeling occurs due to fatigue.

●**Nominal life**

Actual lifespan of linear guide varies enormously. The lifespan of each guide can be different even though they come from the same product batch under the same condition. Therefore, nominal life is usually chosen as bench mark to evaluate lifespan. Nominal life is defined as the moving distance for 90% of linear guides from the same production batch which can perform under the same working condition without peeling.

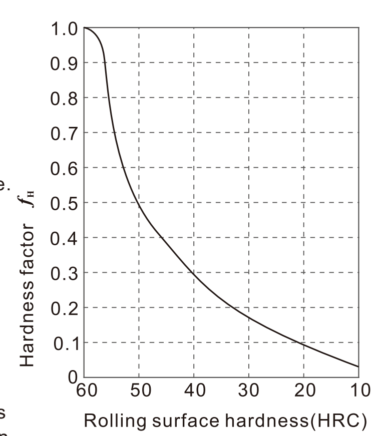
●**Life factor**

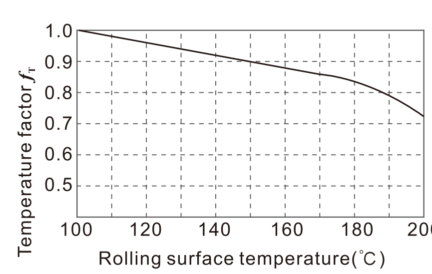
1. Hardness factor(f_H)

Surface hardness of rollers must be HRC 58~62. A softer hardness will reduce load-bearing performance and static load rating. Therefore allowable moment must be multiplied by a hardness factor as correlation shown on the right chart.
Our hardness requirement for linear guide is HRC58~62, therefore f_H = 1.0.

2. Temperature factor(f_T)

High temperature environment will affect lifespan of the linear guide. Therefore, static load rating and allowable moment must be multiplied by a temperature factor f_T as correlation shown on the right graph.
Certain parts of our linear guide are made of plastic and rubber, hence working in temperature higher than 100 is not recommended.





3. Load factor(f_w)

Although loads on a given linear guide can be calculated, it will usually come with vibration or hitting in actual use. This makes actual loads higher than calculated figure. Hence, in heavg vibration or hitting condition, please divide basic dynamic load rating (C) by following empirical load factor.

Working Conditions	Use speed	f_W
Smooth without impact	V≤15m/min	1.0~1.2
Common impact and vibration	15m/min<V≤60m/min	1.2~1.5
Moderate impact and vibration	60m/min<V≤120m/min	1.5~2.0
Strong impact and vibration	V≥120m/min	2.0~3.5

Linear Guide Selection

●**Calculation of nominal life(*L*)**

The nominal life will vary based on applied load. Hardness and working temperature will also have great effects on lifespan of a linear guide. Putting all factors into consideration, nominal life can be calculated by following formula:

$$L=\left(\frac{f_H\times f_T}{f_W}\times\frac{C}{P}\right)^3\times 50Km$$

L : Nominal life (km)
C : Basic dynamic load rating (N)
P : Workload (N)
f_w : Load factor
f_H : Hardness factor
f_T : Temperature factor

●**Calculation of service life time(L_h)**

If stroke length and repeating time are known, service life time (L_h) can be derived based on rated life (L)

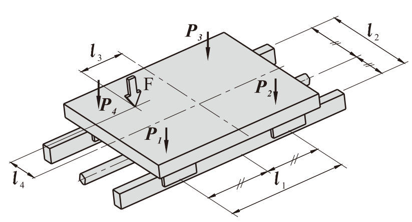
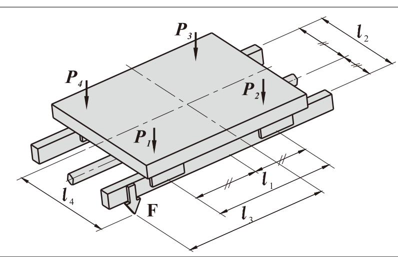
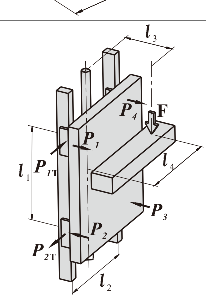
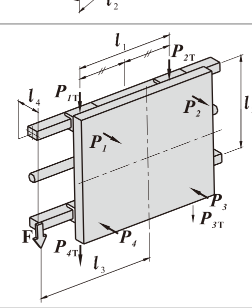
$$L_h=\frac{L\times 10^3}{2\times l_s\times n_1\times 60}$$

L_h : Service life time (hr)
L : Rated life (km)
l_s : Stroke length (m)
n_1 : Rounds per minute (min^{-1})

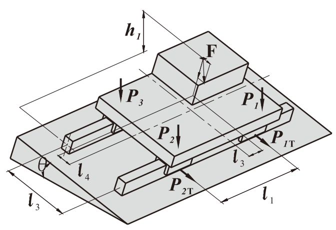
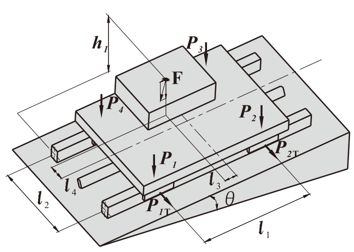
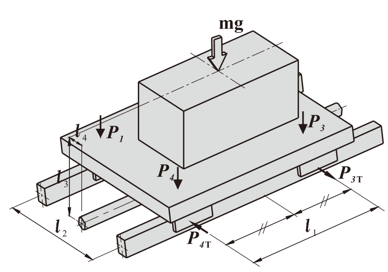
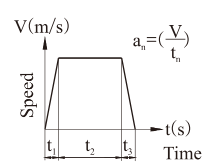
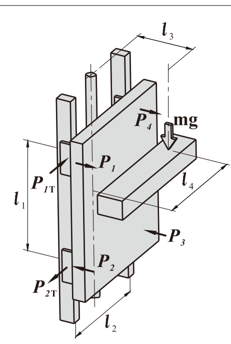
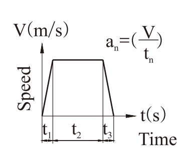
Calculation of working load

Load effect on a linear guide will be affected by its center of mass, position of thrust and inertia force occurring by acceleration when starting or stopping, etcetera. Therefore, most applications of working conditions must be put into consideration in order to acquire accurate nominal life.

Working load calculation

Type	Operation condition	Load on each block
Horizontal use uniform motion Or at rest		$P_1=\frac{F}{4}+\frac{Fl_3}{2l_1}-\frac{Fl_4}{2l_2}$ $P_2=\frac{F}{4}-\frac{Fl_3}{2l_1}-\frac{Fl_4}{2l_2}$ $P_3=\frac{F}{4}-\frac{Fl_3}{2l_1}+\frac{Fl_4}{2l_2}$ $P_4=\frac{F}{4}+\frac{Fl_3}{2l_1}+\frac{Fl_4}{2l_2}$
Horizontal cantilever use uniform motion Or at rest		$P_1=\frac{F}{4}+\frac{Fl_3}{2l_1}+\frac{Fl_4}{2l_2}$ $P_2=\frac{F}{4}-\frac{Fl_3}{2l_1}+\frac{Fl_4}{2l_2}$ $P_3=\frac{F}{4}-\frac{Fl_3}{2l_1}-\frac{Fl_4}{2l_2}$ $P_4=\frac{F}{4}+\frac{Fl_3}{2l_1}-\frac{Fl_4}{2l_2}$
Vertical use uniform motion Or at rest		$P_1=P_2=P_3=P_4=\frac{Fl_3}{2l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{Fl_4}{2l_1}$
Wall-mounted use uniform motion Or at rest		$P_1=P_2=P_3=P_4=\frac{Fl_4}{2l_2}$ $P_{1T}=P_{4T}=\frac{F}{4}+\frac{Fl_3}{2l_1}$ $P_{2T}=P_{3T}=\frac{F}{4}-\frac{Fl_3}{2l_1}$

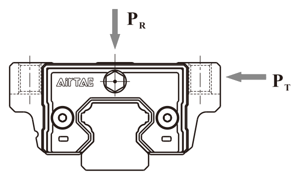
Linear Guide Selection

Type	Operation condition	Load on each block
Lateral Slope		$P_1=\frac{F\cdot cos\theta}{4}+\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}-\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}+\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_2}$ $P_2=\frac{F\cdot cos\theta}{4}-\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}-\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}+\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_2}$ $P_3=\frac{F\cdot cos\theta}{4}-\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}+\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}-\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_2}$ $P_4=\frac{F\cdot cos\theta}{4}+\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}+\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}-\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_2}$ $P_{1T}=P_{4T}=\frac{F\cdot sin\theta}{4}+\frac{F\cdot sin\theta\cdot l_3}{2\cdot l_1}$ $P_{2T}=P_{3T}=\frac{F\cdot sin\theta}{4}-\frac{F\cdot sin\theta\cdot l_3}{2\cdot l_1}$
Axial Slope		$P_1=\frac{F\cdot cos\theta}{4}+\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}-\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}+\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_1}$ $P_2=\frac{F\cdot cos\theta}{4}-\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}-\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}-\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_1}$ $P_3=\frac{F\cdot cos\theta}{4}-\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}+\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}-\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_1}$ $P_4=\frac{F\cdot cos\theta}{4}+\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}+\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}+\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_1}$ $P_{1T}=P_{4T}=+\frac{F\cdot sin\theta\cdot l_4}{2\cdot l_1}$ $P_{2T}=P_{3T}=-\frac{F\cdot sin\theta\cdot l_4}{2\cdot l_1}$
Use horizontally with inertial force	  Speed-time graph	When accelerating $P_1=P_4=\frac{mg}{4}-\frac{m\cdot a_1\cdot l_3}{2\cdot l_1}$ $P_2=P_3=\frac{mg}{4}+\frac{m\cdot a_1\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{m\cdot a_1\cdot l_4}{2\cdot l_1}$ When decelerating $P_1=P_4=\frac{mg}{4}+\frac{m\cdot a_3\cdot l_3}{2\cdot l_1}$ $P_2=P_3=\frac{mg}{4}-\frac{m\cdot a_3\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{m\cdot a_3\cdot l_4}{2\cdot l_1}$ At constant speed $P_1=P_2=P_3=P_4=\frac{mg}{4}$
Use Vertically with inertial force	  Speed-time graph	When accelerating $P_1=P_2=P_3=P_4=\frac{m\cdot(g+a_1)\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{m\cdot(g+a_1)\cdot l_4}{2\cdot l_1}$ When decelerating $P_1=P_2=P_3=P_4=\frac{m\cdot(g-a_3)\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{m\cdot(g-a_3)\cdot l_4}{2\cdot l_1}$ At constant speed $P_1=P_2=P_3=P_4=\frac{mg\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{mg\cdot l_4}{2\cdot l_1}$

Linear Guide Selection

Calculation of equivalent load

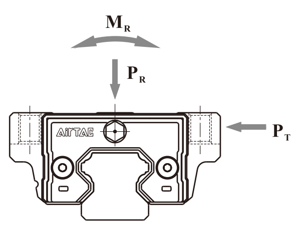
A block can bear force as well as torque from all axial and radial directions. When multiple loads are applied, these loads can be combined as an equivalent axial and radial load for the calculation of nominal life or static safety factor.
Our linear guide can bear loads in four directions, up, down, left, and right. So when using linear slides, it may be subjected to vertical load (P_R) and lateral load (P_T) at the same time. When two or more linear guides are used, the equivalent load (P_E) can be converted according to the following formula.



$$P_E = |P_R| + |P_T|$$

P_E : Equivalent load (N)
P_R : Radial load (N)
P_T : Lateral load (N)

In the case of single linear guide, equivalent load must take torque into account, see following formula.



$$P_E = |P_R| + |P_T| + C_0 \frac{|M|}{M_R}$$

P_E : Equivalent load (N)
P_R : Radial load (N)
P_T : Lateral load (N)
C_0 : Basic static load rating (N)
M : Calculated torque (N·m)
M_R : Allowable static moment (N·m)

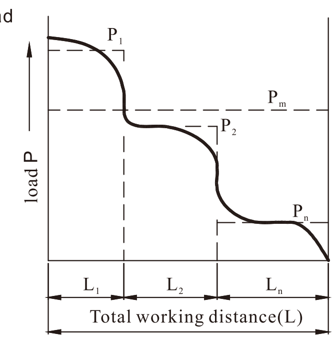
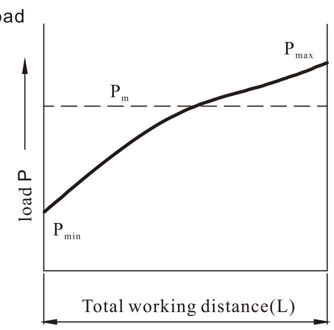
Calculation of average load

The real-time acting load for a block during movement is always variable. One can derive average load for the use of rated life calculation based on different applications. Average load when rollers are steel ball is as follows:

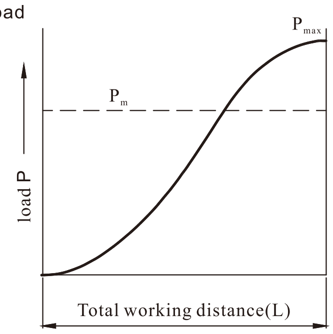
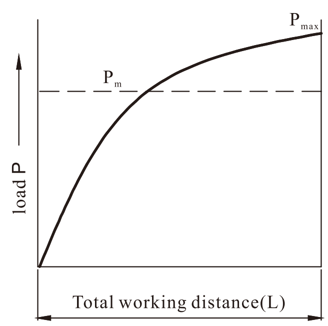
$$P_m = \sqrt[e]{\frac{1}{L} \cdot \sum_{n=1}^{n} (P_n^e \cdot L_n)}$$

P_m: Average load (N)
P_n: Variable load (N)
L: Total Working Distance (mm)
L_n: Moving distance when load P_n applied (mm)
e: Exponent (for steel ball: 3)

Average load calculation example

Varying load type	Average load calculation
Interval Variable Load 	$P_m = \sqrt[e]{\frac{1}{L} \cdot (P_1^e \cdot L_1 + P_2^e \cdot L_2 + ... + P_n^e \cdot L_n)}$ P_m: Average load (N) P_n: Variable load (N) L: Total Working Distance (mm) L_n: Moving distance when load P_n applied (mm) e: Exponent (for steel ball: 3)
Monotonic variable load 	$P_m \approx \frac{1}{3}(P_{min} + 2 \cdot P_{max})$ P_m: Average load (N) P_{min}: Minimum load (N) P_{max}: Maximum load (N)

Linear Guide Selection

Varying load type	Average load calculation
Sinusoidal variable load 	$P_m \approx 0.65 \cdot P_{max}$ P_m: Average load (N) P_{max}: Maximum load (N)
	$P_m \approx 0.75 \cdot P_{max}$ P_m: Average load (N) P_{max}: Maximum load (N)

Calculation example

Conditions of Use

Model：*LSH30HL2X2520S20BP-M6(2 pcs)*

Basic dynamic load rating：$C=45.7\ KN$

Basic static load rating：$C_0=73.1\ KN$

Mass $m_1=700kg$ $m_2=450kg$

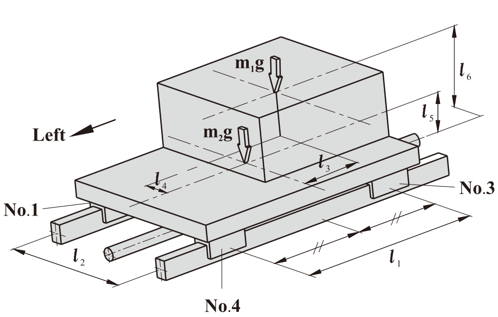
Speed $V=0.75m/s$

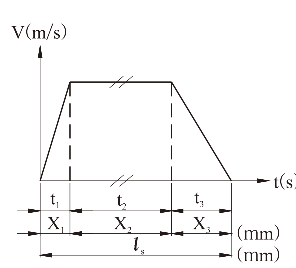
Time $t_1=0.05s$ $t_2=1.9s$ $t_3=0.15s$

Acceleration $a_1=15m/s^2$ $a_3=5m/s^2$

Travel Distance $l_s=1500mm$

Distance l_1=650mm l_2=450mm l_3=135mm l_4=60mm l_5=175mm l_6=400mm





Speed-time graph

Load calculation of each block

At constant speed, the radial load P_n

$$P_1=\frac{m_1g}{4}-\frac{m_1g\cdot l_3}{2l_1}+\frac{m_1g\cdot l_4}{2l_2}+\frac{m_2g}{4}=2562N$$

$$P_2=\frac{m_1g}{4}+\frac{m_1g\cdot l_3}{2l_1}+\frac{m_1g\cdot l_4}{2l_2}+\frac{m_2g}{4}=3987N$$

$$P_3=\frac{m_1g}{4}+\frac{m_1g\cdot l_3}{2l_1}-\frac{m_1g\cdot l_4}{2l_2}+\frac{m_2g}{4}=3073N$$

$$P_4=\frac{m_1g}{4}-\frac{m_1g\cdot l_3}{2l_1}-\frac{m_1g\cdot l_4}{2l_2}+\frac{m_2g}{4}=1648N$$

Acceleration is toward left, the radial load P_nla_1

$$P_1la_1=P_1-\frac{m_1\cdot a_1\cdot l_6}{2l_1}-\frac{m_2\cdot a_1\cdot l_5}{2l_1}=-1577N$$

$$P_2la_1=P_2+\frac{m_1\cdot a_1\cdot l_6}{2l_1}+\frac{m_2\cdot a_1\cdot l_5}{2l_1}=8127N$$

$$P_3la_1=P_3+\frac{m_1\cdot a_1\cdot l_6}{2l_1}+\frac{m_2\cdot a_1\cdot l_5}{2l_1}=7212N$$

$$P_4la_1=P_4-\frac{m_1\cdot a_1\cdot l_6}{2l_1}-\frac{m_2\cdot a_1\cdot l_5}{2l_1}=-2492N$$

Lateral load Pt_nla_1

$$Pt_1la_1=-\frac{m_1\cdot a_1\cdot l_4}{2l_1}=-485N$$

$$Pt_2la_1=\frac{m_1\cdot a_1\cdot l_4}{2l_1}=485N$$

$$Pt_3la_1=\frac{m_1\cdot a_1\cdot l_4}{2l_1}=485N$$

$$Pt_4la_1=-\frac{m_1\cdot a_1\cdot l_4}{2l_1}=-485N$$

Linear Guide Selection

Conditions of Use

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Mass $m_1=700kg$ $m_2=450kg$

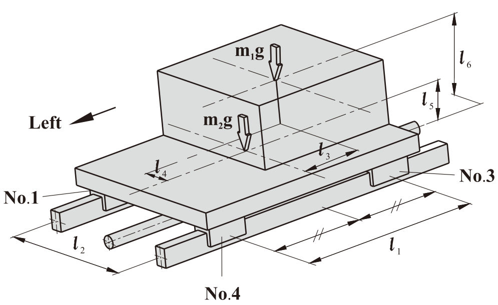
Speed $V=0.75m/s$

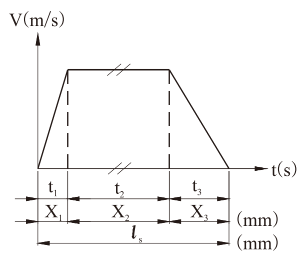
Time $t_1=0.05s$ $t_2=1.9s$ $t_3=0.15s$

Acceleration $a_1=15m/s^2$ $a_3=5m/s^2$

Travel Distance $l_s=1500mm$

Distance l_1=650mm l_2=450mm l_3=135mm l_4=60mm l_5=175mm l_6=400mm





Speed-time graph

Load calculation of each block

Deceleration is toward left, the radial load $P_n la_3$

$$P_1 la_3=P_1+\frac{m_1\cdot a_3\cdot l_6}{2l_1}+\frac{m_2\cdot a_3\cdot l_5}{2l_1}=3942N$$

$$P_2 la_3=P_2-\frac{m_1\cdot a_3\cdot l_6}{2l_1}-\frac{m_2\cdot a_3\cdot l_5}{2l_1}=2607N$$

$$P_3 la_3=P_3-\frac{m_1\cdot a_3\cdot l_6}{2l_1}-\frac{m_2\cdot a_3\cdot l_5}{2l_1}=1693N$$

$$P_4 la_3=P_4+\frac{m_1\cdot a_3\cdot l_6}{2l_1}+\frac{m_2\cdot a_3\cdot l_5}{2l_1}=3028N$$

Lateral load $Pt_n la_3$

$$Pt_1 la_3=\frac{m_1\cdot a_3\cdot l_4}{2l_1}=162N$$

$$Pt_2 la_3=-\frac{m_1\cdot a_3\cdot l_4}{2l_1}=-162N$$

$$Pt_3 la_3=-\frac{m_1\cdot a_3\cdot l_4}{2l_1}=-162N$$

$$Pt_4 la_3=\frac{m_1\cdot a_3\cdot l_4}{2l_1}=162N$$

Acceleration is toward right, the radial load $P_n ra_1$

$$P_1 ra_1=P_1+\frac{m_1\cdot a_1\cdot l_6}{2l_1}+\frac{m_2\cdot a_1\cdot l_5}{2l_1}=6702N$$

$$P_2 ra_1=P_2-\frac{m_1\cdot a_1\cdot l_6}{2l_1}-\frac{m_2\cdot a_1\cdot l_5}{2l_1}=-152N$$

$$P_3 ra_1=P_3-\frac{m_1\cdot a_1\cdot l_6}{2l_1}-\frac{m_2\cdot a_1\cdot l_5}{2l_1}=-1067N$$

$$P_4 ra_1=P_4+\frac{m_1\cdot a_1\cdot l_6}{2l_1}+\frac{m_2\cdot a_1\cdot l_5}{2l_1}=5787N$$

Lateral load $Pt_n ra_1$

$$Pt_1 ra_1=\frac{m_1\cdot a_1\cdot l_4}{2l_1}=485N$$

$$Pt_2 ra_1=-\frac{m_1\cdot a_1\cdot l_4}{2l_1}=-485N$$

$$Pt_3 ra_1=-\frac{m_1\cdot a_1\cdot l_4}{2l_1}=-485N$$

$$Pt_4 ra_1=\frac{m_1\cdot a_1\cdot l_4}{2l_1}=485N$$

Deceleration is toward right, the radial load $P_n ra_3$

$$P_1 ra_3=P_1-\frac{m_1\cdot a_3\cdot l_6}{2l_1}-\frac{m_2\cdot a_3\cdot l_5}{2l_1}=1183N$$

$$P_2 ra_3=P_2+\frac{m_1\cdot a_3\cdot l_6}{2l_1}+\frac{m_2\cdot a_3\cdot l_5}{2l_1}=5367N$$

$$P_3 ra_3=P_3+\frac{m_1\cdot a_3\cdot l_6}{2l_1}+\frac{m_2\cdot a_3\cdot l_5}{2l_1}=4452N$$

$$P_4 ra_3=P_4-\frac{m_1\cdot a_3\cdot l_6}{2l_1}-\frac{m_2\cdot a_3\cdot l_5}{2l_1}=268N$$

Lateral load $Pt_n ra_3$

$$Pt_1 ra_3=-\frac{m_1\cdot a_3\cdot l_4}{2l_1}=-162N$$

$$Pt_2 ra_3=\frac{m_1\cdot a_3\cdot l_4}{2l_1}=162N$$

$$Pt_3 ra_3=\frac{m_1\cdot a_3\cdot l_4}{2l_1}=162N$$

$$Pt_4 ra_3=-\frac{m_1\cdot a_3\cdot l_4}{2l_1}=-162N$$

Equivalent load calculation

At constant speed

$P_{E1}=P_1=2562N$

$P_{E2}=P_2=3987N$

$P_{E3}=P_3=3073N$

$P_{E4}=P_4=1648N$

When acceleration is toward left

$P_{E1}la_1=|P_1 la_1|+|Pt_1 la_1|=2062N$

$P_{E2}la_1=|P_2 la_1|+|Pt_2 la_1|=8611N$

$P_{E3}la_1=|P_3 la_1|+|Pt_3 la_1|=7697N$

$P_{E4}la_1=|P_4 la_1|+|Pt_4 la_1|=2976N$

Linear Guide Selection

Conditions of Use

Model：*LSH30HL2X2520S20BP-M6(2 pcs)*

Basic dynamic load rating：$C=45.7\ KN$

Basic static load rating：$C_0=73.1\ KN$

Mass $m_1=700kg$ $m_2=450kg$

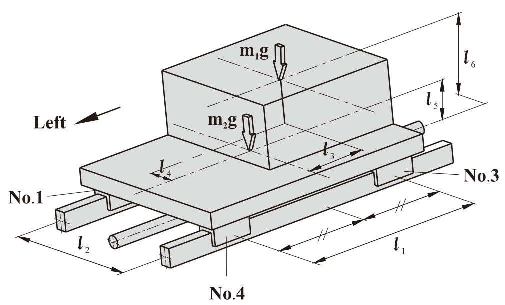
Speed $V=0.75m/s$

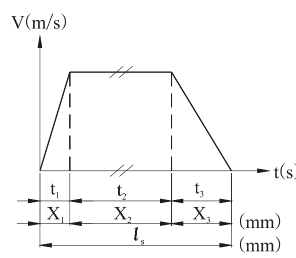
Time $t_1=0.05s$ $t_2=1.9s$ $t_3=0.15s$

Acceleration $a_1=15m/s^2$ $a_3=5m/s^2$

Travel Distance $l_s=1500mm$

Distance l_1=650mm l_2=450mm l_3=135mm l_4=60mm l_5=175mm l_6=400mm





Speed-time graph

Equivalent load calculation

When deceleration is toward left

$P_{E1}la_3=|P_1la_3|+|Pt_1la_3|=4104N$

$P_{E2}la_3=|P_2la_3|+|Pt_2la_3|=2769N$

$P_{E3}la_3=|P_3la_3|+|Pt_3la_3|=1854N$

$P_{E4}la_3=|P_4la_3|+|Pt_4la_3|=3189N$

When acceleration is toward right

$P_{E1}ra_1=|P_1ra_1|+|Pt_1ra_1|=7186N$

$P_{E2}ra_1=|P_2ra_1|+|Pt_2ra_1|=637N$

$P_{E3}ra_1=|P_3ra_1|+|Pt_3ra_1|=1551N$

$P_{E4}ra_1=|P_4ra_1|+|Pt_4ra_1|=6272N$

When deceleration is toward right

$P_{E1}ra_3=|P_1ra_3|+|Pt_1ra_3|=1344N$

$P_{E2}ra_3=|P_2ra_3|+|Pt_2ra_3|=5529N$

$P_{E3}ra_3=|P_3ra_3|+|Pt_3ra_3|=4614N$

$P_{E4}ra_3=|P_4ra_3|+|Pt_4ra_3|=430N$

Calculation of static safety factor

We now know that the maximum equivalent load occurs on No.2 slider. Therefore, one can calculate static safety factor based on it in following formula

$$f_s=\frac{C_0}{P_{E2}la_1}=\frac{73.1\times10^3}{8611}=8.49$$

Calculation of the average load of each slider P_{mn}

$$P_{m1}=\sqrt[3]{\frac{(P_{E1}la_1^3X_1+P_{E1}^3X_2+P_{E1}la_3^3X_3+P_{E1}ra_1^3X_1+P_{E1}^3X_2+P_{E1}ra_3^3X_3)}{2l_s}}$$

$$=2701N$$

$$P_{m2}=\sqrt[3]{\frac{(P_{E2}la_1^3X_1+P_{E2}^3X_2+P_{E2}la_3^3X_3+P_{E2}ra_1^3X_1+P_{E2}^3X_2+P_{E2}ra_3^3X_3)}{2l_s}}$$

$$=4077N$$

$$P_{m3}=\sqrt[3]{\frac{(P_{E3}la_1^3X_1+P_{E3}^3X_2+P_{E3}la_3^3X_3+P_{E3}ra_1^3X_1+P_{E3}^3X_2+P_{E3}ra_3^3X_3)}{2l_s}}$$

$$=3188N$$

$$P_{m4}=\sqrt[3]{\frac{(P_{E4}la_1^3X_1+P_{E4}^3X_2+P_{E4}la_3^3X_3+P_{E4}ra_1^3X_1+P_{E4}^3X_2+P_{E4}ra_3^3X_3)}{2l_s}}$$

$$=1873N$$

Calculation of rated life L_n

Assuming f_w=1.5 and according to rated life formula, the rated life can be calculated as follows:

$$L_1=\left(\frac{C}{f_wP_{m1}}\right)^3\times50=71758Km \qquad L_3=\left(\frac{C}{f_wP_{m3}}\right)^3\times50=43641Km$$

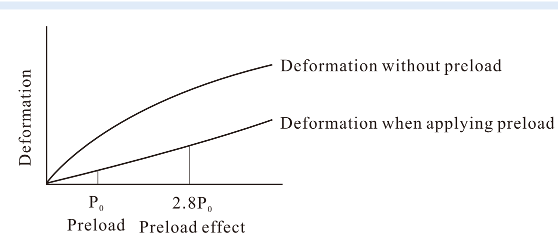
$$L_2=\left(\frac{C}{f_wP_{m2}}\right)^3\times50=20865Km \qquad L_4=\left(\frac{C}{f_wP_{m4}}\right)^3\times50=215195Km$$

Calculation conclusion

Choose the minimum from four sliders to represent rated life, which is 20865 Km on No.2 slider

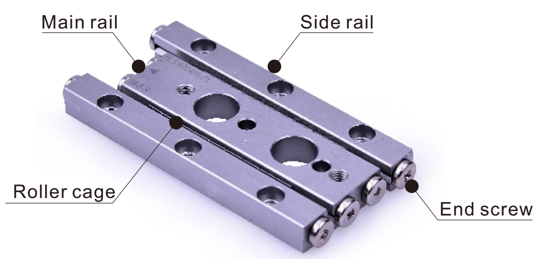
Preload and rigidity

Preload spec can be applied to enhance rigidity. As the graph shows on the right, the effectiveness of preload can maintain until external load reaches 2.8 times of preload strength. In other words, rigidity increases 2.8 times. Preload is applied by choosing bigger diameter of rollers to increase interference between rollers and groove and raise initial loads. Therefore when calculating rated life, preload should be put into consideration.

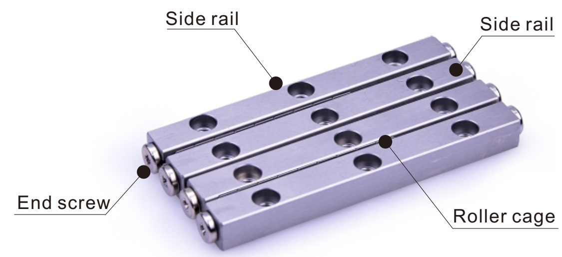


Product Introduction

Crossed Roller provides high rigidity and high accuracy linear movement with non-recirculating rollers design. By cross-arrangement of rollers, it will hugely reduce friction meanwhile provide high rigidity for rollers to bear heavy loads. Crossed roller is mainly used in high precision machine and measurement equipment such as circuit board printer, optical measurement instrument, X-ray equipment or base for multiple kinds of instruments.



Three-Row Type Of Crossed Roller Way



Four-Row Type Of Crossed Roller Way

Order Information

LGC 3 A 200 R25 - H

① ② ③ ④ ⑤ ⑥

① **Model Code**	LGC : Crossed Roller Way
② **Roller Diameter**	1 : Φ1.5mm 2 : Φ2.0mm 3 : Φ3.0mm 4 : Φ4.0mm 6 : Φ6.0mm
③ **Type [Note]**	A: Three-row type [Note] B: Four-row type
④ **Rail dimension**	200:rail length 200X100:main rail length is 200mm/side rail length is 100mm [Reference to spec. table for detail]
⑤ **The number of rollers in each roller cage**	R25:25 rollers .... [Reference to spec. table for detail]
⑥ **Accuracy**	H : High P : Precision

[Note] LGC6: only for type B.

Cross Reference Table for Maximun Stroke & Roller numbers

LGC1 Max. Stroke		Numbers of rollers in one roller cage								
		R6	R7	R8	R9	R10	R11	R13	R16	R19
Shortest length of rails (mm)	20	12	7	-	-	-	-	-	-	-
	30	-	-	22	17	12	7	-	-	-
	40	-	-	-	-	-	27	17	-	-
	50	-	-	-	-	-	-	37	22	7
	60	-	-	-	-	-	-	-	42	27
	70	-	-	-	-	-	-	-	-	47
	80	-	-	-	-	-	-	-	-	67

The standard quantity of rollers
Alternative options of the quantity of rollers

LGC2 Max. Stroke		Numbers of rollers in one roller cage													
		R6	R7	R8	R9	R10	R11	R13	R16	R19	R22	R25	R28	R32	R36
Shortest length of rails (mm)	30	16	8	-	-	-	-	-	-	-	-	-	-	-	-
	45	-	-	30	22	14	-	-	-	-	-	-	-	-	-
	60	-	-	-	-	-	36	20	-	-	-	-	-	-	-
	75	-	-	-	-	-	-	50	26	-	-	-	-	-	-
	90	-	-	-	-	-	-	-	56	32	-	-	-	-	-
	105	-	-	-	-	-	-	-	-	62	38	-	-	-	-
	120	-	-	-	-	-	-	-	-	-	68	44	-	-	-
	135	-	-	-	-	-	-	-	-	-	98	74	50	-	-
	150	-	-	-	-	-	-	-	-	-	-	104	80	48	-
	165	-	-	-	-	-	-	-	-	-	-	-	110	78	45
	180	-	-	-	-	-	-	-	-	-	-	-	140	108	76

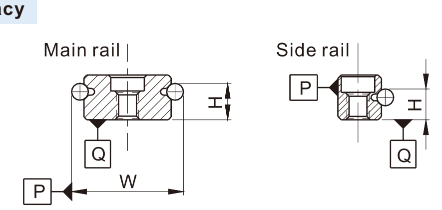
LGC3 Max. Stroke		Numbers of rollers in one roller cage													
		R7	R8	R9	R10	R11	R13	R16	R19	R22	R25	R28	R32	R36	R40
Shortest length of rails (mm)	50	34	24	14	-	-	-	-	-	-	-	-	-	-	-
	75	-	-	-	54	44	24	-	-	-	-	-	-	-	-
	100	-	-	-	-	-	74	44	-	-	-	-	-	-	-
	125	-	-	-	-	-	-	94	64	-	-	-	-	-	-
	150	-	-	-	-	-	-	-	114	84	54	-	-	-	-
	175	-	-	-	-	-	-	-	-	134	104	74	-	-	-
	200	-	-	-	-	-	-	-	-	-	154	124	84	-	-
	225	-	-	-	-	-	-	-	-	-	-	174	134	94	-
	250	-	-	-	-	-	-	-	-	-	-	-	184	144	104
	275	-	-	-	-	-	-	-	-	-	-	-	234	194	154
	300	-	-	-	-	-	-	-	-	-	-	-	-	244	204

LGC4 Max. Stroke		Numbers of rollers in one roller cage													
		R8	R9	R10	R11	R13	R16	R19	R22	R25	R28	R32	R36	R40	R45
Shortest length of rails (mm)	80	54	40	26	-	-	-	-	-	-	-	-	-	-	-
	120	-	-	-	92	64	-	-	-	-	-	-	-	-	-
	160	-	-	-	-	-	102	60	-	-	-	-	-	-	-
	200	-	-	-	-	-	-	140	98	56	-	-	-	-	-
	240	-	-	-	-	-	-	-	178	136	94	-	-	-	-
	280	-	-	-	-	-	-	-	-	216	174	118	-	-	-
	320	-	-	-	-	-	-	-	-	-	254	198	142	86	-
	360	-	-	-	-	-	-	-	-	-	-	278	222	166	96
	400	-	-	-	-	-	-	-	-	-	-	358	302	246	176
	440	-	-	-	-	-	-	-	-	-	-	-	382	326	256
	480	-	-	-	-	-	-	-	-	-	-	-	-	406	336

LGC6 Max. Stroke (mm)		Numbers of rollers in one roller cage												
		R8	R9	R11	R13	R16	R19	R22	R25	R28	R32	R36	R40	R45
Shortest length of rails (mm)	100	62	44	-	-	-	-	-	-	-	-	-	-	-
	150	-	-	108	72	-	-	-	-	-	-	-	-	-
	200	-	-	-	-	118	64	-	-	-	-	-	-	-
	250	-	-	-	-	-	164	110	56	-	-	-	-	-
	300	-	-	-	-	-	-	210	156	102	-	-	-	-
	350	-	-	-	-	-	-	-	256	202	130	-	-	-
	400	-	-	-	-	-	-	-	-	302	230	158	-	-
	450	-	-	-	-	-	-	-	-	-	330	258	186	-
	500	-	-	-	-	-	-	-	-	-	-	358	286	196
	550	-	-	-	-	-	-	-	-	-	-	458	386	296
	600	-	-	-	-	-	-	-	-	-	-	-	486	396

Accuracy

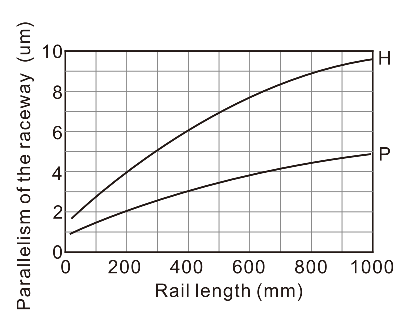
Accuracy



Unit mm

Item	High(H)	Precision(P)
Tolerance of height **H**	±0.02	±0.01
Variation of height **H**	0.01	0.005
Tolerance of width **W**	±0.02	±0.01

Rail Length and Parallelism of The Raceway

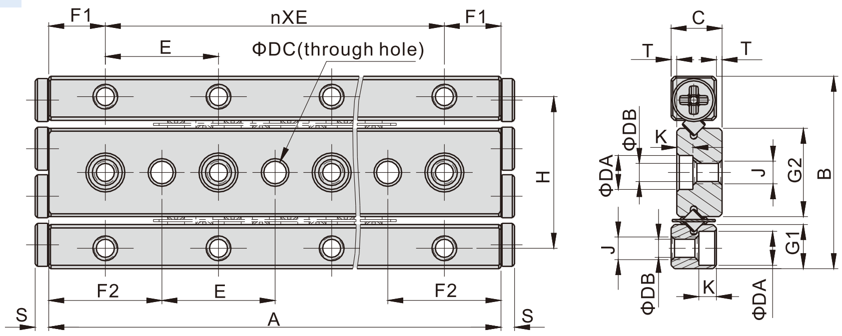


Crossed Roller Way

LGC Series

Specification Table

Dimensions of Three-row Type

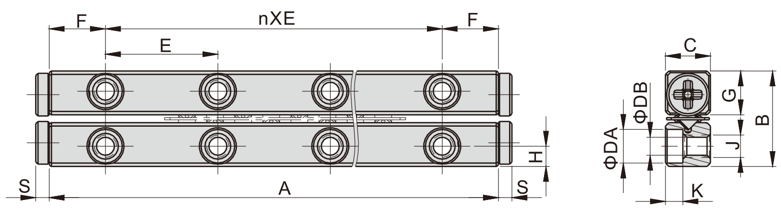


Model\Item	A	B	C	ΦDA	ΦDB	ΦDC	nXE	F1	F2	G1	G2	H	J	K	S	T
LGC1A20	20						1X10									
LGC1A30	30						2X10									
LGC1A40	40						3X10									
LGC1A50	50	17	4.5	3.0	1.55	$2^{+0.03}_{+0.005}$	4X10	5	10	3.9	7.8	13.4	M2X0.4	1.5	1.2	0.5
LGC1A60	60						5X10									
LGC1A70	70						6X10									
LGC1A80	80						7X10									
LGC2A30	30						1X15									
LGC2A45	45						2X15									
LGC2A60	60						3X15									
LGC2A75	75						4X15									
LGC2A90	90						5X15									
LGC2A105	105	24	6.5	4.4	2.5	$3^{+0.03}_{+0.005}$	6X15	7.5	15	5.5	11	19	M3X0.5	2.1	1.5	0.5
LGC2A120	120						7X15									
LGC2A135	135						8X15									
LGC2A150	150						9X15									
LGC2A165	165						10X15									
LGC2A180	180						11X15									
LGC3A50	50						1X25									
LGC3A75	75						2X25									
LGC3A100	100						3X25									
LGC3A125	125						4X25									
LGC3A150	150						5X25									
LGC3A175	175	36	8.5	6.0	3.4	$4^{+0.03}_{+0.005}$	6X25	12.5	25	8.3	16.6	29	M4X0.7	3.1	2	0.5
LGC3A200	200						7X25									
LGC3A225	225						8X25									
LGC3A250	250						9X25									
LGC3A275	275						10X25									
LGC3A300	300						11X25									
LGC4A80	80						1X40									
LGC4A120	120						2X40									
LGC4A160	160						3X40									
LGC4A200	200						4X40									
LGC4A240	240						5X40									
LGC4A280	280	44	11.5	7.5	4.3	$5^{+0.03}_{+0.005}$	6X40	20	40	10	20	35	M5X0.8	4.1	2	0.5
LGC4A320	320						7X40									
LGC4A360	360						8X40									
LGC4A400	400						9X40									
LGC4A440	440						10X40									
LGC4A480	480						11X40									

[Note] One set includes one main rail, two side rails, two roller cages, and the corresponding screws for mounting.

Specification Table

Dimensions of Four-row Type



Model\Item	A	B	C	ΦDA	ΦDB	nXE	F	G	H	J	K	S
LGC1B20	20					1X10						
LGC1B30	30					2X10						
LGC1B40	40					3X10						
LGC1B50	50	8.5	4	3.0	1.55	4X10	5	3.9	1.8	M2X0.4	1.5	1.2
LGC1B60	60					5X10						
LGC1B70	70					6X10						
LGC1B80	80					7X10						
LGC2B30	30					1X15						
LGC2B45	45					2X15						
LGC2B60	60					3X15						
LGC2B75	75					4X15						
LGC2B90	90					5X15						
LGC2B105	105	12	6	4.4	2.5	6X15	7.5	5.5	2.5	M3X0.5	2.1	1.5
LGC2B120	120					7X15						
LGC2B135	135					8X15						
LGC2B150	150					9X15						
LGC2B165	165					10X15						
LGC2B180	180					11X15						
LGC3B50	50					1X25						
LGC3B75	75					2X25						
LGC3B100	100					3X25						
LGC3B125	125					4X25						
LGC3B150	150					5X25						
LGC3B175	175	18	8	6.0	3.4	6X25	12.5	8.3	3.5	M4X0.7	3.1	2
LGC3B200	200					7X25						
LGC3B225	225					8X25						
LGC3B250	250					9X25						
LGC3B275	275					10X25						
LGC3B300	300					11X25						
LGC4B80	80					1X40						
LGC4B120	120					2X40						
LGC4B160	160					3X40						
LGC4B200	200					4X40						
LGC4B240	240					5X40						
LGC4B280	280	22	11	7.5	4.3	6X40	20	10	4.5	M5X0.8	4.1	2
LGC4B320	320					7X40						
LGC4B360	360					8X40						
LGC4B400	400					9X40						
LGC4B440	440					10X40						
LGC4B480	480					11X40						
LGC6B100	100					1X50						
LGC6B150	150					2X50						
LGC6B200	200					3X50						
LGC6B250	250					4X50						
LGC6B300	300					5X50						
LGC6B350	350	31	15	9	5.3	6X50	25	14.7	6	M6X1.0	5.2	3
LGC6B400	400					7X50						
LGC6B450	450					8X50						
LGC6B500	500					9X50						
LGC6B550	550					10X50						
LGC6B600	600					11X50						

[Note] One set includes four side rails, two roller cages, and the corresponding screws for mounting.

Roller Cage Order Information

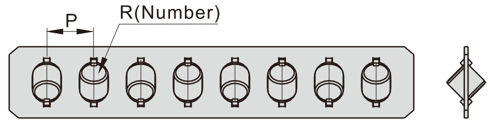
LGC 3 R25

① ② ③

	Model Code	LGC : Crossed Roller Way
①	Model Code	LGC : Crossed Roller Way
②	Roller Diameter	1: Φ1.5mm 2: Φ2.0mm 3: Φ3.0mm 4: Φ4.0mm 6: Φ6.0mm
③	The number of rollers	R25:25 rollers .... [Reference to spec. table for detail]

Specification Table

Informations of Roller Cage

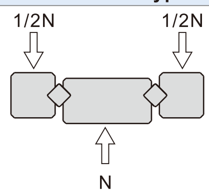
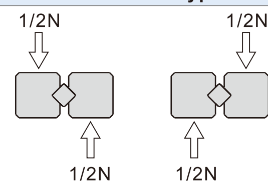
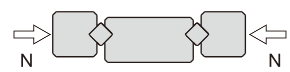
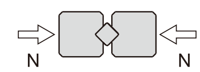


Model\	P	R	Basic Dynamic Load Rating (C_1)	Basic Static Load Rating (C_0)	Allowable Load (F_0)
LGC1R6		6			
LGC1R7		7			
LGC1R8		8			
LGC1R9		9			
LGC1R10	2.5	10	125N per roller	120N per roller	39N per roller
LGC1R11		11			
LGC1R13		13			
LGC1R16		16			
LGC1R19		19			
LGC2R6		6			
LGC2R7		7			
LGC2R8		8			
LGC2R9		9			
LGC2R10		10			
LGC2R11		11			
LGC2R13		13			
LGC2R16	4	16	292N per roller	290N per roller	97N per roller
LGC2R19		19			
LGC2R22		22			
LGC2R25		25			
LGC2R28		28			
LGC2R32		32			
LGC2R36		36			
LGC3R7		7			
LGC3R8		8			
LGC3R9		9			
LGC3R10		10			
LGC3R11		11			
LGC3R13		13			
LGC3R16		16			
LGC3R19	5	19	640N per roller	610N per roller	203N per roller
LGC3R22		22			
LGC3R25		25			
LGC3R28		28			
LGC3R32		32			
LGC3R36		36			
LGC3R40		40			

Model\	P	R	Basic Dynamic Load Rating (C_1)	Basic Static Load Rating (C_0)	Allowable Load (F_0)
LGC4R8		8			
LGC4R9		9			
LGC4R10		10			
LGC4R11		11			
LGC4R13		13			
LGC4R16		16			
LGC4R19		19			
LGC4R22	7	22	1230N per roller	1170N per roller	390N per roller
LGC4R25		25			
LGC4R28		28			
LGC4R32		32			
LGC4R36		36			
LGC4R40		40			
LGC4R45		45			
LGC6R8		8			
LGC6R9		9			
LGC6R11		11			
LGC6R13		13			
LGC6R16		16			
LGC6R19		19			
LGC6R22	9	22	3175N per roller	2550N per roller	810N per roller
LGC6R25		25			
LGC6R28		28			
LGC6R32		32			
LGC6R36		36			
LGC6R40		40			
LGC6R45		45			

User Manual

Load Rating

Load direction	Vertical load		Lateral load	
Type	Three-Row type	Four-Row type	Three-Row type	Four-Row type
Schematic				
Basic dynamic load rating - C_a (N)	$C_a=\{2P\times(\frac{R}{2}^{*}-1)\}^{\frac{1}{36}}\times(\frac{R}{2}^{*})^{\frac{3}{4}}\times C_1$ * Effective roller number R/2: round off to integer (EX : 5/2=2.5 , take 2)		$C_a=\{2P\times(\frac{R}{2}^{*}-1)\}^{\frac{1}{36}}\times(\frac{R}{2}^{*})^{\frac{3}{4}}\times2^{\frac{7}{9}}\times C_1$ *Effective roller number R/2: round off to integer (EX : 5/2=2.5 , take 2)	
Basic Static load rating - C_{a0} (N)	$C_{a0}=R\times C_0$		$C_{a0}=R\times C_0$	
Allowable load-F_{a0} (N)	$F_{a0}=R\times F_0$		$F_{a0}=R\times F_0$	

P: Pitch of roller cage (mm)
R: The number of cylindrical rollers incorporated in a roller cage
C_1: Basic dynamic load rating per cylindrical roller (N)
C_0: Basic static load rating per cylindrical roller (N)
F_0: Allowable load per cylindrical roller (N)

Ex : Calculate LGC3A180R25 basic load rating
From specification table(Informations of Roller Cage)
Pitch of roller cage :P=5mm
The number of cylindrical rollers incorporated in a roller cage : R = 25
Basic dynamic load rating per cylindrical roller : C_1 = 640 N
Basic static load rating per cylindrical roller : C_0 = 610N
Allowable load per cylindrical roller: F_0=203N
Effective roller number R/2 = 12.5, take 12
Take these parameters into calculation, we can get
For Vertical load :Basic dynamic load rating C_a = 4,701.88 N ;
Basic Static load rating C_{a0} = 15,250 N ;
Allowable load F_{a0} = 5,075 N ;
For Lateral load : Basic dynamic load rating C_a = 8,061.31 N ;
Basic Static load rating C_{a0} = 15,250 N ;
Allowable load F_{a0} = 5,075 N .

Static Safety Factor(fs)

Inertia force caused by impact, sudden start or stop will exert unexpected force on crossed roller guide. Therefore, safety factor based on working condition needs to be put into consideration, see as follows:

Load Condition	fs
Normal Load	1.0~1.3
Load with Impacts or Vibrations	2.0~3.0

$$f_s=\frac{C_{a0}}{F}$$

f_s: Static safety factor
C_{a0}: Basic static load rating (N)
F: Calculated working load (N)

Nominal Life(L)

Nominal life is calculated as follow:

$$L=\left(\frac{f_T}{f_w}\cdot\frac{C_a}{F}\right)^{\frac{10}{3}}\times100$$

L:Nominal life (km)
C_a:Basic dynamic load rating (N)
F:Calculated working load (N)
f_T:Temperature factor (Reference to Temperature Factor Chart)
f_w:Load factor (Reference to Load Factor Table)

Calculating the Service Life Time(L_h)

Based on the calculated nominal life, the Service Life Time is obtained through the following equation as if the stroke length and the value of reciprocations per minutes remain constant.

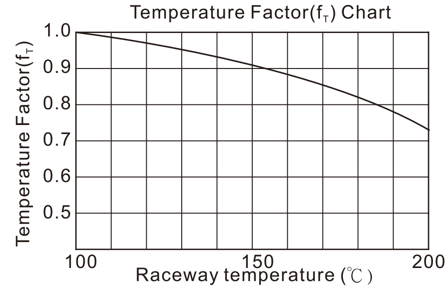
$$L_h=\frac{L\times10^6}{2\times\ell_s\times m\times60}$$

L_h:Service life time (h)
ℓ_s:Stroke length (mm)
m:Rounds per minute (min^{-1})

Temperature Factor(f_T)

If the environmental temperature exceeds 100℃, take the adverse effect of the high temperature into account by multiplying the basic load ratings by the temperature factor.

Temperature Factor(f_T) Chart



Load Factor(f_w)

In general, reciprocating machines tend to involve vibrations or impact during operation. it is extremely difficult to accurately determine the impact caused by high-speed motion or frequent start and stop motion. However, the calibrated load can be expected by experience.
The basic load rating(C_a or C_{a0}) divide by load factor(f_w) in the following table to calibrate from speed effect and vibrations.

Load Factor Table

Vibrations/Impact	Speed(V)	f_w
Faint	V≤0.25m/s	1~1.2
Weak	0.25<V≤1m/s	1.2~1.5

Stroke

When moving, roller cage will move along with rail about half of its moving distance. Therefore, distance between center of loads and roller cage will vary with motion. In order to maintain accuracy, please conform to 'Cross Reference Table for Max. Stroke & Roller Numbers' table when deciding specs.
EX: Choose spec for a roller diameter 6 mm, high accuracy type and desiring length of rails are 300 and 200 mm, desiring moving distance is 50 mm.
Refer to 'Cross Reference Table for Max. Stroke & Roller Numbers' : roller diameter 6 mm with 200 mm as shortest rail, its roller numbers can be R16 or R19, and admissible moving distance is 118 and 64 mm respectively.
Both roller numbers can meet the required working distance 50mm.

Mounting Screw

Tightening torque for fixing screw

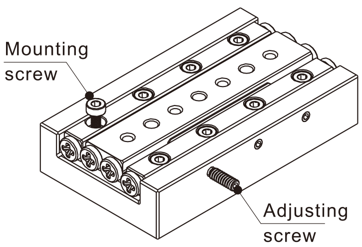
Spec	Screw size	
LGC1	M1.4X0.3PX6L	
LGC2	M2.0X0.4PX8L	
LGC3	M3.0X0.5PX9.5L	1.40
LGC4	M4.0X0.7PX16L	3.20
LGC6	M5.0X0.8PX20L	6.60

※High strenth screw is preferred.

Adjusting Screw

Tightening torque for fixing screw

Spec	Screw size	
LGC1	M2	
LGC2	M3	
LGC3	M4	
LGC4	M4	
LGC6	M5	



Precautions on use

1.Caution in handling

Dropping crossed roller way may cause damage on surface and further affect its accuracy, and even jerks during movement.

2. Adjustment

Fail to adjust the preload or mounting surfaces correctly will affect the product lifetime and accuracy. Make sure to assemble, install, and adjust the product with care. Appropriate preload will help with rigidity and accuracy; yet overloading the crossed roller way will result in damages and deformation. On installation, please follow the installation procedure and recommended torque.

3. Use as a Set

The accuracy of crossed roller guide is controlled as a set. Accuracy is not guaranteed when mixing parts from different sets.

4. Allowable Load

Definition of allowable load is the maximum loads applied on crossed roller to cause acceptable elastic deformation while maintain a smooth movement.
When working condition requires high accuracy and smooth movement, be sure load applied on product is under allowable load.

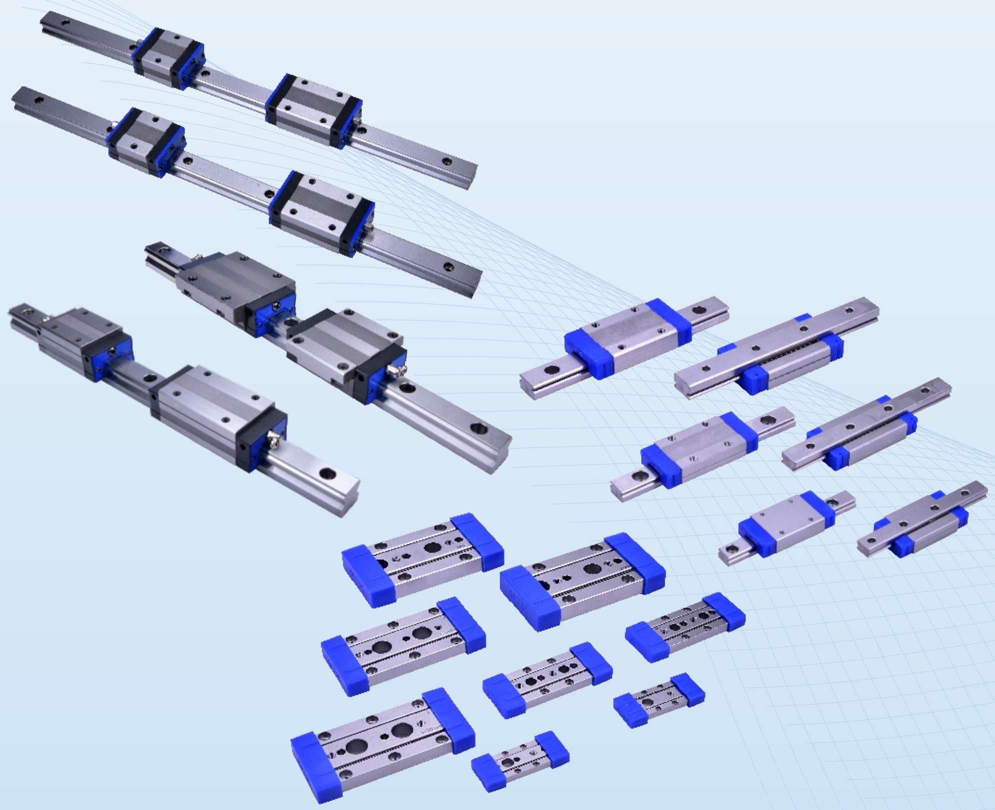
5. Cage Slippage

The roller cage could slip under high speed motion, vertical use application, unbalanced load, and vibration conditions.
Avoiding excessive loads is recommended. Meanwhile, using crossed roller within range of allowable stroke while applying safety factors will help avoid compression and damage.

AirTAC INTERNATIONAL GROUP

Lineaire Geleidingen (2022A)

- LSH Series Standard Linear Guide
- LSD Series Low Profile Type Linear Guide
- LRM Series Miniature Linear Guide
- LGC Series Crossed Roller Way



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