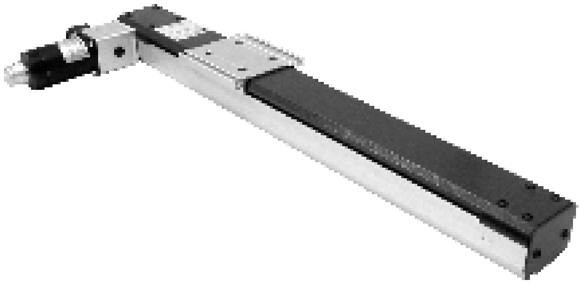
Selecting a Belt Slide

First, you must determine...



Travel Distance
Load
Orientation of Load
Cycle Time
Max Speed
Max Acceleration

With this information, you can start to determine which belt slide is suitable for your application.

Loading Capacity and Life Expectancy

Fundamental Principle

The specification of a linear guide is based on the loading capacity of the individual element. The loading capacity is described by:

- the dynamic load data **C**
- the static load data $\mathbf{C_0}$
- the static moments $\mathbf{M_x}$, $\mathbf{M_y}$, $\mathbf{M_z}$

The basis of the dynamic load data, according to DIN standards, is a nominal life expectancy of 100,000 m travel. For a nominal life expectancy of 50,000 m, the load data is 20% higher than those values supplied in this catalog.

Dynamic Loading Capacity

The fatigue behavior of the materials determines the dynamic loading capacity. The life expectancy is dependent on:

- the load on the linear guide

- the travel speed of the linear guide

- the statistical contingency of the first defect taking place

Nominal Life Expectancy

The nominal life expectancy is achieved, or exceeded 90% of the time before the first indication of fatigue appears.

$$L = \left(\frac{C}{P}\right)^p \times 1 \times 10^5 m \qquad (1)$$

$$L_h = \frac{833}{H \times n} \times \left(\frac{C}{P}\right)^p \qquad (2)$$

$$L_h = \frac{1666}{V} \times \left(\frac{C}{P}\right)^p \qquad (3)$$

L [m] nominal life expectancy in meters

$\mathbf{L_h}$ [h] nominal life expectancy in operating hours

C [N] dynamic load

P [N] dynamic equivalent load

p Life expectancy index:

ball-bearing linear guides: **p** = 3
roller bearing linear guides: **p** = 10/3

H [m] single stroke length

n [min] number of complete strokes per minute

v [m / min] average travel speed

Usable Life

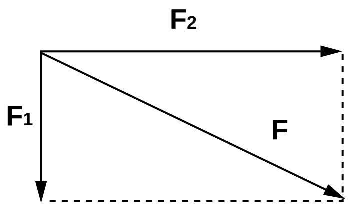
The actual life expectancy achieved by a linear guide is known as usable life. The usable life can deviate from the calculated life expectancy.

These conditions can lead to early defects:

- alignment error between guide rails or guide elements
- insufficient lubrication
- oscillatory motion with very small strokes (rippling)
- vibration during standstill (rippling)

Due to the variation in installations and operating conditions, it is not possible to determine the exact usable life of a linear guide in advance. The safest method to obtain a correct assessment of the usable life is to compare cases with similar installations.

Combined Loading Capacity



(4)

When the loading direction of an element does not coincide with one of the loading directions, this is the way the equivalent load is calculated as follows:

$$P = |F_1| + |F_2| \qquad (5)$$

for a force **F** and a moment **M** at the same time, the dynamic equivalent load is:

$$P = |F| + |M| \times \frac{C_0}{M_0} \qquad (6)$$

P [N] dynamic equivalent load

F [N] applied force = $\sqrt{F_1^2 + F_2^2}$

F_1 [N] vertical components, see sketch (4)

F_2 [N] horizontal components, see sketch (4)

C_0 [N] static load in the direction of the applied force

M [Nm] applied moment

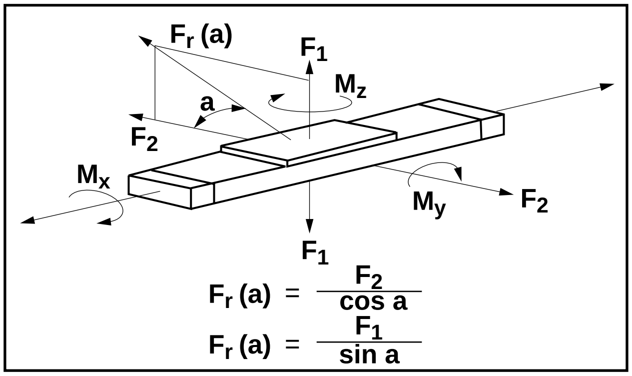
M_0 [Nm] static moment in the direction of the applied moment

According to DIN standards, the dynamic equivalent load should not exceed the value **P** = 0.5 x **C**.

1 TECHNICAL INFORMATION

Load and Moment Data (reference diagram on next page)

Model	BL1	BL3	ZF1 bearing carriage	ZF1 roller carriage	ZF2 bearing carriage	ZF2 roller carriage	ZF3 bearing carriage	ZF3 roller carriage	NP1 belt slide
Co [N]	3061.5	4701.7	3061.5	1440.7	4701.7	1440.7	4701.7	1440.7	1270.0
C [N]	1598.1	2127.7	1598.1	2668.0	2127.7	2668.0	2127.7	2668.0	750.0
F1 stat [N]	2648.0	4060.0	2648.0	2881.4	4060.0	2881.4	4060.0	2881.4	1270.0
F1 dyn [N]	1382.7	1840.3	1382.7	2531.9	1840.3	2531.9	1840.3	2531.9	750.0
F2 stat [N]	3061.5	4701.7	3061.5	1440.7	4701.7	1440.7	4701.7	1440.7	1270.0
F2 dyn [N]	1598.1	2127.7	1598.1	2668.0	2127.7	2668.0	2127.7	2668.0	750.0
Mx stat [Nm]	37.2	175.0	37.2	80.8	175.0	164.7	175.0	164.7	22.0
My stat [Nm]	98.8	151.8	98.8	129.7	151.8	201.7	151.8	201.7	12.6
Mz stat [Nm]	114.3	175.5	114.3	64.8	175.5	100.9	175.5	100.9	12.6
Mx dyn [Nm]	19.4	79.2	19.4	71.0	79.2	144.7	79.2	144.7	13.5
My dyn [Nm]	51.6	68.7	51.6	113.9	68.7	177.2	68.7	177.2	7.5
Mz dyn [Nm]	59.7	79.4	59.7	120.1	79.4	186.8	79.4	186.8	7.5



Drive Dimensioning and Calculation of Drive Torque

The nominal drive torque consists mainly of ‘load torque’, ‘acceleration torque’ and ‘no-load torque’.

Definitions

M_A [N·m]	required drive torque	**m** [kg]	total mass to be moved
M_{Last} [N·m]	resulting load torque	**a** [m/s²]	acceleration
M_{NLT} [N·m]	no load torque *	d_0 [mm]*	effective diameter of pulley
M_{rot} [N·m]	rotary acceleration torque	**P** [kW]	driving power
M_{trans} [N·m]	acceleration torque	J_{syn} [kgm²]*	mass moment of inertia of the pulley
F_X [N]	feed force	n_{max} [1/min]	max. speed
F_a [N]	acceleration force	µ	friction factor = 0.05
g [m/s²]	gravity = 9.81	ρ [kg/m]*	specific mass of belt
V_{max} [m/s]	max feedrate	**i**	gear ratio
F_E [N]	external force	M_E [N·m]	external load torque

mass of belt = ρ x 2 x length of feed profile/1000 m = transport mass + mass of slide + mass of belt

* relevant data are given on the corresponding data sheets for each Belt Drive Slide

Acceleration Force F_a

$$F_a = m \times a$$

with vertical loads, the acceleration to gravity g must be added to the mass acceleration (g=9.81 m/s²)

Feed Force F_x

$$F_x = m \times g \times \mu$$

External Torque M_E

$$M_E = \frac{F_E \times d_0}{2 \times 1000}$$

Resulting Torque M_{Last}

$$M_{Last} = \frac{F_x \times d_0}{2 \times 1000}$$

Driving Power P

$$P = \frac{M_A \times n_{max} \times 2\pi}{60 \times 1000}$$

Acceleration Torque F_{trans}

$$M_{trans} = \frac{F_a \times d_0}{2 \times 1000}$$

Rotary Acceleration Torque M_{rot}

$$M_{rot} = J_{syn} \times \frac{n_{max} \times 2\pi \times a}{60 \times V_{max}}$$

Drive Torque Formula: $M_A = M_{Last} + M_{trans} + M_{rot} + M_{NLT} + M_E$