2.8 Drive power

2.8.1 Friction

Linear guides basically consist of a carriage a rail and rolling elements that move between the tracks of the carriage and the rail. A friction force F_R occurs, as with any movement (Figure 2.24). The friction coefficient (μ) is mainly affected by the following factors:

> Load (F)
> Preload
> Osculation
> Design principle (circular arc groove or Gothic arc groove)
> Rolling element shape
> Material combinations in the runner block
> Lubricant

The stick-slip effect at start-up, so familiar with sliding guides, hardly occurs.

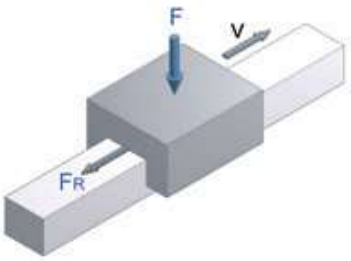
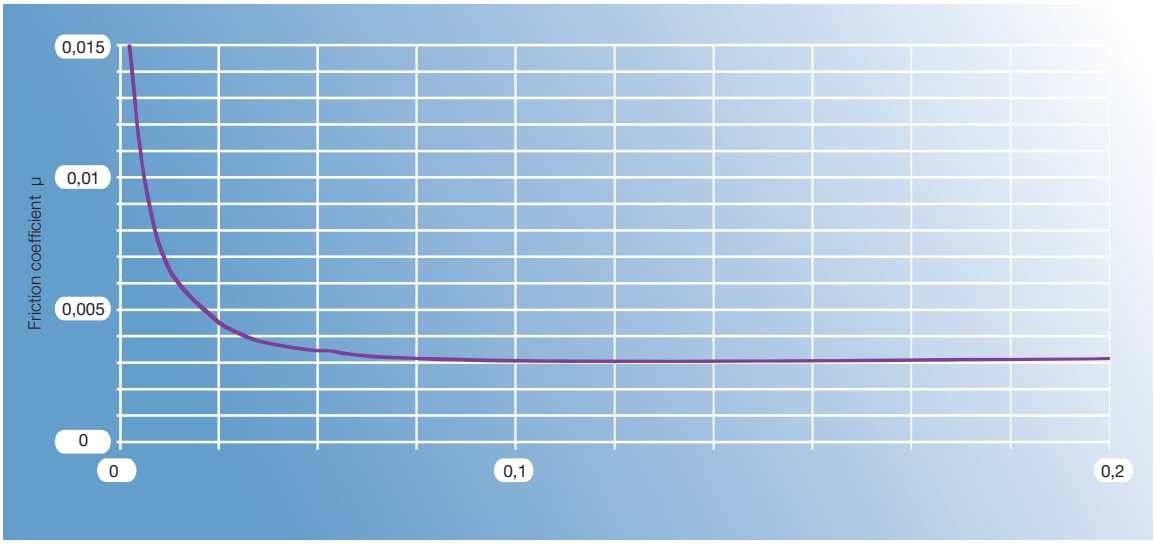


Figure 2.24 Friction force

Figure 2.25 Ratio of load / friction coefficient of linear guides with balls



NTN-SNR linear guides with balls as rolling elements have a friction coefficient (μ) of approx. 0.003 (Figure 2.25). The forces acting on the system include internal as well as external forces. The external forces may be weight forces, process forces (e.g. milling forces) and dynamic forces (e.g. acceleration forces). Internal forces result from preload, assembly tolerances and installation faults.

The friction caused by the lubricant strongly depends on the properties of the lubricant used. Immediately after relubrication, the friction forces of a linear guide increase for a short time. After some rolling movements of the rolling elements, the optimal grease distribution of the system is again reached and the friction force drops to its normal value.

2.8.2 Driving resistance

The driving resistance of a linear guide consists of the friction force and the sealing resistance (Figure 2.26).

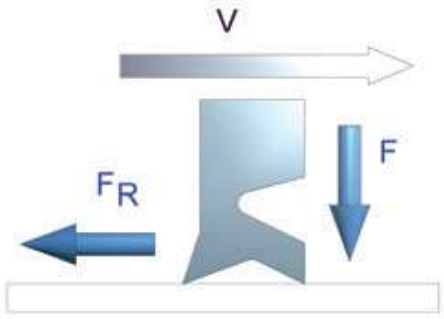


Figure 2.26 Friction force of a two-lip seal

The seal resistance is in turn dependent on the respective combination of seals used. The standard configuration of NTN-SNR linear guides includes an inner seal (not for miniature guides), two lateral seals and end seals on both sides. All seals are implemented as two-lip seals. The maximum sealing resistances are shown in Table 2.12.

Table 2.12 Maximum sealing resistances

Series	Sealing resistance N
LGB__15_S	2,0
LGB__15_N	2,5
LGB__15_L	2,8
LGB__20_S	2,9
LGB__20_N	3,7
LGB__20_L	4,1
LGB__20_E	4,7
LGB__25_S	3,9
LGB__25_N	4,9
LGB__25_L	5,5
LGB__25_E	6,1
LGB__30_S	5,0
LGB__30_N	6,0
LGB__30_L	6,6
LGB__30_E	7,2
LGB__35_S	5,0
LGB__35_N	6,0
LGB__35_L	6,5
LGB__35_E	7,2

Series	Sealing resistance N
LGB__45_N	6,9
LGB__45_L	7,4
LGB__45_E	8,2
LGB__55_N	6,9
LGB__55_L	7,8
LGB__55_E	8,2
LGM_07BN	0,2
LGM_09BN	0,3
LGM_09BL	0,4
LGM_09WN	0,4
LGM_09WL	0,5
LGM_12BN	0,7
LGM_12BL	0,8
LGM_12WN	0,8
LGM_12WL	0,9
LGM_15BN	0,9
LGM_15BL	1,0
LGM_15WN	1,1
LGM_15WL	1,2

2.8.3 Driving force

The driving force for a linear guide system (Figure 2.27) is calculated according to the following formula:

$$F_a = \mu \cdot F + n \cdot f \qquad [2.13]$$

F_a: Driving force [N]
μ: Friction value
F: Load [N]
n: Number of runner blocks
f: Specific movement resistance of a carriage [N]

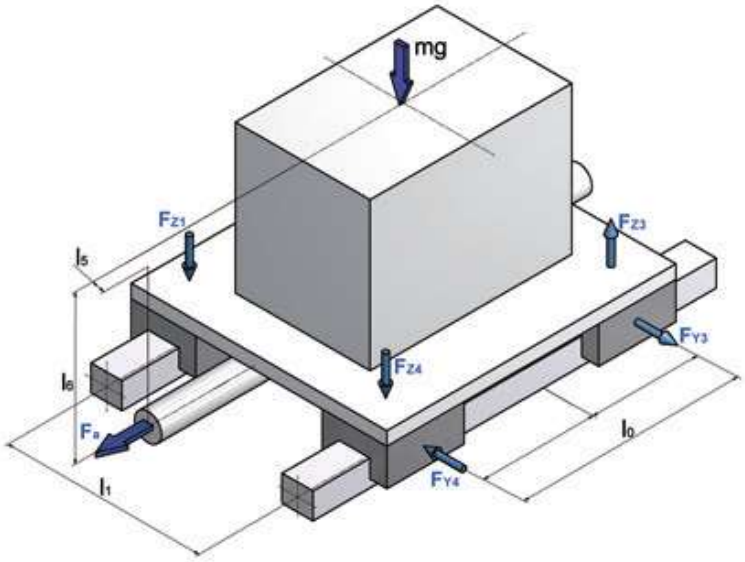


Figure 2.27 Driving force calculation

The maximum driving resistances shown in Table 2.13 result for NTN-SNR linear guides with standard sealing and greasing at room temperature and without load. This value may vary considerably when different sealing options or grease types are chosen.

Table 2.13 Driving resistances

Series	Z0 [N]	Z1 [N]	Z2 [N]	Z3 [N]
LGBC_15_S	2,9	3,3	3,7	4,1
LGBC_15_N	3,7	4,6	5,4	6,3
LGBC_15_L	4,2	5,3	6,2	7,3
LGBC_20_S	4,4	5,1	5,7	6,4
LGBC_20_N	5,8	7,1	8,2	9,6
LGBC_20_L	6,6	8,4	9,8	11,6
LGBC_20_E	7,6	9,7	11,4	13,5
LGBC_25_S	6,3	7,2	8,0	9,0
LGBC_25_N	8,3	10,0	11,7	13,5
LGBC_25_L	9,6	11,8	13,9	16,3
LGBC_25_E	10,7	13,2	15,6	18,3
LGBC_30_S	8,3	9,6	10,8	12,2
LGBC_30_N	11,1	13,6	16,1	18,9
LGBC_30_L	12,8	16,1	19,3	22,9
LGBC_30_E	14,3	17,9	21,5	25,5
LGBC_35_S	10,6	12,4	14,1	16,1
LGBC_35_N	14,3	17,9	21,3	25,2
LGBC_35_L	16,3	20,8	25,0	30,0
LGBC_35_E	18,4	23,3	28,0	33,4
LGBC_45_N	18,5	23,3	27,9	33,3
LGBC_45_L	20,7	26,4	31,9	38,3
LGBC_45_E	23,7	30,3	36,6	44,0
LGBC_55_N	22,6	28,1	33,8	40,3
LGBC_55_L	27,2	34,6	42,3	51,0
LGBC_55_E	31,0	41,1	51,5	63,3

Series	Z0 [N]	Z1 [N]	Z2 [N]	Z3 [N]
LGBX_15_S	2,4	2,9	3,3	3,7
LGBX_15_N	3,2	4,1	4,9	5,8
LGBX_15_L	3,6	4,7	5,6	6,7
LGBX_20_S	3,8	4,5	5,0	5,7
LGBX_20_N	5,0	6,4	7,5	8,8
LGBX_20_L	5,8	7,5	9,0	10,7
LGBX_20_E	6,6	8,7	10,4	12,5
LGBX_25_S	5,5	6,4	7,2	8,2
LGBX_25_N	7,4	9,1	10,7	12,6
LGBX_25_L	8,5	10,7	12,8	15,2
LGBX_25_E	9,5	12,0	14,4	17,1
LGBX_30_S	7,4	8,6	9,9	11,2
LGBX_30_N	10,0	12,6	15,0	17,8
LGBX_30_L	11,6	14,9	18,1	21,7
LGBX_30_E	12,9	16,6	20,1	24,1
LGBX_35_S	9,5	11,3	13,0	15,0
LGBX_35_N	13,0	16,6	20,0	24,0
LGBX_35_L	14,9	19,4	23,6	28,5
LGBX_35_E	16,8	21,7	26,4	31,8
LGBX_45_N	16,9	21,6	26,3	31,7
LGBX_45_L	18,8	24,5	30,0	36,4
LGBX_45_E	21,6	28,2	34,5	41,9
LGBX_55_N	20,6	26,1	31,7	38,2
LGBX_55_L	24,8	32,2	39,8	48,6
LGBX_55_E	28,2	38,3	48,7	60,5